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PRENATAL TESTOSTERONE, PERSONALITY, AND ECONOMIC BEHAVIOR

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tot het behalen van de graad
van Doctor in de Toegepaste
Economische Wetenschappen
door

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Daar de proefschriften in de reeks van de Faculteit Economische en Toegepaste Economische Wetenschappen het persoonlijke werk zijn van hun auteurs, zijn alleen deze laatsten daarvoor verantwoordelijk.

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INTRODUCTION

"Man with all his noble qualities, with sympathy which feels for the most debased, with benevolence which extends not only to other men but to the humblest living creature, with his god-like intellect which has penetrated into the movements and constitution of the solar system - with all these exalted powers- Man still bears in his bodily frame the indelible stamp of his lowly origin."

Charles Darwin

In this dissertation, I argue for an integration of an evolutionary and more general biologically inspired psychological approach into traditional consumer behavior research. I argue that this may yield a better understanding of a diverse set of consumer phenomena and economic behavior in general. Darwinian principles are nearly non-existent within the consumer behavior discipline (Saad 2006). However, evolutionary inspired psychological research might bring additional value to traditional research in consumer behavior. While traditional consumer behavior research seeks to explain consumer phenomena at the proximate level, evolutionary psychology looks into the ultimate causes of behavior. *Proximate* causation tries to explain behavior based on trigger stimuli and internal mechanisms, whereas *ultimate* causation points to the evolutionary function of that behavior: “why” was this specific trait favored by natural selection. To illustrate the difference between both types of causation, consider the strong disposition to prefer sweet food. The *proximate* cause of sweetness is a biological system that links sweetness to the pleasure center of the brain which reinforces the behavior leading to the perception of sweetness, thus not because we think it will help us survive and reproduce. The *ultimate* cause of human preference for sweetness, however, is the caloric value of sugar. The fitness of our ancestors was maximized by eating sweet food: A sweet tooth (a tendency to eat all the sugar we can get) arose because sugar was important because of its caloric value and thus for energy acquisition, hence survival and reproduction. The health threats that come with over-consumption today are a modern phenomenon because sugar was rare in our EEA¹. Over evolutionary time, proximate and ultimate causation are linked: natural selection favors proximate mechanisms that produce maximizing behavior (Burnham 2003). So, ultimate explanations (i.e. the evolutionary origins

¹ EEA or “environment of evolutionary adaptiveness” : The past environment in which current adaptations were designed by natural selection (Gaulin & McBurney 2004, p. 376)

behind a phenomenon) are not meant to replace proximate ones nor is one superior to the other. However, both levels of explanation are valuable (or even necessary) to get a better understanding of a diverse set of phenomena. Therefore, we agree with the viewpoint that evolutionary origins of consumer (e.g. Saad & Gill 2000) and economic behavior (e.g. Robson & Kaplan 2006) should get attention.

However, not only an evolutionary inspired approach, focused on ultimate causation, may add to the field of consumer research. In a broader sense, up to now every biological inspired type of research has been neglected in the field. I performed a search on all 1329 abstracts of the leading journal in the field, *Journal of Consumer Research*, spanning the period 1974-2006 (catalogued by Cambridge Scientific abstracts on PsychInfo). Not one of the words ‘hormones’, ‘hormonal’, ‘testosterone’, ‘genetic’, ‘gene’ or even ‘biology’ and ‘biological’ was mentioned in a single abstract. When an interested reader thoroughly studies papers in the field, he would not have any indication that the research also goes about a ‘being’ that is influenced by fundamental biological mechanisms, such as e.g. hormonal actions in the body. This denial of the role of biology in human behavior is widespread. Nevertheless, there is no doubt that our biological make-up makes possible everything we do and sets boundaries to all things we could possibly do.

Summarized, an ultimate, biologically inspired approach covers the general theme of my dissertation and tries to point to its potential value and to the importance of this type of research in traditional consumer behavior research and in the study of economic behavior in general. The first part is concerned with the potential of a specific biological theory, costly signaling theory, to augment our understanding of certain consumer phenomena. The second part adopts a biological marker for prenatal testosterone levels in which I try to document its value in understanding economic or consumer behavior. More specifically, I focus on costly signaling theory throughout the first section of my dissertation (manuscripts I and II) and on the so-called second to fourth digit ratio (2D:4D) as a marker of prenatal testosterone levels in the second section of my dissertation (manuscripts III, IV and V).

SECTION I:

A COSTLY SIGNALING PERSPECTIVE

INTRODUCTION

The purpose of the present research is to investigate altruistic behavior (manuscript I) and non-conformist consumer behavior (manuscript II) from a costly signaling framework. Costly signaling theory (Grafen 1990; Zahavi 1975, 1997) deals with the problem of how an agent may honestly signal an unobservable quality to others. Agents (e.g. people or firms) have qualities that are partially concealed, while simultaneously being valuable to others. These qualities can be very diverse, such as e.g. economic status, or abilities. To avoid that everyone can afford to display the signal, the signal needs a quality-dependent cost. Otherwise, agents lacking this quality may imitate the signal. Quality dependence of the cost reflects that the cost is smaller for agents who possess the quality than for agents who lack it. As the behaviors are costly, those displaying these behaviors give useful information to others about themselves (Bliege Bird & Smith 2005; McAndrew 2002). For example, being able to purchase a Picasso painting and to expose it in your living room (signal) implies that you must be very wealthy (quality). Signaling enormous wealth in a reliable way therefore requires an extreme financial cost. The cost and the quality are inherently related to each other. As a result, only the ‘high quality’ types can afford the cost that the signal entails (Gintis, Smith & Bowles 2001). When very costly (seemingly irrational) behavior signals a highly appreciated characteristic of the actor, this costly behavior itself may lead to reputational benefits for the signaler. As a consequence, the (in first instance) costly behavior is no longer that irrational. As, a century before Zahavi, Veblen (1899) pointed out: one has to ‘waste’ to show his wealth, reputation is ‘deserved’ by excesses. Exactly this cost structure gives costly behavior an irrational appearance. Although we gave the example of extreme wealth, extensive modeling and empirical studies have demonstrated that any behavior can, in theory, function as a costly signal when the above-mentioned conditions are met (McNamara & Szent-Imrey 2007). Nevertheless, costly signaling theory has also only very recently begun to influence research in psychology (Griskevicius et al. in press). Accordingly, a costly signaling framework has not been adopted before to study consumer-to-consumer signaling.

A first focus of my research is directed to unconditional altruism, a behavior from which the cost is obvious. Consumers give something away in return for nothing, so the net result is a loss. There is theoretical evidence that altruism may function, under certain conditions, as a costly signal (e.g. Gintis, Smith & Bowles 2001; Lotem et al. 2002; Roberts et al. 1998; Zahavi 1995). A first step to identify a certain behavior as a costly signal lies in the illustration of an association with a plausible underlying quality. However, up to now there is almost no evidence what the underlying characteristic of the altruistic actor could be. In the first manuscript I propose that altruistic behavior may serve as a signal of general intelligence (a highly valued characteristic in e.g partner choice, Li et al. 2002). After all, general intelligence is a predictor of future resources (see e.g. Gottfredson 2004; Kanazawa 2004) and as a consequence the cost of generosity is lower for highly intelligent persons. Therefore highly intelligent people may expect to regain the drained resources in the future. Accordingly, we show that general intelligence and altruism are related to each other.

The second manuscript aims to apply the costly signaling framework to non-conformist consumer behavior. The proposition is that non-conformist consumer behavior might also serve as a costly signal of general intelligence. We first argue that non-conformity can be considered as costly behavior. Non-conformist behavior may threaten the belongingness to a social group, or has the potential of enlarging the psychological distance from others. People who deviate from the group are more likely to be punished, ridiculed, or even rejected by other group members (Griskevicius et al. 2006). In human's ancestral environment acquiring resources in isolation was more difficult than in groups (Baumeister & Leary 1995). Prospects for isolated people were rather grim. Therefore, the need to belong may, through the motivation to secure the acquisition of resources, reduce people's inclination to follow their own preferences if these lead to non-conformist behavior. However, as general intelligence is a strong predictor of future resources (Gottfredson 2004; Kanazawa 2004), the more intelligent someone is, the less this person depends on the group to acquire resources. This means that highly intelligent people can afford more non-conformist behavior because of their capacity to secure resources in isolation. Therefore, in the second manuscript we propose and investigate the hypothesis that as general intelligence increases the emotional cost of non-conformist consumer behavior and the need to conform to group norms decreases.

MANUSCRIPT I:

**ALTRUISTIC BEHAVIOR AS A COSTLY SIGNAL
OF GENERAL INTELLIGENCE²**

ABSTRACT

Unconditional altruism is an enduring puzzle for evolutionary approaches to social behavior. In this paper we argue that costly signaling theory, a well-established framework in biology and economics, may be useful to shed light on the individual differences in human unconditional altruism. Based on costly signaling theory, we propose and show that unconditional altruistic behavior is related to general intelligence. The cost incurred by engaging in unconditional altruism is lower for highly intelligent people than for less intelligent people because they may expect to regain the drained resources. As a result, unconditional altruism can serve as an honest signal of intelligence. Our findings imply that distinguishing altruistic behavior from cooperative behavior in social psychological and economic theories of human behavior might be useful, and that costly signaling theory may provide novel insights on various individual difference variables.

² This manuscript is adapted from Millet, K., & Dewitte, S. (2007). Altruistic behavior as a costly signal of general intelligence. *Journal of Research in Personality*, 41, 316-326.

1.1 INTRODUCTION

Altruistic behavior is difficult to reconcile from a Darwinian perspective. A behavior that reduces an individual's fitness cannot survive the selective forces of natural selection. As altruism appears to reduce an individual's fitness, natural selection seems to predispose individuals to selfishness (Williams 1992). Individuals need resources to survive and reproduce, therefore finite resources imply competition. Incurring a cost to help another organism does not seem to fit in the strict Darwinian framework. Many theories explaining various types of cooperation have been proposed in biology and economics (Fehr & Fischbacher 2003; Gurven 2004) but a theoretical explanation of *unconditional* altruism (defined as benefiting others at a cost to oneself, Wilson 1976) has remained elusive to date.

The purpose of the present investigation was to provide a first step towards establishing the potential of costly signaling theory for increasing our understanding of altruistic behavior. In essence, we propose that altruistic behavior may serve as a costly signal of general intelligence. Before describing the specific studies, it may be helpful to review costly signaling theory. Costly signaling theory (CST; Grafen 1990a&b; Zahavi 1975, 1997) explains how individuals use costly behaviors to convey information about themselves. People may differ in the qualities that they possess, such as economic status or certain skills. These qualities may be partially concealed, while simultaneously being valuable to others. For instance, potential partners prefer an actor possessing a certain quality to an actor not possessing it. As a result, actors possessing an unobservable but desirable quality have an incentive to signal their quality to perceivers because perceivers are more likely to select them as a partner if they know their true type. However, actors *not* possessing the quality have an incentive to mimic the signal. Costly signaling theory provides a framework that explains how signals can be transmitted in a reliable way. Signal reliability is secured by making the signal costly and the signal-cost quality-dependent (Zahavi & Zahavi 1997). Quality-dependence of the cost reflects the characteristic that the cost is smaller for individuals possessing the quality than for agents lacking it. Only those possessing the quality can afford the quality-dependent cost that the signal entails. As a consequence of the quality-dependent cost structure, the perceiver of the signal can be confident that the signaling actor has the underlying quality. For example: the purchase of a very expensive (i.e. the cost) piece of art provides the reliable

information that the buyer is very wealthy (i.e. the quality). After all, someone lacking a huge amount of resources is simply not able to waste money on this kind of luxury product.

1.2 COSTLY SIGNALING THEORY AND ALTRUISM

The statement that altruism may serve as a costly signal has received theoretical support in anthropology, biology, and economics (e.g. Boone 1998; Gintis, Smith & Bowles 2001; Lotem, Fishman & Stone 2000; Roberts 1998; Gurven 2004). Empirical support for the theory is beginning to emerge. Anthropological fieldwork (in a Meriam community, living on islands off the northeast tip of Australia) investigated the typical profile of men who provided turtles for a feast, which is considered as an altruistic act because it is costly for the providers (Bliege Bird, Smith & Bird 2001). The research showed that success at hunting (and hence the ability to provide the feast) depends on several qualities of the hunter such as his environmental knowledge, strength, leadership skills, and organizational skills. As the amount of food that a hunter can provide is reliably related to these skills, altruism may serve as a costly signal of those underlying abilities (Bliege Bird et al. 2001; Smith & Bliege Bird 2000). Additionally, experimental work has shown that participants may compete by means of altruism to signal trustworthiness (Barclay 2004).

Altruistic behavior is costly by definition. However, it is less clear what quality altruistic behavior might be related to. Although unequivocal evidence for the link is still missing, some authors mentioned the possibility that altruism is related to intelligence and others reported data that seem consistent with our claim. We now turn to a brief review of that literature. As mentioned above, Bliege Bird et al. (2001) found that some men of the Meriam spend their time turtle-hunting, which requires specific valued skills of the hunter. As hunting turtles is a relatively costly way of collecting food, it may serve as a costly signal of underlying qualities. Bliege Bird et al. (2001) proposed that problem solving ability as one underlying quality that is needed to be successful at hunting: Hunters with higher cognitive skills should be more successful at capturing turtles as they know better where they can find turtles, how exactly to catch them, etc. Providing turtles for a feast (an altruistic act) may serve as a signal for this underlying quality as the lower quality hunters are expected to fail more often on a hunt than high-quality individuals and as a consequence would not have the same success in providing turtles. Accordingly, unpublished data by Dewitte and De Cremer

(2005) showed that students who had contributed much to group assignments had higher grades than those who contributed their fair share or less than their share. Furthermore, Van Vugt, Roberts and Hardy (2007) recently suggested that altruism might signal intelligence as it may take brainpower to appreciate the long-term benefits of cooperation. In addition, Glazer and Konrad (1996) provided evidence that alumni's sponsoring of their former college qualifies as a costly signal of wealth. As children's intelligence predicts later socio-economic success better than parents' attributes (Gottfredson 1994), Glazer and Konrad's finding is consistent with our claim that altruism and IQ are related. We assume that intelligent people are better able to acquire resources. As a consequence, donating part of these resources is relatively less costly for highly intelligent people even before these resources are acquired. Our claim that altruism is a costly signal of the underlying quality intelligence led us to predict a relationship between intelligence and altruism.

1.3 STUDY 1

We hypothesize that someone who is acting altruistically is more intelligent than someone acting cooperatively or egoistically. However, in typical public good games altruism and cooperation are indistinguishable. Either players can choose from only two options (cooperation or not), or giving more than the appropriate amount (i.e. altruistic act) does not make much sense. Millet and Dewitte (2006) slightly adapted the public good game in such a way that cooperative and altruistic behavior can be differentiated. We adopt the same methodology in this study.

1.3.1 Method

One hundred seventy-six undergraduates at a large European University (60 women and 113 men) aged between 18 and 27 year participated. The monetary reward depended on their performance (minimum of 5 euro).

We organized a repeated public good game with four players, similar to the procedure by Millet and Dewitte (2006). Decisions were made simultaneously and involved contributing a certain amount to the provision of a public good. At the beginning of each round, all

participants received an endowment of 40 points. In each round, they had to decide how much of the endowment they would invest in the public good or keep for themselves. Every point was worth 3.39 eurocent. All the points that were invested, were subtracted from their 40 points endowment. If the good was obtained (100 points, i.e. the provision point), 160 points were distributed equally across the four players in that round, irrespective of individual contributions.

Upon arrival, each participant was assigned to a computer in a partially enclosed carrel. Participants neither saw nor talked to each other. They believed that they played a game involving six people, but in reality they played against the computer. Participants were told that four of the six participants were players in the game, and that two others were observers of the game. The observers did not play themselves. They were told that the roles of player and observer could change during the game. All participants started, allegedly by random selection, as an observer. They twice observed that the good was not obtained. The shortage was 5 (out of 100) points in the first round and 2 points (out of 100) in the second. They did not receive information about individual contribution levels. After the first two rounds, participants replaced one person in the game and decided how much they invested in the public good. As the group had twice failed to reach the public good, the third round was a very uncertain situation in which the outcome was highly unpredictable. We distinguished three behavioral categories, defined in relation to the fair contribution level of 25 points, i.e. the provision point divided by the number of players. Participants could contribute either exactly (i.e. cooperative decision), less (i.e. egoistic decision), or more than the fair share (i.e. altruistic decision). We measured participants' decisions (cooperative, egoistic or altruistic) in the first round that they played (i.e. the third round of the game). The game ended after the third round.

1.3.2 Measures of General Intelligence

Approximately 20 minutes after the game, participants received a computerized short-version of Raven Advanced Progressive Matrices IQ - test (RPM) (adapted from Verguts and De Boeck 2002). They had to solve as many problems as possible in 15 minutes. A recent review showed that the RPM-test is one of the best measures of general intelligence (Gray & Thompson 2004). We predict a higher score on this test for the altruists than for the others.

Additionally, participants were assessed on a simple (SRT) and four-choice (CRT) reaction time task before the game. The procedure was similar to that used by Deary, Der and Ford (2001), except for the fact that our task was administered on computer. In SRT, digits were presented with varying interstimulus intervals (1-3 s) and participants had to press an assigned key as fast as possible. In CRT, one of four possible digits was presented with varying interstimulus intervals (1-3 s). Each digit was linked to one key. Participants had to press the corresponding key as fast as possible when a digit was presented. Each digit appeared 10 times in randomized order. Eight practice trials were presented before the actual reaction time task. There were 20 trials for the SRT and 40 for the CRT task. Means and standard deviations were obtained for both tasks, based on correct responses only. Because CRT is more strongly related to intelligence than SRT in the high range of the IQ continuum (Der & Deary 2003), we predicted the relation of altruism with CRT to be stronger than with SRT (as our sample consists of university students).

1.3.3 Results and discussion

Four participants were not considered for analysis because they did not comply with instructions. Of the remaining 169 participants 68 acted egoistically (42 men, 26 women), 59 cooperatively (41 men, 18 women) and 42 altruistically (26 men, 16 women). A two (Sex) by three (Public Goods Choice) factorial Anova revealed that RPM score ($M = 30.46$, $SD = 7.22$) was significantly affected by a main effect of Public Goods Choice ($F(2, 163) = 3.27$, $p < .05$, $\eta^2 = .04$). Altruists ($M_{altruistic} = 33.07$, $SD_{altruistic} = 6.80$) scored higher on the RPM than egoists ($M_{egoistic} = 29.84$, $SD_{egoistic} = 7.08$; $p < .07$) and cooperators ($M_{cooperative} = 29.32$, $SD_{cooperative} = 7.33$, $p < .02$) (see Figure 1.1). There was no difference between egoists and cooperators ($p = .38$).³

³ Consistent with Abad, Colom, Rebollo, and Escorial (2004) we found that men scored significantly higher than women ($F(1, 163) = 7.54$, $p < .01$), presumably because of the test's visuo-spatial nature. No other significant effects emerged (p 's $> .10$).[0]

FIGURE 1.1

RPM-score as a function of public goods choice.

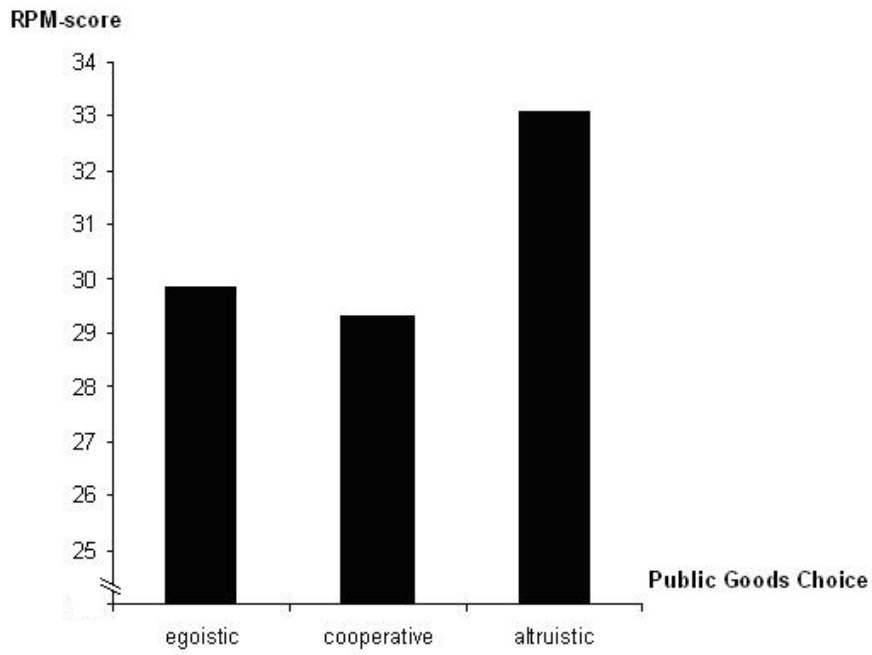
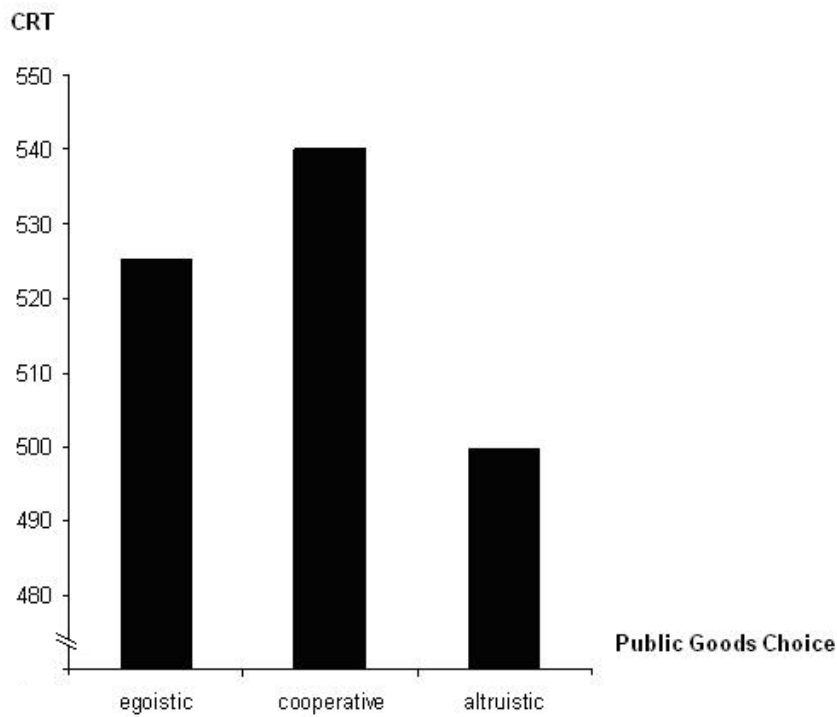


FIGURE 1.2

Choice Reaction Time as a function of public goods choice.



The analogous analysis showed a significant effect of Public Goods Choice on CRT ($M = 524.03$, $SD = 74.38$; $F(2, 163) = 3.26$, $p < .05$, $\eta^2 = .04$). Altruists ($M_{altruistic} = 499.74$, $SD_{altruistic} = 79.10$) reacted faster than egoists ($M_{egoistic} = 525.14$, $SD_{egoistic} = 63.11$; $p < .04$) and cooperators ($M_{cooperative} = 540.03$, $SD_{cooperative} = 79.45$; $p < .02$) (see Figure 1.2). There was no difference between egoists and cooperators ($p = .62$). Sex did not have any effect. No other significant effects emerged (all p 's $> .10$). For SRT, no effect emerged ($F(2, 163) = 0.66$, $p = .517$).

This study shows that those people opting to behave altruistically in the public good game were more intelligent, as measured by two well-established but relatively independent measures of general intelligence (relation between both: $r = -.14$, $p = .07$). The fact that the simple reaction time was not faster among altruists, rules out the possibility that altruists were just more motivated to help the experimenter.

1.4 STUDY 2

To rule out the concern that the altruistic choice in the public good situation may partially result from self-interested motives, we conducted a follow-up study to investigate the link between a genuine pro-social motivation and general intelligence as measured by the RPM. We adapted Van Lange, Otten, De Bruin, and Joireman's (1997) Social Value Orientation measure and added a fourth option to each choice situation that reflected the altruistic option. That option maximizes joint outcome rather than own outcome (see also Eek & Gärling 2005).

1.4.1 Method

One hundred twenty-five undergraduates at a large European University (80 women and 45 men) aged between 17 and 28 year participated in exchange for a participation fee. Standard instructions were given that valuable points had to be distributed between oneself and an other person. One had to imagine that the other person was someone they had never met and that they would never meet again. Afterwards participants got nine different choice situations (see Appendix A). These situations were similar to the following one:

	A	B	C	D
You get	500	500	550	500
The other gets	100	500	300	550

Alternatives A, B and C are identical to the options in the items of the original Social Value Orientation measure of Van Lange et al. (1997). Option *A* maximizes the difference between oneself and the other (competitive); option *B* minimizes the difference between oneself and the other (equal-outcome prosocial or ‘cooperative’) and option *C* maximizes the own outcome with disregard for the other’s outcome (individualistic). We added option *D*, where the joint outcome is maximized at the cost of inequality in the advantage of the other (joint-outcome prosocial or ‘altruistic’). This last option is similar to the one adopted by Eek and Gärling (2005). Our extended version was preprogrammed on computer and for each choice situation (9 in total) we asked participants to rank order the attractiveness of the four alternatives (1 = most attractive; 4 = least attractive option). Afterwards we summed the nine ranks for each of the four social motives and reversed the scores for clarity, so that high scores mean high levels of the motive. In that way we obtained values for 4 different variables that we called altruistic (cfr. *D*), cooperative (cfr. *B*), individualistic (cfr. *C*), competitive (cfr. *A*).

1.4.2 Results and discussion

Scores on the altruistic variable were separated into three groups based on the lower (below percentile 33.3), middle and upper (above percentile 66.6) thirds of the distribution. Two participants were not considered for analysis because they did not comply with instructions. In line with literature, we focused only on the ‘high’ and ‘low’ altruistic group and left out the middle group for analysis (see e.g. Giesler et al. 1996). Therefore, 78 participants remained for statistical analysis. In line with our hypothesis, we found that the RPM score ($M = 29.62$, $SD = 5.58$) was higher for the high than for the low altruistic group ($M_{\text{high}} = 30.90$, $SD_{\text{high}} = 5.43$; $M_{\text{low}} = 28.36$, $SD_{\text{low}} = 5.57$; $F(1, 74) = 4.34$, $p < .05$, $\eta^2 = .06$). There was no effect of gender nor of the interaction between gender and altruistic group (all p 's $> .10$). In a similar manner we distinguished between a high and low group on the individualistic, cooperative and competitive variables. Raven IQ-scores did not differ between

the high and low groups for the individualistic and cooperative variables (all F 's < 1). However, we found that the average raven-IQ score was marginally higher for the low than for the high competitive group ($M_{high} = 28.28$, $SD_{high} = 5.82$; $M_{low} = 29.93$, $SD_{low} = 4.55$; $F(1, 79) = 5.23$, $p < .08$, $\eta^2 = .04$).

In this study, we found evidence for a positive relationship between intelligence and a genuine pro-social motivation, namely maximizing the joint outcome even at the cost of inequality in the advantage of the other. This motivation is very similar to the altruistic behavior in study 1 because in that situation, giving more than the fair share implies giving more than most others, and hence ending up with less than the others. We found no relation between intelligence and the traditional normative pro-social motivation, namely minimizing differences between contributors (Van Lange et al. 1999). We also found no relation between intelligence and the individualistic orientation, which is inconsistent with the explanation of the results of study 1 in terms of self-interest. Instead, we found a slight *negative* relationship between intelligence and self-interested motivations that maximize the relative advantage at the cost of the joint outcome.

1.5 DISCUSSION

The results of these studies show consistent support for the positive relationship between intelligence and altruistic behavior. In the first study, we found that those who contributed more than their fair share to a public good were more intelligent, as measured by two relatively independent measures of general intelligence. In the second study, we showed that those who possess a dispositional tendency to value joint benefits more than their own, scored higher on an intelligence test. The evidence presented supports the possibility that unconditional altruism may serve as a costly signal of general intelligence because altruism is costly and is reliably linked to the quality 'general intelligence'. Consistent with the finding that children's intelligence predicts later socio-economic success better than parents' attributes (Gottfredson 1994), we assume that intelligence is an indicator of future resources. As a consequence, someone with high cognitive skills may be able to donate more in advance than someone with lower skills. As such, the cost of altruistic behavior could be quality-dependent. This finding and the theoretical approach we provide opens up various avenues for future research.

First, the role of altruism in mate selection should be further explored. Pro-social behavior in men appears to be a desirable trait for women (Jensen-Campbell, Graziano, & West 1995). Intelligence also seems to be one of the most important criteria for both genders in choosing partners (Li, Bailey, Kenrick & Linenmeier 2002). Future research may look at whether altruism is a desirable mate characteristic for its own sake (e.g. predicting care), whether it is attractive because it signals intelligence, or both. Second, our theoretical approach focused on the ultimate cause of the relation between general intelligence and altruistic behavior. However, the proximate cause of the link between general intelligence and altruism is not clear until now. Our second study already suggests that general intelligence is related to a genuine pro-social motivation. These motives may trigger emotional reactions to an opportunity to act altruistically, such as empathy or feelings of responsibility which may lead to the altruistic act itself. It is also possible that high levels of intelligence allows people to take a broader perspective on their decisions (Vallacher and Wegner 1987). This may help them go beyond the pursuit of immediate gratification, which often coincides with egoistic behavior (Dewitte & De Cremer 2001). Third, the search for proximate causes points at the possible role of intervening variables. Leadership is a possible candidate. Van Vugt (2006) reviewed evidence showing that generosity and leadership are related and that leaders' social skills are better developed than those of followers. Moreover, Bass (1990) reviewed evidence that intelligence and leadership are positively related. Combined with these insights, our data point at an interesting possibility: general intelligence may explain part of the relation between leadership and generous behaviors.

Finally, we submit the hypothesis that altruism may be a costly signal of general underlying fitness, including not only intelligence but also leadership status and health. Remarkably, leadership and health are associated: leaders's health is better than that of followers (Van Vugt 2006). In addition, Brown et al. (2003) found that providing support to the spouse, friends, relatives and neighbors predicted mortality in a sample of married elderly: those giving support had lower mortality risk (controlled for current health and degree of support received). Although the authors concluded that providing support to others benefits health, their data are also consistent with the costly signaling framework: providing support may be a costly signal of fitness. Several recent lines of research indeed support the suggestion that intelligence may be closely linked to general fitness. First, a link between general intelligence and longevity was shown by Deary and Der (2005). This link was found

for two diverse measures of intelligence: A reaction times task and a classical psychometric intelligence test, and did not depend on social class, education, or smoking status. Second, Prokosch et al. (2005) recently showed that body symmetry - a general fitness indicator – is also positively related to scores on a Raven Progressive Matrices Test. In their vision, general intelligence and body symmetry tap into an underlying “fitness factor” and this underlying fitness indicator may explain the relation between intelligence and longevity among others. So, the findings of Prokosch et al. (2005) may suggest a positive relationship between general fitness indicators (different from general intelligence) and altruism. In that way, altruistic behavior may serve as a general fitness indicator and not only as indicator for general intelligence.

MANUSCRIPT II:

NON-CONFORMIST CONSUMER BEHAVIOR AS A COSTLY SIGNAL OF GENERAL INTELLIGENCE

ABSTRACT

We claim that non-conformist consumer behavior may serve as a costly signal of general intelligence. We suggest that the cost that accompanies non-conformist consumer behavior is lower for highly than for less intelligent consumers. This has three testable implications. First, people should perceive non-conformist consumer behavior as a sign of intelligence. Second, highly intelligent consumers should suffer less emotionally from incidental non-conformity. Third, non-conformity as indicated by trait measures of unconventionality or actual consumer choices should be positively correlated with general intelligence. Data from four studies confirmed all of these predictions.

1.1 INTRODUCTION

Albert Einstein's wife often suggested that he dress more professionally when he headed off to work. "Why should I?" he would invariably argue. "Everyone knows me there." When the time came for Einstein to attend his first major conference, she begged him to dress up a bit. "Why should I?" said Einstein. "No one knows me there!"(Ehlers, 1994). Remarkably, arguably the smartest person of the last century did not like to conform to the rules.

Looking around us, we observe a variety of non-conformist behavior. Some people wear extravagant clothes, some use solar energy, buy the strangest stuff or the newest peculiarities, others use dated products when better alternatives are readily available at a low price. What these behaviors have in common is the fact that they diverge from the consumption norm. They all reflect activities that the majority of people would not engage in in the same consumption situation. In this paper, we provide an integrating framework for this diverse set of consumer behaviors. We approach these behaviors with costly signaling theory, which was independently developed in economics and biology during the seventies (Nelson 1974; Spence 1973; Zahavi 1975). We first review costly signaling theory and subsequently apply it to non-majority consumption behavior. We refer to this type of consumer behavior as "*non-conformist behavior*", and we define it as any consumer behavior that moderately differs from the consumption norm in someone's direct social environment without being extremely abnormal. We next derive a set of testable hypotheses and report four studies that support the predictions.

1.2 COSTLY SIGNALING THEORY

Costly signaling theory (Grafen 1990; Zahavi 1975, 2003) deals with the problem of how an agent may honestly signal an unobservable quality to an audience. From our perspective, we define a signal as a perceivable behavior that points to an otherwise not directly perceivable quality in the signaler. Agents (e.g. people or firms) have qualities that are partially concealed, while simultaneously being valuable to others. These qualities can be very diverse, including economic status, skills, or abilities. To avoid that everyone can afford

to display the signal, the signal needs a quality-dependent cost. Otherwise, agents devoid of this quality may be tempted to imitate the signal. Quality dependence of the cost reflects that the cost is smaller for agents who possess the quality than for agents who lack it. For instance, buying Pollock's Number 5 (the most expensive painting in the world, sold for 140 \$ dollar) may serve as a costly signal of wealth because it shows that the buyer has so much money that he can waste a lot of it on non-essential goods or activities (cfr. Veblen 1957). Only extremely wealthy people can afford to do so. Thus, the signal is honest because only the ones who possess the quality can afford the associated quality-dependent cost. The cost of extremely expensive goods is too high for those devoid of the quality, in this case wealth. Therefore, the perceiver of the signal can be confident that the signaling agent truly has the underlying quality.

This mechanism has been applied to different types of business-to-consumer signaling (e.g. Boulding and Kirmani 1993; Kirmani 1990; Kirmani 1997; Kirmani and Rao 2000; Kirmani and Wright 1989; Rao, Qu and Ruekert 1999). For instance, warranty has been identified as a signal of product quality to the consumer. After all, firms selling low-quality products will face higher repair costs for the same level of warranty because low-quality products are likely to require more frequent repairs. As a consequence, low-quality firms will self-select a strategy that offers relatively poor warranties. Therefore, rational consumers can infer unobservable quality from the level of warranty coverage (Kirmani and Rao 2000). In this paper we focus on consumer-to-consumer rather than on business-to-consumer signaling. Our paper focuses on non-conformist consumer behavior as a costly signal of general intelligence. We claim that a consumer who engages in non-conformist behavior incurs a cost. We further claim that this cost is dependent on the consumer's level of general intelligence. Specifically, we submit the hypothesis that the cost associated with behaving in a non-conformist way is smaller for highly than less intelligent consumers. As a result, non-conformist behavior may serve as a signal of a high level of general intelligence.

We now turn to literature on conformity, and argue that non-conformity entails a cost that is psychological in nature (i.e. the 'social pain' or the 'pain of standing alone', see below). Afterwards, we argue why this cost may be smaller for highly intelligent compared to less intelligent consumers.

1.3 CONFORMITY

1.3.1 Conformity and the pain of standing alone.

The conformity studies of Asch (1956) and Sherif (1936) showed that the perception of what most others are doing has a compelling influence on people's thoughts and actions. For instance, in Asch's studies, naive participants conformed often to an obviously errant group norm. This also applies to consumer choices, e.g. consumers accept information that is provided by the prevailing group standard on the quality, style of a product, etc. (Venkatesan 1966). Norms that indicate what is typical or common in a group (Cialdini, Reno, and Kallgren 1990) are important guidelines of conduct as they inform people on what to do. Norms might influence people to the extent to which they want to 'fit in' with the majority: being liked or accepted by the group is an important human motivation (Hornsey, Majkut, Terry and McKimmie 2003). Hornsey et al. (2003) stated that a minority position is aversive as people know that it can lead to hostility, disapproval, or rejection by others. In a similar vein, Baumeister and Leary (1995) pointed to the innate need to belong. They referred to an evolutionary basis for this need to belong, since the desire to form and maintain social bonds provides important survival and reproductive benefits. When the need to belong is not satisfied, strong emotional reactions are typically observed (for an overview, see Baumeister and Leary 1995). Accordingly, higher activation in the amygdala (frequently associated with negative emotions, LeDoux 2000) has recently been observed in a modified Asch paradigm when participants went against the group (Berns et al. 2005). Moreover, Eisenberger and Lieberman (2004) define *social pain* as: "the distressing experience arising from the perception of actual or potential psychological distance from close others or a social group." They have shown that the emotional pain of standing alone in a social group has a neurocognitive overlap with physical pain (Eisenberger, Lieberman and Williams 2003). Social and physical pain may rely on overlapping neural processes in the form of a common neural alarm system.

A mechanism that prevents someone from social isolation situations seems a very useful adaptation (cfr. the belongingness hypothesis by Baumeister and Leary 1995). After all, in the ancestral environment it was much more difficult to acquire resources for isolated individuals. Prospects for isolated people were rather grim. Therefore, an early detection

system that reacts to the mere *threat* of standing alone seems adaptive as well (cfr. the detection of social danger; Eisenberger and Lieberman 2004). The detection of this threat and its regulation by social pain may prevent people from breaking up with the group and as a consequence secures the acquisition of resources. Non-conformist behavior may threaten the belongingness to a social group, or has the potential of enlarging the psychological distance from others. As a result, and in line with the classic Asch (1959) and Sheriff (1936) findings, non-conformist behavior may be emotionally costly. Then, from an evolutionary perspective the question arises why non-conformist behaviors are so common. After all, someone acting in a non-conformist way is more likely to stand alone and hence to fail in acquiring sufficient resources. We draw attention to a differential psychological cost related to the situation in which one is standing alone. More specifically, we submit the hypothesis that the pain of standing alone may differ from one individual to the next.

1.3.2 The pain of standing alone and intelligence

Having argued that one of the main functions of group belongingness is the acquisition of resources, we infer that the necessity to stay in a group is lower when the ability to acquire resources is higher. Therefore, the pain of the threat to stand alone may differ as a function of this ability. After all, the better one can acquire resources, the less harmful a social isolation situation is. When a social isolation situation is less or even not harmful, the ‘social pain’ detection system (see above) should be less likely to send an alarm message, or should be characterized by a higher threshold. More concrete, this implies that a threat of social isolation should evoke fewer negative emotional reactions in those who are better able to acquire resources. There is convincing evidence that general intelligence and the acquisition of resources are related to each other: Kanazawa (2004) shows and also cites numerous other studies showing that more intelligent people obtain greater resources. Moreover, children’s intelligence predicts later socio-economic success even better than parents’ attributes (Gottfredson 2004). Therefore, we assume that high compared to less intelligent⁴ people are better able to acquire resources.

⁴In this paper we talk about ‘general intelligence’, not about ‘practical intelligence’ (see e.g. Sternberg et al. 1995), which are different constructs and only weakly related (Gottfredson 1998).

In sum, we rely on two plausible assumptions. First, isolation implies a threat to one's future prospects of acquiring resources. Second, intelligence has a strong positive influence on the acquisition of resources. Combining these assumptions leads us to the statement that the threat that isolation poses to an individual reduces with increasing levels of intelligence. Thus, whether or not one conforms to the group should evoke fewer emotional reactions in highly than in less intelligent actors. Therefore, we suggest that a non-conformist act may be reliably linked to a high level of general intelligence.

1.4 NON-CONFORMITY AS A COSTLY SIGNAL

Identifying a behavior as a costly signal of an underlying quality requires that the target behavior meets three conditions (Zahavi 1975). First, the observed behavior should be perceived as a signal of the identified underlying quality. Second, the cost has to be lower for the high than for the low quality type. Third, the behavior and the quality should be effectively related to each other. In the following section, we summarize these conditions, apply them to non-conformist behavior and derive specific hypotheses.

Condition 1. The signal is generally perceived as a signal of the underlying quality (Studies 1a,b).

The first condition that has to be fulfilled if we are to identify a behavior as a 'signal' for the underlying quality in the signaler, is the fact that it is perceived as such. Consumers emitting the signal should be perceived as being more likely to possess the quality. When people perceive non-conformity as a signal of intelligence, they should also expect that highly intelligent consumers are more inclined to act in a non-conformist way than less intelligent consumers. Therefore, applied to intelligence as the underlying quality and non-conformist consumer behavior as the signal, we outline the following hypotheses that we will test in Study 1.

H_{1A} : Highly intelligent consumers are expected to act in a less conformist way than less intelligent consumers.

H_{1B}: Consumers acting in a non-conformist way are perceived as more intelligent than consumers acting in a conformist way.

Condition 2. The signal is less costly for those possessing the quality than for those who do not (Study 2).

The second condition to be met is the *differential cost structure*: the cost of the signal is relatively lower for consumers of the high-quality type than for consumers of the low-quality type. Applied to intelligence as the underlying quality and non-conformist consumer behavior as the signal, the cost of a non-conformist act should be lower for high than for less intelligent consumers. We already argued that non-conformity may invoke strong emotional reactions for its threat of social isolation (cfr. Baumeister and Leary 1995; Eisenberger and Lieberman 2004; Eisenberger et al. 2003). Because intelligence has an impact on the acquisition of resources and as a consequence on the chance of surviving when one stands alone, we hypothesize that social isolation is less threatening for people with high levels of intelligence. This has two testable implications that we will address in study 2. First, when someone is in a social isolation situation, the valence of emotions should be related to general intelligence:

H_{2A}: In a situation in which one does not conform, mood valence is positively related to general intelligence.

Second, taken from another perspective, conformity vs. non-conformity to the group should invoke less emotional reactivity for highly than for less intelligent consumers.

H_{2B}: Emotional reactivity to a situation in which one conforms in contrast to a situation in which one does not conform is lower for highly than for less intelligent consumers.

Condition 3. The emission of the signal is actually related to the quality (Studies 3, 4).

Applied to general intelligence as the underlying quality and non-conformist consumer behavior as the signal, we predict that non-conformist consumer behavior is reliably related to general intelligence.

H₃: Non-conformist consumer choices are related to higher levels of general intelligence.

We test this hypothesis in two ways. In Study 3, we compare general intelligence levels for people choosing a traditional or a new product of a particular brand. In that study we also examine the link between a scale that measures trait unconventionality and intelligence. We expect that people with higher levels of intelligence will (a) have higher trait unconventionality scores and thus (b) be more likely to choose a new, (unconventional) product than a traditional (conventional) product. In study 4 we investigate the relationship between intelligence and trait consumer innovativeness. Assuming that both lagging and innovating is non-conformist behavior (as both are non-majority behavior), we expect that both laggards and innovators will have higher levels of intelligence than the majority because both resist the pressure of the social system (Bass 1969).

1.5 STUDY 1

The purpose of the first study is to examine how non-conformist consumer behavior is perceived. Therefore, we investigate whether people expect highly intelligent people to behave in a more non-conformist way (Study 1a) and whether people expect high levels of intelligence in people who behave in a non-conformist way (Study 1b).

Conformity is doing the way others do. We distinguish two types of non-conformist behavior: action and inaction. Non-conformist *action* is distinguishing oneself from others by acting in a way that is different from the way others typically act in a certain consumption situation, for instance, ordering pancakes after dinner, while no one else is doing so. In contrast, non-conformist *inaction* is distinguishing yourself from the others by not doing what others typically do in a certain consumption situation, for instance, *not* ordering pancakes after dinner, although everyone else is doing so. We operationalize non-conformist behavior accordingly in this study. We do not make an a priori distinction between both types of non-conformity. We predict that both types of non-conformity will be perceived as more intelligent than conformist behavior.

1.5.1 Study 1a

Participants and method. Forty-four participants (23 men; 21 women) aged between 17 and 24 years old ($M = 20.32$, $SD = 1.64$) participated in exchange for course credit. They received a one-sentence description of a seventeen year old boy (Gert) who was either a) very intelligent, or b) not intelligent at all (between subjects factor ‘intelligence’). Afterwards, they rated the probability on a 7-point Likert scale (1: not likely at all; 7: very likely) that Gert is a) going to a movie that everyone else wants to see (conformity), b) going to a movie that nobody else wants to see (non-conformist action), or c) not going to a movie that everyone else wants to see (non-conformist inaction). These three measures reflect the within subjects factor ‘conformity’.

Results. A mixed model ANOVA with gender, intelligence and conformity revealed the expected interaction between intelligence and conformity ($F(2, 80) = 35.06$, $p < .001$, $\eta^2 = .47$). Participants assessed the probability that Gert would go to a movie that everyone else wants to see (conformist option) higher in the ‘not intelligent at all’ ($M_{not} = 6.13$, $SD_{not} = 1.19$) than in the ‘highly intelligent’ condition ($M_{high} = 3.62$, $SD_{high} = 1.36$), $F(1, 40) = 45.26$, $p < .001$, $\eta^2 = .53$ (see Figure 2.1). In contrast, participants assessed the probability that Gert would go to a movie that nobody wants to see (non-conformist action) higher in the ‘highly intelligent’ ($M_{high} = 4.38$, $SD_{high} = 1.28$) than in the ‘not intelligent at all’ condition ($M_{not} = 2.78$, $SD_{not} = 1.24$), $F(1, 40) = 18.41$, $p < .001$, $\eta^2 = .32$ (see Figure 2.1). Similarly, the probability that Gert would not go to a movie that everyone else wants to see (non-conformist inaction), was assessed higher in the ‘highly intelligent’ ($M_{high} = 4.38$, $SD_{high} = 1.47$) than in the ‘not intelligent at all’ condition ($M_{not} = 2.61$, $SD_{not} = 1.14$), $F(1, 40) = 20.76$, $p < .001$, $\eta^2 = .34$ (see Figure 2.1).

1.5.2 Study 1b

In study 1b, we assess whether non-conformist rather than conformist behavior is perceived as a cue that the actor is highly intelligent.

Participants and method. Fifty-five participants (27 men; 28 women) aged between 18 and 24 years old ($M = 19.40$, $SD = 1.75$) participated in exchange for course credit. They

received a one-sentence description in which Gert was described as someone who typically: a) went to a movie that everyone else wanted to see (conformist behavior); b) did not go to a movie that everyone else wanted to see (non-conformist inaction); c) went to a movie that nobody else wanted to see (non-conformist action). Fifty-five participants rated on a seven-point Likert-scale how likely it was that Gert was highly intelligent (0: not likely at all; 7: very likely).

Results. In the two non-conformist conditions (action and inaction), participants considered it more likely that Gert was very intelligent ($M_{inaction} = 5.22$, $SD_{inaction} = .94$ and $M_{action} = 4.32$, $SD_{action} = 1.00$ resp.) than in the conformist condition ($M_{conformity} = 3.56$, $SD_{conformity} = .92$; $F(1, 49) = 22.55$, $p < .001$ and $F(1, 49) = 5.47$, $p < .05$ respectively; see Figure 2.2). Interestingly, non-conformist inaction was perceived as more intelligent than non-conformist action, ($F(1, 49) = 6.34$, $p < .05$; see Figure 2.2).

FIGURE 2.1

Expected likelihood of (non-)conformist behavior as a function of intelligence (Study 1a).

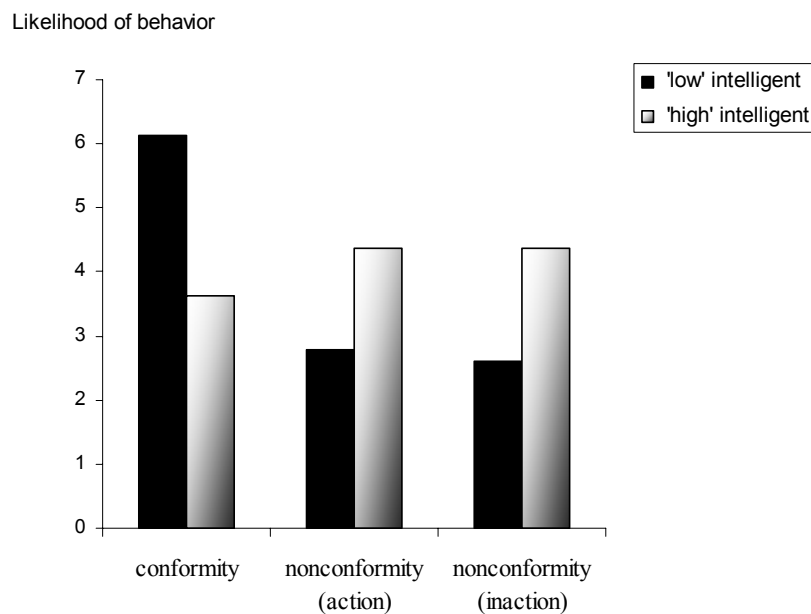
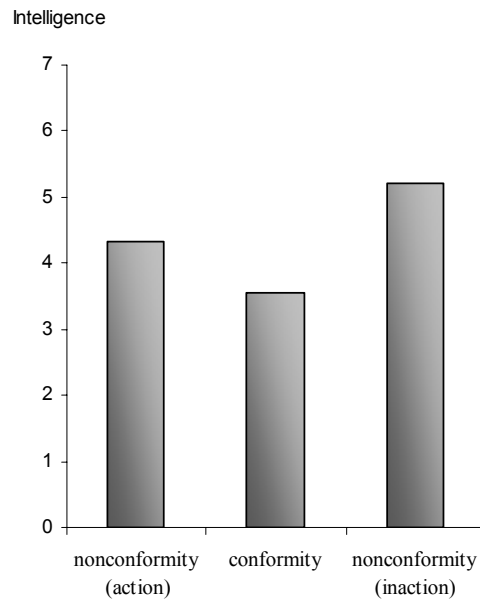


FIGURE 2.2

Expected likelihood of high intelligence as a function of (non)conformity (Study 1b).



1.5.3 Discussion

In study 1a we showed, consistent with H_{1A} , that differences in nonconformity are expected as a function of general intelligence. Subjects expect that highly intelligent people will behave in a less conformist way. In accordance with study 1a and H_{1B} , we find evidence in study 1b that one expects higher intelligence levels from someone behaving in a non-conformist way compared to someone behaving in a conformist way. These data suggest that the first condition is met: non-conformist behavior is perceived as being related to the actor's intelligence. In the next study, we examine the second requirement: differential cost structure.

1.6 STUDY 2

As non-conformist behavior is related to general intelligence in participants' perception, the question arises how the relationship between non-conformist behavior and general intelligence may be regulated. Based on costly signaling theory, we expect that highly intelligent consumers incur a lower cost when they act in a non-conformist way than do less intelligent consumers. To get insight in the differential cost structure, we measured the

affective reaction to a situation of conformity versus a situation of non-conformity. We suggest that when one finds oneself in a situation in which one behaves in a non-conformist way, lower intelligence is related to a less positive mood valence (i.e. the psychological cost) (H_{2A}). Moreover, we hypothesize that there is less emotional reactivity to the degree of conformity of the situation for highly than for less intelligent people. In other words, we expect for the high intelligent group a much smaller or no difference in mood valence between both conditions than for the less intelligent group (H_{2B}). To test this, we let participants imagine that they made a choice that happens to be either similar (conformist choice condition) or dissimilar (non-conformist choice condition) to the choice that others made in the same consumption situation, using a between subjects design. We measured participants' affective reactions to this situation, here operationalized by means of mood valence (that is, positive affect minus negative affect; cfr. Keller et al. 2005).

1.6.1 Participants and method

Hundred twenty-two students (83 women, 39 men) aged between 17 and 28 years old ($M = 21.28$, $SD = 2.14$) participated in exchange for course credit. Participants had to imagine the following situation: You are in a pub with a group of friends and order a drink. In the 'non-conformist' condition they had to imagine standing alone in their choice.

“You and 8 of your friends go to a bar, and everyone orders something to drink. You need to go to the bathroom, but on your way over there you ask the waiter to go and take orders at your table already. You return just in time to order something as well, but you haven't heard what the others ordered. On serving the drinks, it turns out that your friends have all ordered something else than you have, BUT your friends all ordered the same drink. (Meaning you are the only person at the table having a different drink.) (E.g. You've ordered a coffee and they've all ordered a beer, or you've ordered a beer and they've all ordered a glass of white wine, or you've ordered a glass of white wine and they've all ordered an iced tea...)”

In the 'conformist' condition participants' choice is the same as the others' choice (“you have the same drink as everyone else”). Afterwards we measured mood valence with the PANAS (Watson, Clark, and Tellegen 1988). After an unrelated filler task, participants received a computerized adapted version of Raven Progressive Matrices (RPM) IQ – test in

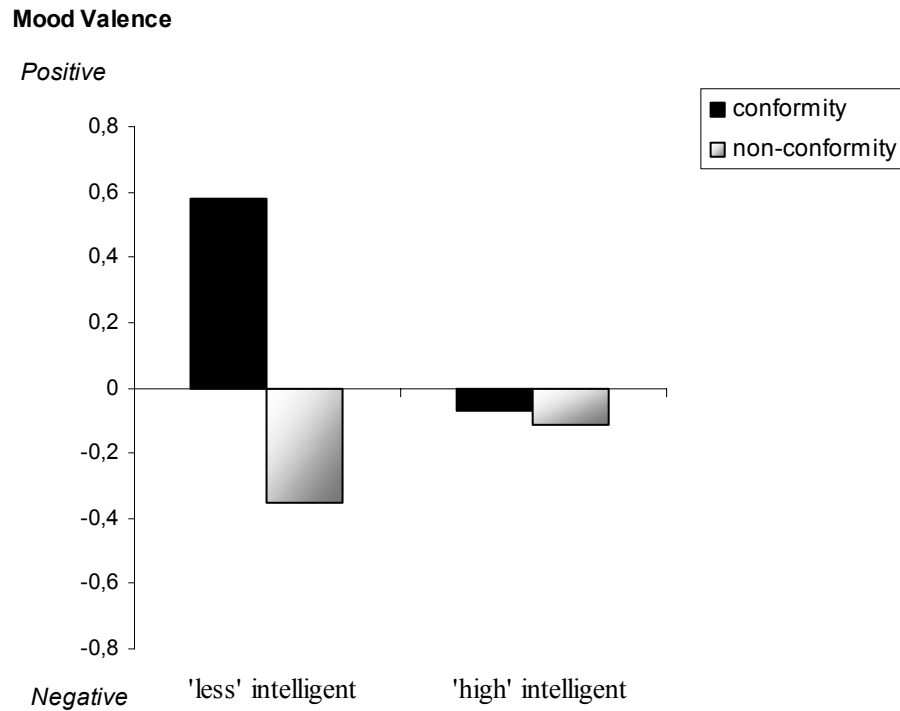
which they had to solve as many problems as possible in 15 minutes (see Millet and Dewitte in press). A recent review showed that the RPM-test is one of the best measures of general intelligence (Gray and Thompson, 2004). Intelligence scores are calculated by summing the number of correct answers, we refer further to this variable as ‘intelligence’. Intelligence did not differ between conditions ($p = .14$). As the within subjects variance of PANAS-items measuring the positive affect dimension ($M_{SD} = 11.85$) was much larger than the within subjects variance of items measuring the negative affect dimension ($M_{SD} = 7.15$; $t(121) = 6.56, p < .001$), we decided to do a varimax principal axis factor analysis for the positive and the negative items separately as we assume one underlying factor for each dimension (Sharma 1996). For the positive affect subscale we obtained one factor explaining 46.56 % of the variance. For the negative affect subscale we obtained one factor explaining 63.63 % of the variance. Subsequently, we subtracted the values of the negative affect factor from the positive affect factor to create a measure of mood valence, with higher scores denoting a more positive mood (see Barrett and Russell (1998) for justification of this measure and e.g. Keller et al. 2005 for the application of such a measure). Following Keller et al. (2005), we refer to this variable as ‘mood valence’.

1.6.2 Results

We performed an ANOVA on mood valence with condition, intelligence, gender and their interactions as predictor variables. A significant main effect of condition emerged ($F(1,114) = 10.14, p < .01, \eta^2 = .08$) but this effect was qualified by a significant interaction between condition and intelligence ($F(1,114) = 7.67, p < .01, \eta^2 = .06$). No other results approached significance ($F(1, 114) < 1$). Consistent with H_{2A}, we found that mood valence was marginally significantly positively related to intelligence in the non-conformist condition ($r = .24, p = .06, n = 61$). However, it was negatively related in the conformist condition ($r = -.33, p < .01, n = 61$). From another point of view and to get further insight in the data, we dichotomized the continuous variable intelligence. We refer further on to the ‘high’ and ‘less’ intelligent group. As Figure 2.3 shows and consistent with H_{2B}, the effect of condition was larger for the ‘less’ ($M_{non-conformity} = -.35, SD_{non-conformity} = .96$ vs. $M_{conformity} = .58, SD_{conformity} = .99$; $F(1, 60) = 11.00, p < .005, \eta^2 = .16$) than for the ‘high’ intelligent group ($M_{non-conformity} = -.12, SD_{non-conformity} = .93$ vs. $M_{conformity} = -.07, SD_{conformity} = .67$; $F(1, 54) = 0.00, p = .96, \eta^2 = .00$).

FIGURE 2.3

Mood Valence as a function of intelligence and condition.



1.6.3 Discussion

We find evidence for H_{2A} that intelligence is positively related to mood valence when one finds oneself in a situation in which one behaves in a non-conformist way. In addition, we find also evidence for H_{2B} that emotional reactivity to the situation (conformity or not) decreases as the level of general intelligence increases (as measured by a RPM-task). The data support the second requirement that has to be met in order to identify non-conformist behavior as a costly signal: the relative emotional cost of non-conformist behavior is lower for highly than for less intelligent people.

1.7 STUDY 3

Identifying non-conformist behavior as a costly signal of intelligence should live up to three conditions. The previous studies showed that two conditions are met: non-conformist behavior is perceived as a cue of high intelligence, and it is also less costly for highly than for less intelligent consumers. The third study examines whether the third condition is fulfilled: the actual relationship between non-conformist behavior and general intelligence should be positive.

We asked participants to make a choice between two candy bars of the same brand, a traditional, ‘conventional’ type versus a new, unconventional one. We predict that the mean level of general intelligence of participants choosing the unconventional bar is higher than that of participants choosing the conventional candy bar. Moreover, we measured trait unconventionality and expected a positive relationship with intelligence.

1.7.1 Participants and procedure

One hundred forty students (63 women, 77 men) participated in exchange for course credit. All participants were between 18 and 26 years ($M = 19.72$, $SD = 1.40$). We measured intelligence using the RPM-test (cfr. study 2). We measured unconventionality (see Appendix B) using a scale adopted from the International Personality Item Pool (2001; Goldberg 1999). At the end of the session participants got a candy bar as expression of gratitude for their participation. To that purpose, the experimenter asked which of both candy bars one preferred: the (conventional well-known) Cha-Cha® or the (new, and hence unconventional) Cha-Cha Croc®.

1.7.2 Results

Two participants were removed from analyses as they expressed suspicion and/or did not do the tasks seriously. Further, concerning the Cha-Cha (Croc)® choice analysis, two participants indicated that they did not like Cha-Cha (Croc)® and did not make a choice

consequently⁵. First, we performed an ANOVA on unconventionality with intelligence, gender and their interaction as predictor variables. Only a significant main effect of intelligence emerged ($F(1,134) = 8.14, p < .005, \eta^2 = .06$). Intelligence and unconventionality are positively related ($r = .24$, controlled for gender). Second, we performed the Cha-Cha (Croc)[®] choice analysis. The Cha-Cha Croc[®] was chosen by 37.5 % of the participants (30 out of 74 men, 21 out of 62 women). Moreover, participants who chose the Cha-Cha Croc[®] obtained higher scores on unconventionality than the ones who chose the conventional candy bar ($M = 41.61, SD = 8.06$ vs. $M = 37.66, SD = 8.65; F(1,132) = 6.42, p < .05, \eta^2 = .05$). To examine the relation between intelligence and choice, we performed an ANOVA on intelligence with product choice, gender and their interaction as predictor variables. Only a significant main effect of product choice on intelligence ($M = 28.69, SD = 6.34$) emerged ($F(1,132) = 3.97, p < .05, \eta^2 = .03$). Participants who chose the new Cha-Cha Croc[®] ($M = 29.78, SD = 6.07$) achieved higher RPM-scores than those who chose the conventional Cha-Cha[®] ($M = 27.86, SD = 6.38$).

1.7.3 Discussion

In support of the third hypothesis we find that intelligence is positively related to unconventionality. Moreover, we find a similar effect on real choice behavior: participants who chose a new Cha-Cha Croc[®] instead of a conventional Cha-Cha[®] had higher intelligence scores.

1.8 STUDY 4

In this final study, we want to generalize our findings to a broader form of non-conformist behavior: new product adoption. Gatignon and Robertson (1985) compared innovators with the rest (including the majority and the laggards) and stated that “consumers who are highly dependent on normative influence (conformity intention) will be slower to adopt.”(p. 856). Midgley and Dowling (1978) already suggested defining innovators as individuals who make adoption decisions independently of other individuals’ opinions and

⁵ Note that indicating not to like a cha-cha[®] and declining our offer can be considered as extremely non-conformist behavior. Consistent with our approach, these two participants obtained much higher unconventionality scores and much higher scores on the RPM-task than the others.

non-innovators as the individuals who are influenced by others' opinions. So, at a conceptual level, consumer innovativeness is closely related to non-conformist behavior. Therefore, we will examine the relationship between general intelligence and consumer innovativeness. However, the distinction one always made in the literature is between innovators and the "others". Nevertheless, given our conceptual analysis in terms of costly signaling, we do not expect a linear relationship between general intelligence and consumer innovativeness. It is true that an innovator is acting in a non-conformist way by definition. However, as we pointed out in the introduction of study 1, "not doing what everyone is doing" also meets the definition of non-conformist behavior. As Bass (1969) remarked: "apart from innovators, adopters are influenced in the timing of adoption by the pressures of the social system, the pressure increasing for later adopters with the number of previous adopters" (p. 216). Hence, the "pressure" by other members of the social system is initially the strongest for the innovators. However, as other members of the social system adopt these products, the pressure increases for those who do not adopt, being the highest for the laggards. As a consequence, we derive the specific hypothesis that also the other extreme side of the distribution, namely lagging, is non-conformity to the majority: not adopting products although the majority does. In fact, innovating is non-conformist action and lagging is non-conformist inaction (cfr. study 1). Therefore, we predict a curvilinear relationship between consumer innovativeness and general intelligence.

1.8.1 Participants and method

One hundred sixty-five participants (83 men, 82 women) received the RPM – test (see study 2 and 3). In addition we gave subjects an 8 items questionnaire (Cronbach's $\alpha = .75$) measuring consumer innovativeness (Steenkamp and Gielens 2003).

1.8.2 Results

We found a significant curvilinear relationship between intelligence and consumer innovativeness (both standardized) ($F(1, 159) = 8.55, p < .005$): participants who scored high (innovator) or low (laggard) on innovativeness had higher RPM-scores than the ones with an

average innovation score (majority). No other results approached significance ($F_s(1, 159) < 1$).

1.8.3 Discussion

As predicted, we show a curvilinear relationship between consumer innovativeness and general intelligence. It has already been stated that people may honestly signal wealth by ‘wasteful’ activities (Veblen, 1957) and new product adoption may be considered as such a wasteful activity, as the price of new products is often very high. Accordingly, wealth is closely related to adoption of innovations (Rogers 1963). However, we state, and find support in our data that adopting new products may not only function as a signal of wealth, but also as one of general intelligence (under the condition of new product adoption as a non-conformist act and thus resisting to social pressure). If we assume that innovation is a special case of non-conformity, and given the strong relation between general intelligence and socio-economic status and thus wealth (Gottfredson 2004), we suggest that the relation that we document between general intelligence and innovation may be more fundamental. The finding that lagging is also related to general intelligence, supports this claim.

Our finding may have some implications for e.g. high-tech firms that wrestle with their choice of an initial target market to pursue with promising new technologies. Independent of the content of the new product, our data suggest that more intelligent people are more prone to adopt a new product on the market. Therefore, markers of intelligence may be helpful to segment markets in which consumers are more responsive to the firm’s offering.

1.9 GENERAL DISCUSSION

The purpose of the present investigation was to provide a first step in establishing the potential of costly signaling theory for our understanding of non-conformist consumer behavior. In essence, we propose that non-conformist consumer behavior may serve as a costly signal of general intelligence. Therefore, we examined the essential conditions for non-conformist consumer behavior to be identified as a costly signal of general intelligence. First, we found that people who act in a non-conformist way are perceived as more intelligent than

people acting in a conformist way (Study 1a). Conversely, perceivers expect highly intelligent people to act in a less conformist way than people with less cognitive abilities (Study 1b). Second, negative mood valence as a result of acting in a non-conformist way is lower when general intelligence is higher (Study 2). Moreover, emotional reactivity on the situation (conformity vs. non-conformity) is also lower for high than for less intelligent people (Study 2). Third, non-conformist consumer choices are related to higher levels of general intelligence (Study 3). Consistently, on a trait level, we found that intelligence is related to trait unconventionality (Study 3), consumer innovativeness and lagging (Study 4). As we found evidence for the three conditions, the data support our initial hypothesis that non-conformist consumer behavior may effectively serve as a costly signal of general intelligence.

So in sum, our paper shows that non-conformist behavior is linked to general intelligence. Judge, Colbert and Ilies (2004) stated that in our Western society few characteristics are more valued or valuable than intelligence and that intelligence is associated with many social advantages. Accordingly, it has been shown that general intelligence is one of the most important criteria for both genders in choosing partners (Li, Bailey, Kenrick, and Linenmeier, 2002). Therefore, when someone is able to afford the cost, engaging in non-conformist behavior as a signal of intelligence may have benefits later on because e.g. the increased attractiveness of people acting in a non-conformist way. Thus, although non-conformist behavior may appear irrational in the short run from an economic and psychological perspective, it may not be that irrational from a long term perspective. Doing things that others find strange or acting differently from your social environment notwithstanding the social pressure, requires strength (i.e. intelligence). Although it is difficult to resist the pressure of social norms, our data suggest that this is not as difficult for highly than for less intelligent people. As a consequence, resistance to social norms may impress under some circumstances. Accordingly, it has been shown that people who stand up for their beliefs in the face of social pressure are sometimes liked better than those who conform to other's values (Braver, Linder, Corwin, and Cialdini 1977). While it is unclear under which conditions such an effect is most likely to occur (Leary 1996), costly signaling theory may be useful to identify these conditions. We spell out some of these potential moderators in the future research section.

1.10 FUTURE RESEARCH

A costly signaling perspective may shed another light on various types of ‘irrational’ consumer behaviors such as the novel use of old products when better alternatives are available (e.g. sticking to the abandoned Apple Newton personal digital assistant, Muñiz and Schau 2005), using unhealthy products, donating money, forgoing good deals, etc. When a positively valued personality characteristic is reliably linked and communicated by seemingly ‘irrational’ behaviors such as non-conformist behavior, this irrational behavior may pay off in the long run because of the reputation benefits of being perceived as highly intelligent or very wealthy. Finding other irrational consumer behaviors that may serve as costly signals for hidden qualities may be one avenue for future research.

Based on our findings and the costly signaling framework, we predict that the relationship between intelligence and non-conformist behavior should be stronger in situations where social pressure is higher. The more social pressure in a specific situation, the more difficult to bear the psychological cost under these circumstances. We suggest that ‘public’ non-conformist behavior is more emotionally costly than unidentifiable non-conformity. Accordingly, it has been shown that individuals adhere more to social norms when their behavior is easily perceived than in a private situation (see e.g. Deutsch and Gerrard 1955; Singer, Brush and Lublin 1965). In a sense, social pressure creates a signaling opportunity. Let us now assume that as social pressure increases, the frequency of non-conformist acts decreases. Being among the few ones who act differently in circumstances of high social pressure then may serve as an even more reliable signal of high intelligence. Therefore, the frequency of behavior may indicate the strength of the “non-conformist” signal. Remark that we already find an effect of choice in our third study although this was a situation with minimal threat. As a consequence, still 37.5 % of the participants chose the unconventional candy bar. When the threat of non-conformist choice behavior becomes larger, we expect that fewer people would choose the unconventional option and thus the difference in intelligence between both groups (those who choose the conformist option and those who don’t) would become larger. As an example, we point out that altruistic behavior (in the sense of giving more than the fair contribution in a social dilemma situation) is an uncommon option and hence non-conformist. As a result, the positive relationship between intelligence and altruistic behavior (Millet and Dewitte in press) may be due to the non-conformist nature of altruistic behavior. We suggest that other infrequent behaviors may be

explained by the same mechanism. For example, we predict that the few people who often buy the newest stuff in contrast to the greater part of people in their social environment will be smarter than the average member of their social environment. However, when everyone around wears the most extravagant clothing style, drives the newest cars, etc. (like e.g. Hollywood movie stars), highly intelligent people may prefer to signal via modest or very casual clothing and modest life styles. So, the social environment appears to be an important moderator of the direction of the relationship between new product adoption behavior and intelligence. As we presume that a particular situation determines the cost of some behaviors, costly signaling theory is able to give a clear account of the impact of situational cues on these behaviors.

Further, we want to focus on the curvilinear relationship between consumer innovativeness and intelligence (Study 4). As we mentioned before, both innovating and lagging may serve as a costly signal of intelligence. However, we suggest that lagging may be a more subtle signal of intelligence than innovating. First, lagging can hardly be considered as a signal of wealth as no wasteful activity is involved. Second, the inaction of not adopting what all the others adopt (lagging) may be perceived as more non-conformist than the action of being the first one to adopt (innovating). After all, when others follow the innovator, he is not longer standing alone. The perception of non-conformist inaction as more intelligent than non-conformist action (study 1b) may be explained accordingly. Hence, lagging may be a more robust signal of intelligence than innovating and this should be a focus of future research. Finally, we acknowledge that our results are collected within a college student population, a population that is – on average – more intelligent than the rest of the population (Jensen 1984). However, based on the costly signaling framework, we predict that the observed relationships should even be stronger in the general population, which is more heterogeneous with respect to general intelligence. This remains a matter for further research.

SECTION II:

DIGIT RATIO & ECONOMIC BEHAVIOR

INTRODUCTION

Behavior depends for a substantial extent on evolutionary older systems that humans share with animals (Camerer et al. 2005). Camerer et al. (2005) state that standard economic theories rely on an implicit assumption that controlled, cognitive processes are the key to economic decision making. However, they argue that most human behavior, like that of other mammals, are not the product of cognitive controlled processes. We agree with their point and focus on the impact of prenatal exposure to testosterone, as behavioral effects of prenatal hormones are found in both human (e.g. Collaer 1995) and nonhuman primates (e.g. Wallen 1996). Moreover, studies of the behavioral effects of prenatal exposure to hormones provide a rich opportunity to unravel and document the oft-cited but poorly studied interaction between biology and the social environment (Cohen-Bendahan et al. 2005). Consequentially, we focus, in the following section, on the second to fourth digit ratio (2D:4D), a marker of prenatal exposure to testosterone. This is the ratio between the length of index (or second digit, 2D) and ring finger (or fourth digit, 4D) and seems to be established in utero (e.g. Csatho et al. 2003; Manning et al. 1998; Williams et al. 2003). This variable, which is believed to be an indicator of fetal exposure to testosterone, has recently been related to many different personality characteristics (e.g. Manning 2002). Therefore, studies using this variable have greatly multiplied in biological and personality psychology literature in recent years. The aim of this part of my dissertation is to introduce and show the importance of 2D:4D for economic decision making.

First, I give a short introduction on what 2D:4D is and to which - for our research relevant - behavior it has been related up to now. A lot of evidence suggests that 2D:4D reflects the degree to which humans are exposed to fetal testosterone (Manning 2002), some of which we summarize next. (a) It has been shown that the maternal waist to hip ratio is related to 2D:4D: women with high waist to hip ratio (a proxy for higher testosterone and lower estrogen concentrations; Evans et al. 1983) tended to have children with low 2D:4D

(Manning et al. 1999). (b) Childhood behaviors which are thought to be related to prenatal testosterone (hyperactivity and poor social cognition) are associated with low 2D:4D (Williams et al. 2003). (c) It has been found that humans with congenital adrenal hyperplasia, a trait associated with elevated fetal testosterone levels, have lower digit ratios compared to controls (Ökten et al. 2002; Brown et al. 2002). (d) It has already been known for a while that men have much higher testosterone levels than women (Mazur and Booth 1998). Consistently, 2D:4D is sexually dimorphic, with male 2D:4D lower on average than female (e.g. Bailey and Hurd 2005; Fink et al. 2006; Lippa 2006; Luxen & Buunk 2005). In addition, females from opposite-sex twins have lower ratios compared to controls, which is consistent with the idea that they are affected by testosterone from their male twin (Van Anders et al. 2006). Also several behavioral traits that are more typically male such as high visuo-spatial ability (Manning & Taylor 2001; Kempel et al. 2005), left hand preference (Manning et al. 2000), autism, and Asperger's syndrome (Manning et al. 2001) have been shown to be associated with low values of 2D:4D.

Exposure to testosterone in utero as indexed by 2D:4D also seems to have a broad impact on human behavior. Recent research shows a relationship between 2D:4D and aggression (Bailey & Hurd, 2005; Benderlioglu & Nelson, 2004). In children, a low 2D:4D has been related to physical aggression in school boys (Manning & Wood, in Manning 2002) and to lower levels of pro-social behavior in pre-school girls (Williams et al. 2003). Moreover, a low 2D:4D has been associated to high status in competitive sports (Manning & Taylor 2001; Paul et al. 2006; Pokrywka et al. 2005) and in music (Manning 2002; Sluming & Manning 2000). These findings are consistent with literature investigating the relationship between circulating testosterone levels and aggression. Testosterone levels have been found to increase aggressive behavior in a wide range of vertebrate species (Archer 1988) and there also seems to be a relationship between testosterone and aggression in humans (Mehta & Josephs in press). The same holds for the relationship between testosterone and status. Josephs et al. (2006) argue that a lot of evidence linking testosterone and status comes from research with nonhuman species and accordingly show that people's preference for high status positions are linked to their baseline levels of testosterone.

This part of my doctoral dissertation consists of three different manuscripts. The first two manuscripts deal with research based on the potential link between status and 2D:4D. We argue that economic decision making (such as altruism, manuscript III) and impulsive

consumer behavior (such as money discounting, manuscript IV) may be influenced by status considerations and therefore, in certain circumstances, are related to 2D:4D. The first manuscript focuses on decision making in a public good game. As both egoistic and altruistic behavior may enhance someone's status, we expected that people with a low 2D:4D were more likely to act in this way. However, we found exactly the opposite pattern as hypothesized: people with a low 2D:4D were more likely to act cooperatively, while egoists and altruists had a relatively higher level of 2D:4D. I refer to the manuscript itself for the discussion of these surprising results. The second manuscript deals with the subjective present value of money as money is one indicator in determining people's status position. We manipulated the relative status position of men in two different studies in two different ways. Consistent with our predictions we found that the present value of money increased for low 2D:4D men when they were in a subordinate, but not in a dominant status position. The third manuscript of this section (manuscript V) deals with research based on the potential link between aggression and 2D:4D. Consumers are almost daily exposed to violence in popular media: violence in news bulletins, music videos, movies, video games, etc. Moreover, violence sells: the average consumer is attracted to violent scenes (Huesmann et al. 2000). However, an important question pertains to the generality of the effect of violent media on aggression: which consumers are most susceptible to media violence influences? We show in two studies that the effect of violent music videos on aggression is moderated by 2D:4D and that the same holds for the effect of violent music videos on cooperative decision making. Especially participants with a low 2D:4D became more aggressive and less cooperative after exposure to an aggressive music video.

MANUSCRIPT III:
SECOND TO FOURTH DIGIT RATIO (2D:4D)
AND COOPERATIVE BEHAVIOR⁶

ABSTRACT

A low second to fourth digit ratio (2D:4D) has been related to high testosterone levels and to markers of high status. In a social dilemma context, status can be obtained either by acting egoistically (i.e. not contributing one's share) or by acting altruistically (i.e. contributing more than one's fair share). We therefore predicted that a low 2D:4D would be associated with high levels of egoism *and* altruism and low levels of common cooperativeness (i.e. contributing exactly one's fair share). We found the exact opposite: participants with a low 2D:4D were more likely to act cooperatively and less likely to act altruistically and egoistically. These findings suggest that (1) there might be a high and a low testosterone strategy to gain status and (2) that the high testosterone strategy is characterized by a preference for normative behavior.

⁶ This manuscript is adapted from Millet, K., & Dewitte, S. (2006). Second to fourth digit ratio and cooperative behavior. *Biological Psychology*, 71, 111-115.

1.1 INTRODUCTION

A low second to fourth digit ratio (2D:4D) has been related to high prenatal testosterone levels (Manning et al. 1998; Manning 2002) and to a number of psychological factors such as masculine gender identity (Csatho et al. 2003), aggression in men (Bailey & Hurd 2005), high status in competitive sports (Manning & Taylor 2001) and in music (Sluming & Manning 2000). In younger humans, a low 2D:4D has been related to lower levels of prosocial behavior in pre-school girls (but not in boys) (Williams, Greenhalgh, & Manning 2003), and to physical (but not verbal) aggression in school boys (Manning & Wood, in Manning 2002). High testosterone has been related to high dominance status (Mazur & Booth 1998) and the correlates of a low 2D:4D seem consistent with this interpretation. Hitherto, a low 2D:4D has been related to outcomes that mark status (e.g. status in music, fertility; Manning 2002), or to traits that are believed to either lead to, maintain, or reflect high status (e.g. gender identity, and aggression). In this paper, we explore whether the relationship between 2D:4D and status exists at the behavioral level. Testosterone seems to have an impact on social behavior (Mazur & Booth 1998). A well-documented type of social behavior is cooperative behavior in social dilemmas. Social dilemmas are characterized by a conflict between collective and individual interests (Hardin 1968).

The findings reported in the literature do not allow straightforward predictions with respect to cooperativeness in low 2D:4D people. There are two possibilities. Low levels of cooperation in social dilemmas are typical of a strategy that strives towards maximizing the *differences* between one's own benefits and those of others (van Lange 1999). Two other frequently used interactive strategies, specifically 'maximizing one's own gains', and 'maximizing joint outcomes while minimizing interindividual differences', often yield higher levels of cooperation in social dilemmas. Because one individual's status gain entails an other individual's status loss by definition, a strategy that maximizes differences between one's own and others' benefits (i.e. low cooperation levels) seems consistent with status gain, and hence, with higher levels of testosterone. Hypothesis 1 therefore proposes that a lower 2D:4D, as a marker of higher prenatal testosterone level and a precursor of high status, should be related to lower contribution levels in social dilemmas. This comes down to a positive correlation between 2D:4D and contribution level. A low 2D:4D ratio has indeed been shown

to be related to lower levels of (aggregate) prosocial behavior and lower social cognition (Williams et al. 2003), at least in girls.

There is a second possibility. Other literature suggests that the relation between 2D:4D and contribution in social dilemmas might not be linear but rather curvilinear. To explain the reasoning, it is useful to distinguish altruistic behavior from ‘common’ cooperativeness. In many social dilemmas people have a clear idea about what constitutes appropriate behavior and free-riding. Paying for one’s ticket for the opera is appropriate, whereas trying to get in for free is not appropriate (i.e. is free-riding). In many real life circumstances, however, a third option exists: One can contribute more than the appropriate contribution level. To help the orchestra survive one could pay for a program booklet or contribute more than the ticket price. At first sight, this type of behavior seems irrational. However, the cost incurred by such a type of behavior has been identified as a costly signal of some underlying quality (e.g. Glazer & Konrad 1996; Roberts 1998; Zahavi & Zahavi 1997). Consistent with the costly signaling perspective on altruism, altruistic behavior has been shown to be competitive on some occasions (Barclay 2004), and has been shown to increase status, both in field settings (Bliege-bird, Smith, & Bird 2001) and in lab situations (Dewitte & De Cremer 2004). Because a low 2D:4D seems to be related to high status (see above), and altruism (i.e. doing more than what is “appropriate”) appears in the recent literature as one means to reach high status (e.g. Bliege-Bird et al. 2001), altruism might be related to a low 2D:4D. Considering that acquiring resources (e.g. hunting large game) involves a lot of risky behavior (e.g. Bliege-Bird et al. 2001), a link between testosterone and altruism is at least conceivable. This leads to hypothesis 2: a low 2D:4D might be related to higher levels of egoism *and* higher levels of altruism in social dilemmas, and to lower levels of ‘appropriate’ levels of cooperative behavior. Therefore, according to hypothesis 2 we expect a quadratic relationship between 2D:4D and contribution level.

Typical social dilemma games often obscure altruistic acts because only two options (i.e. cooperate or not) are available to the players or because it does not make much sense to give more than what is appropriate. In this paper, we adapted the traditional public good game slightly to allow differentiation between cooperation and altruism. In this way we could tease both hypotheses apart.

1.2 METHOD

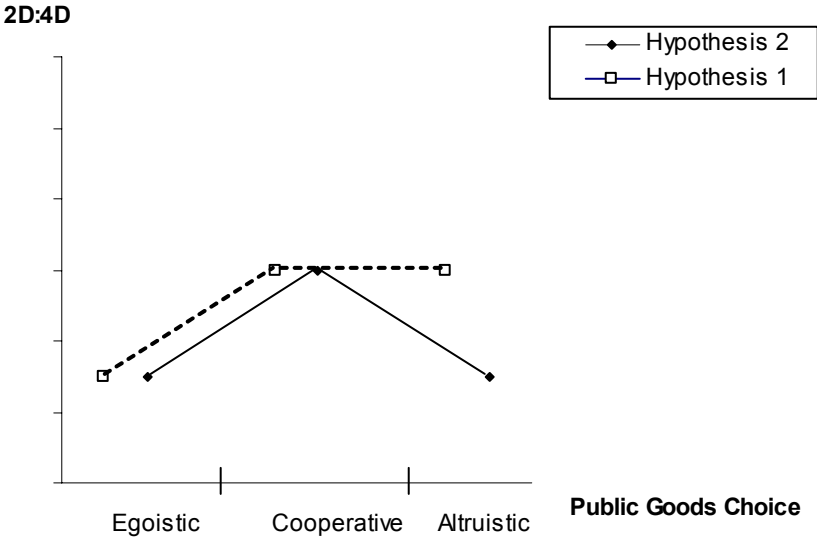
Seventy undergraduate students (43 women and 27 men) at the University of Leuven, aged between 18 and 23, participated in this study. The monetary reward depended on their performance (with a minimum of 5 euro, €1 ≈ \$1).

We used a social dilemma situation, namely a repeated public good game with four players. At the beginning of each round of the game, all participants received an endowment of 40 points. In each round, they had to decide how much of the endowment they would invest in the public good or keep for themselves. Decisions were made simultaneously. Every point was worth 3.39 eurocent. All the points that were invested, were subtracted from their 40 points endowment. When the sum of all contributions reached the provision point (= 100 points), 160 points (= the public good) were distributed equally across the four players, irrespective of their individual contributions. The norm equals the provision point divided by the number of players. In a pre-test ($N = 32$), we asked what the appropriate behavior would be in this type of situation. Ninety-seven percent of the people answered that people should invest 25 points, which suggests that this is indeed the appropriate behavior in this situation.

Upon arrival in the laboratory, each participant was assigned to a computer in a partially enclosed carrel. Participants did not see one another and could not talk. They believed that they played a game involving six people, but in reality they played against the PC. We told that four of the six participants were players in the game, and that two others were observers of the game. The observers did not play themselves but they were told that the roles of player and observer could change randomly during the game. All participants started as an observer and they observed twice that the good was not obtained. In the first round, the shortage was 5 (out of 100) points. In the second round, the shortage was 2 points (out of 100). They did not receive information about individual contribution levels. After the first two rounds, the participants replaced one person in the game and had to decide how much to invest in the public good. We distinguished three behavioral categories, defined in relation to the fair share, i.e. the provision point divided by the number of players (= 25). They could contribute either exactly the fair share (= cooperative decision), less than the fair share (= egoistic decision), or more than the fair share (= altruistic decision). We registered participants' decisions (cooperative, egoistic or altruistic) in the first round they played (i.e. the third round of the game). The first hypothesis implies that 2D:4D will be lower among

egoistic decision makers than among cooperative and altruistic decision makers. The reasoning underlying hypothesis 1, however, does not allow to predict a difference between cooperative and altruistic decision makers. In contrast, the second hypothesis implies that 2D:4D will be higher among the cooperative decision makers and lower among both egoistic and altruistic decision makers (i.e. the two strategies that are related to high status). To make both hypotheses clear, we present them in a graph (see Figure 3.1).

FIGURE 3.1
 2D:4D as hypothesized functions of public goods choice.



After the game, the right-hand was scanned to measure finger lengths. Participants placed their hand palms on the glass plate of a scanner. We ensured that details of major creases could be seen on the scans. Lengths of the second and fourth digits were measured from the ventral proximal crease of the digit to the finger tip by means of an Adobe® Photoshop 7.0 tool. We measured from the most proximal crease when there was a band of creases at the base of the digit. Using scanned pictures is a valid method to measure finger lengths (Williams et al. 2003). The lengths of index (2D) and ring (4D) fingers were measured twice by the same rater with a time span of ten weeks. The two measurements of 2D:4D were highly correlated ($r = .96, p < .0001, N = 70$). In the analysis, we used the average between the two measurements. An independent rater also measured finger lengths. His computed

2D:4Ds were highly correlated with the compound measure ($r = .95$). Raters were blind to contribution level and gender.

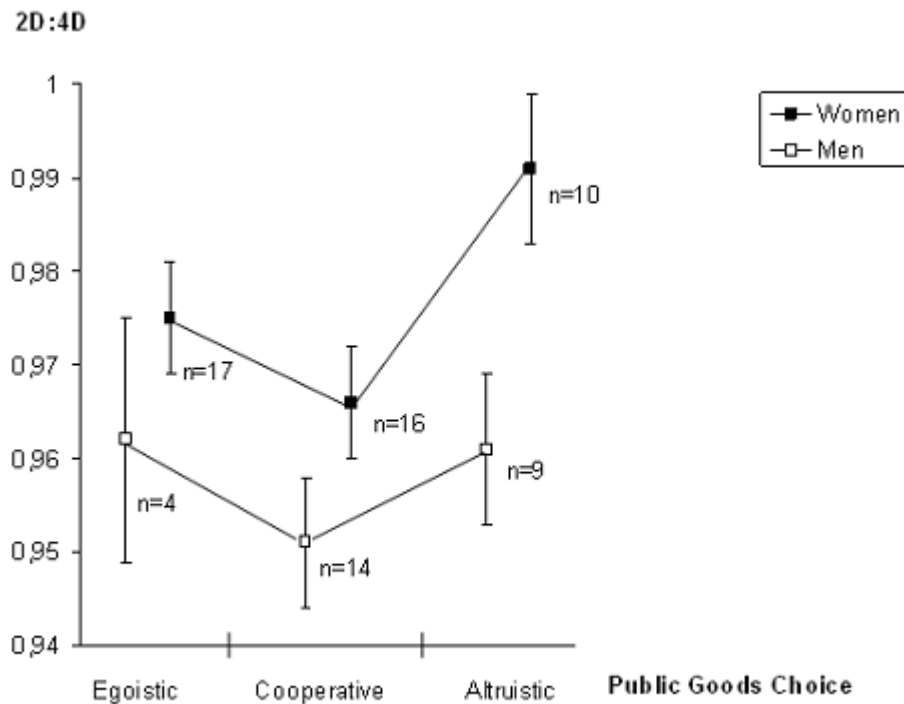
1.3 RESULTS

In accordance with previous literature (e.g. Fink et al. 2004; Lippa 2003; Manning 2002; Williams et al. 2003), 2D:4D was significantly lower for men ($M = .956$, $SD = .025$) than for women ($M = .975$, $SD = .027$; $t(68) = -3.01$, $p < .005$). Thirty participants acted cooperatively, 19 altruistically and 21 egoistically. In contrast with hypothesis 1, the correlation between contribution size and 2D:4D was not positive, $r = -.06$ (*ns.*, for men and women resp. $-.01$, *ns.* and $-.03$, *ns.*). We performed a 2 (Sex) by 3 (Public Goods Choice) factorial Anova to examine hypothesis 2. We found a significant main effect of Sex ($F(1, 64) = 7.95$, $p < .01$) and a marginally significant main effect of Public Goods Choice ($M_{\text{egoistic}} = 0.972$, $SD_{\text{egoistic}} = .026$; $M_{\text{cooperative}} = 0.959$, $SD_{\text{cooperative}} = .024$; $M_{\text{altruistic}} = 0.977$, $SD_{\text{altruistic}} = .031$; $F(2, 64) = 2.99$, $p < .06$). As expected, the quadratic trend was significant ($F(1, 64) = 4.62$, $p < .04$). However, Figure 3.2 shows that the trend went in the opposite direction as expected in hypothesis 2. Players that contributed the fair share, had a *lower* 2D:4D than either the players that contributed more than the fair share or the players that contributed less than the fair share. The interaction between Sex and Public Goods Choice did not approach significance ($F(2, 64) < 1$). Figure 3.2 shows that the trend is parallel for men and women.⁷

⁷An ANOVA on the 43 women only shows a significant quadratic trend ($F(1, 40) = 4.69$, $p < .04$). For men, the trend is similar, but the statistical test lacks the sufficient power to yield significance.

FIGURE 3.2

2D:4D as a function of public goods choice.



1.4 DISCUSSION

In the public good game we designed, we found a curvilinear relation between the 2D:4D ratio (reflecting prenatal testosterone level) and level of contribution. Specifically, egoists and altruists (as identified through their choice) had a relatively higher 2D:4D, whereas common cooperators had a relatively lower 2D:4D. How could our findings that a low 2D:4D is related to norm-consistent cooperative behavior in a public good game be reconciled with traits such as aggression and masculinity that have been related to a low 2D:4D? We consider that acting cooperatively in the public good game reflects a strong preference for social norms (= giving the fair share). Possibly, the status indicators that are related to a low 2D:4D require a strong preference for normative behavior. For instance, becoming a top soccer player implies high skill but also requires the player to follow the rules of the game and the coach's instructions. Czikszentmihalyi (1997) interviewed hundreds of very successful people in domains as various as top sports, science, business, and arts. The most salient characteristic common to all these people was that their creativity relied on a

profound knowledge of their field. Compliance with the ruling standards seems to be a necessary condition to reach the top, whatever the domain one is in. Aggression and masculinity might be related to cooperation if one considers that those following the cooperative norm are willing to punish those who free-ride (Fehr & Gächter 2002). Consistently, Axelrod (1984) found that the most successful interactive strategies in social dilemma's was nice but tough (i.e. retaliatory).

Given that altruism is related to status (Bliege-bird, Smith, & Bird 2001) as well as to high 2D:4D, the relation between 2D:4D (and testosterone) and status might be less linear than previously assumed. Possibly, two major strategies to obtain status could co-exist in the population (Henrich & Gil-white 2001): (1) the well-known testosterone driven, norm-abiding, aggressive, 'masculine' strategy yielding dominance status, and (2) a non-normative, generous, 'feminine' strategy yielding prestige status. The former seems related to low 2D:4D, and the latter might be related to high 2D:4D. The major limitation of this study is the small sample size and the resulting lack of statistical power. Nevertheless, the findings raise several relevant questions that deserve future research attention. First, findings suggest that not only a low 2D:4D might yield fitness advantages, but that a high 2D:4D might do so in some circumstances too. Insight is needed in the environmental moderators that determine whether the non-normative (high 2D:4D) versus the normative (low 2D:4D) strategy is the fittest. Second and related, 2D:4D cannot predict whether an individual will act altruistically or egoistically in our experimental setting. This raises the intriguing possibility that two opposite strategies (i.e. egoism and altruism) co-exist in one individual. This calls for research into the situational factors that promote either altruism or egoism (as opposed to normative cooperative behavior). Third, future research is needed that relates 2D:4D to individual differences in Social Value Orientation (Van Lange 1999). In general sticking to the norm in public good situations meets two goals that are typical of pro-social individuals: maximizing joint outcomes and minimizing inter-individual differences. These goals are difficult to disentangle in social dilemma situations. If everyone contributes exactly the norm, the joint outcome is maximal while the inter-individual differences are minimal. However, our paradigm allows to differentiate between these goals because sticking to the norm appears not to work in the first two rounds. Maximizing joint outcomes therefore requires altruistic contributions, whereas minimizing interindividual differences requires contributing the normative amount. Therefore, our paradigm might help to find out more about the goals pro-social individuals strive for and how these are related to 2D:4D. Fourth, to make our findings

consistent with extant literature, we assumed that masculine, aggressive, and norm-abiding behaviors are related. This assumption should be tested in future research. For instance, if the situation allows it, low 2D:4D individuals should also be more inclined to retaliate against free-riders. Fifth and finally, we do not know at this point whether current testosterone levels or rather an early formed personality trait mediates the relation between prenatal testosterone and cooperative behavior. Insight into this process might also help explain the relation between norm-following cooperation and testosterone.

MANUSCRIPT IV:

A SUBORDINATE STATUS POSITION INCREASES THE PRESENT VALUE OF FINANCIAL RESOURCES FOR LOW 2D:4D MEN⁸

ABSTRACT

It has been suggested that the ratio of the length of the 2nd and 4th fingers (digit ratio or 2D:4D) is related to prenatal testosterone with lower ratios thought to be influenced by higher prenatal testosterone levels. Accordingly, low 2D:4D has been associated to a number of fitness related factors, such as high status in competitive sports and in music. Recent evidence suggests that 2D:4D is also related to economic decision making. We combine both streams of research in the present paper. In two studies we manipulated status in two different ways. We found that a subordinate position raises discount rates, consistent with the reasoning that the present utility of money is higher for men in this position. Moreover, the effect was more pronounced for men with a low 2D:4D. There was a significant negative relationship between 2D:4D and level of discounting in a subordinate status position, but no significant relationship emerged in the dominant status position. Our studies add evidence to the recent line of research associating digit ratio and economic decision making. Moreover, our studies show that future 2D:4D research should focus on plausible interactions between 2D:4D and context cues rather than on linear relations.

⁸ This manuscript is adapted from Millet, K., & Dewitte, S. (in press). A subordinate status position increases the present value of financial resources for low 2D:4D men. *American Journal of Human Biology*.

1.1 INTRODUCTION

Second to fourth digit ratio (2D:4D) is the ratio between the length of index (or second digit, 2D) and ring (or fourth digit, 4D) finger. This ratio or “*2D:4D*” should reflect the influence of prenatal testosterone during development. A lot of evidence suggests that a higher 2D:4D indicates a lower level of prenatal testosterone exposure (see e.g. Csatho et al. 2003; Manning et al. 1998; Manning 2002; Williams, Greenhalgh & Manning 2003). In this paper, we investigate the relation between 2D:4D and responsiveness to status information. High baseline testosterone levels have been related to high dominance status (Mazur & Booth 1998). Accordingly, recent research suggests that individuals higher in baseline testosterone levels have a higher drive to gain and maintain high status and are also more responsive to information about their status in particular situations (Josephs et al. 2006). The correlates of a low 2D:4D seem consistent with this interpretation. There is some evidence that 2D:4D is related to traits that are believed to either lead to, maintain, or reflect high status (e.g. gender identity, Csatho et al. 2003; and aggression, Bailey & Hurd 2005; Benderlioglu & Nelson 2004; Millet & Dewitte 2007a). Moreover, a low 2D:4D has indeed been related to markers of high status (Manning & Taylor 2001; Manning 2002; Pokrywka et al. 2005; Sluming & Manning 2000). However, this effect seems to be more pronounced in men than in women (see e.g. Manning & Taylor 2001 and Sluming & Manning 2000). Consistently, Pokrywka et al. (2005) state that androgens may be indispensable in the development of competitive instincts as contests that have evolved to determine social status in the animal world almost exclusively involve males.

Nevertheless, up to now, there is no evidence that low 2D:4D men are more responsive to information about their status in particular situations. Therefore we manipulate the relative position of our participants in two different studies. We propose that a threatened status position should affect low 2D:4D men to a larger extent, resulting in a greater need to restore status. We selected a measure from economic literature, more specifically money discounting (Frederick et al. 2002), as our dependent variable. After all, financial resources are one of the most important sources of power and status (see e.g. Powers & Reiser 2005; Thompson & Subich 2006) and money discounting measures the present need for financial resources. We first review two studies suggesting that low 2D:4D may be associated with a

higher sensitivity to status information, and then argue why money discounting is an appropriate measure of status striving.

First, Josephs et al. (2006) showed that individuals with high measured testosterone levels reacted more strongly to a status threat (as operationalized by a loss in a contest) than low testosterone individuals. As 2D:4D should serve as a marker of prenatal testosterone exposure, we would expect a similar effect. Second, Millet & Dewitte (2007a) showed that the relation between aggression cues (which can be considered as a threat to one's status: Indeed high dominant individuals react immediately and at high level to violent movies, Leyens et al. 1975) and aggressive behavior was stronger for low than for high 2D:4D people. This moderation study supports our claim that low 2D:4D may be associated with cues that signal status information. We therefore put forward that status information will have a larger impact on low 2D:4D men's status related behavior. Wilson & Daly (2004) showed that exposure to attractive women raises for men the value of present money relative to that of future money. They suggested that money that is available in the present can be used in mating effort, whereas future money cannot. Following a similar reasoning, we state that cues signaling an opportunity to raise the status position should make men more present-oriented towards money. After all, it has been shown that financial resources are an important source of status (see e.g. Powers & Reiser 2005; Thompson & Subich 2006) and resource expenditure is more likely to pay off when in a low status position. As Frederick (2006) states: "It is better to eat when hungry, drink when thirsty, and have sex when amorous ... people will prefer experiencing something when it will be most enjoyed." (p. 670). We hypothesize, following a similar reasoning, that money will be most valued when one has a need for high status (thus in a subordinate position). Summarized, we predict that a subordinate position raises discount rates as the present utility of money is higher for men in this position (Hypothesis 1). Moreover, if a low 2D:4D is a marker for a high status drive, this effect should be more pronounced for men with a low 2D:4D than for men with a high 2D:4D. For men with a low status drive, the utility of present money should not change as a reaction to status threat. However, for men with a high drive towards status, the utility of present money should increase as a reaction to status loss. Therefore, we hypothesized that a "subordinate" status position as induced by loss in a contest would raise the discount rates of men with a low 2D:4D in comparison with men with a high 2D:4D. A subordinate status position could make low 2D:4D men more present-oriented to money as money can be used in the effort to raise their status position. Therefore, we expect a more negative relationship

between 2D:4D and level of discounting in a subordinate status position than in a dominant status position (Hypothesis 2).

1.2 METHOD

1.2.1 Study 1

Fifty male undergraduates between 18 and 24 years of age participated in this study. As a manipulation of status, we relied on the bogus performance feedback paradigm (see e.g. Greenlees 1999; Kumashiro & Sedikides 2005). Participants were instructed to engage in a computerized “sudoku”-task. The objective of a “sudoku” type of game is to fill blank squares in a table with correct numbers. In a 9 by 9 square sudoku task consisting of nine 3 by 3 partitions, every row of 9 numbers must include all digits 1 through 9 in any order. Every column of 9 numbers must include all digits 1 through 9 in any order and every mutually exclusive 3 by 3 subsection of the 9 by 9 square must include all digits 1 through 9. Several squares of the table are already filled with numbers. After providing extensive explanation of the task and several examples, we offered participants 10 trials in which several squares were empty. One of these empty squares was indicated. Participants had to click on the number (1-9) that correctly completed that empty square. They had to fill in the correct number as quick as possible. We told them that both the number of correct answers and the time spent to fill in the 10 numbers determined performance on the task. When the task was finished, participants got bogus feedback on their performance. Participants were told that their performance was compared to the performance of participants in a previous study in our lab. In the dominant status condition, participants were informed that they did better than 90.7 % of the participants in a previous study. In contrast, in the subordinate status condition, they were informed that they did better than 11.4 % of the participants in a previous study.

Subsequently, participants engaged in a delay discounting task. Subjects specified the amount of money they would require in one week, one month, three months, six months, and one year to make them indifferent to receiving €15 now (cfr. Thaler 1981). This procedure allows us to specify a discounting value for each participant. We consider the area under the empirical discounting function as a measure of delay discounting (cfr. Myerson et al. 2001).

The area under the curve can vary between 0.0 (steepest possible discounting) and 1.0 (no discounting) (see Myerson et al. 2001 for the details of the adequate procedure to measure this area). The steeper the discounting, the smaller the area under the curve will be. This area measure provides a single, statistically advantageous measure and has no theoretical assumption regarding the form of the discounting function (Myerson et al. 2003). As there is no evidence that hypothetical rewards are discounted differently than real rewards (see e.g. Johnson & Bickel 2002; Lagorio & Madden 2005), we employed a hypothetical delay discounting task.

1.2.2 Study 2

Forty male undergraduates between 18 and 28 years of age participated in the study. Participants had to engage in a cognitive reasoning task to determine their role in an unrelated game afterwards. Before the task began, the computer informed them that they were linked to another unknown participant in the lab against whom they played for a role in an unrelated game afterwards. To determine their role in this game, they received a cognitive task, which was in fact a computerized short-version of Raven Advanced Progressive Matrices test (adapted from Millet & Dewitte 2007b). Participants had to solve as many problems as possible in 5 minutes. In reality this procedure served as a tool to reliably induce a status manipulation afterwards. In fact, everyone was allocated to the same role in the unrelated game. When time was up, participants got the following bogus information: a) in the dominant status condition: “Your opponent was not as good as you on the task. As you won, you have the position of player B in the game.”; b) in the subordinate status condition: “Your opponent was better than you on the task. As you did not win, you have the position of player B in the game.”

Subsequently, participants engaged in a delay discounting task. Subjects specified the amount of money they would require in one week, one month, three months, six months, and one year to make them indifferent to receiving €15 now. This time, we asked them to indicate on a 10-point Likert scale how much money they would require over a specified time interval (1 = 16 euro; 10 = 25 euro). In fact, participants who scored higher on the scale measuring how much money they would require after one week, scored also higher on the items one month, etc. As a result, the internal consistency between the five items was high ($\alpha = .93$),

therefore we decided to sum the scores to one general ‘discounting’ variable. A higher value denoted a higher level of discounting in general.

1.2.3 General methods

After both studies, participants’ right-hand was scanned to measure finger lengths. Participants placed their hand palm on the glass plate of a scanner and we ensured that details of major creases could be seen on the scans. Finger lengths were measured from the ventral proximal crease to the fingertip by means of the Adobe® Photoshop 7 measure tool. When there was a band of creases at the base of the digit we measured from the most proximal crease (cfr. the procedure by Millet and Dewitte 2006). To check for reliability, a second independent rater also measured finger lengths. Both measurements of 2D and 4D were highly correlated (study 1: $r_{2D} = .98$; $r_{4D} = .99$; study 2: $r_{2D} = .99$; $r_{4D} = .98$).

Before starting analyses, a Mahalanobis distance (within condition) was calculated for each participant (based on 2D:4D and discounting) to determine outlying participants in each study (see Barnett and Toby 1994; Hawkins 1980). Mahalanobis distances follow a Chi-Square distribution, in this case with 1 degree of freedom. Participants with a distance higher than the .99 fractile were considered outliers. Accordingly, we identified 1 outlier in study 1 and 1 outlier in study 2 which we excluded from analyses. Moreover, for purposes of clarity, we inverted the discounting scores in study 1 so that higher scores always indicate higher levels of discounting. We made always use of spearman’s correlation coefficients to explore the relationship between 2D:4D and discounting within each specific condition as this is a more robust test in small samples. In both samples, we conducted an ANOVA with condition, 2D:4D and their interaction as independent variables and with discounting as the dependent measure.

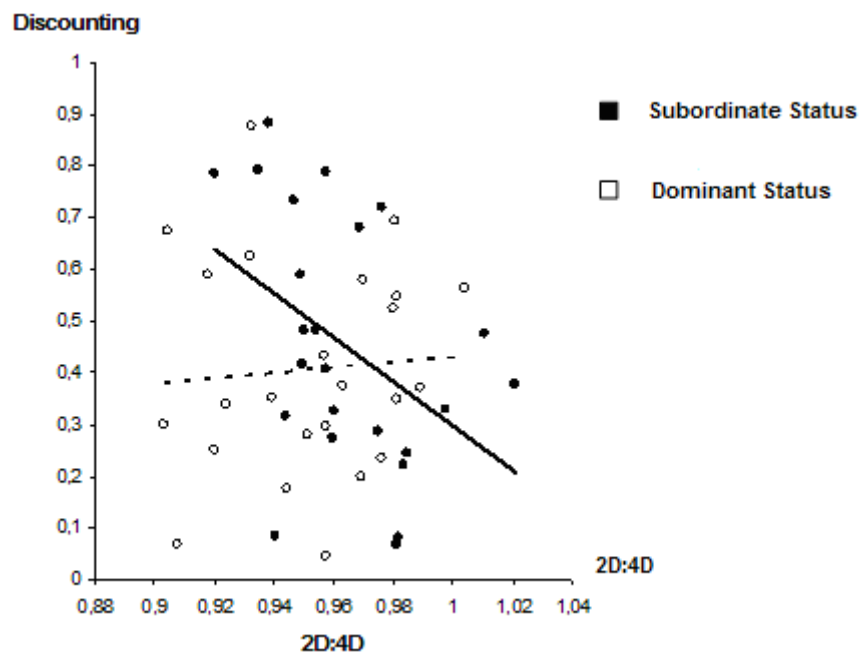
1.3 RESULTS

1.3.1 Study 1

The ANOVA revealed no significant effect of 2D:4D on discounting ($F(1, 45) = 2.15$, $p = .15$, $\eta^2 = .05$). However, a significant main effect of condition ($F(1, 45) = 4.37$, $p = .04$, $\eta^2 = .09$) emerged: Participants discounted more in the subordinate than in the dominant status condition, consistent with hypothesis 1. More importantly, this main effect was qualified by the interaction between 2D:4D and condition ($F(1, 45) = 4.25$, $p = .04$, $\eta^2 = .09$). Further inspection indicated that the relation between 2D:4D and discounting was not significant in the dominant status condition ($r = .14$, $p = .50$). However, there was a significant negative correlation between 2D:4D and level of discounting in the subordinate status condition ($r = -.50$, $p = .01$; see Figure 4.1). This finding is consistent with hypothesis 2.

FIGURE 4.1

Level of Discounting as a function of 2D:4D in the subordinate and dominant status position.

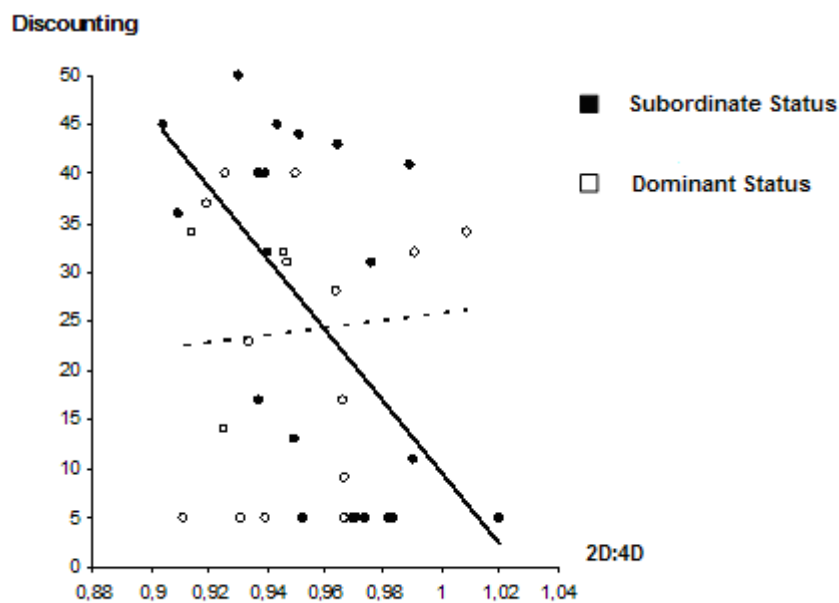


1.3.2 Study 2

The ANOVA revealed no significant effect of 2D:4D on discounting ($F(1, 35) = 3.51, p = .07, \eta^2 = .09$). However, a significant main effect of condition ($F(1, 35) = 5.38, p = .03, \eta^2 = .13$) emerged: Participants discounted more in the subordinate than in the dominant status condition, consistent with hypothesis 1. More importantly, this main effect was qualified by the interaction between 2D:4D and condition ($F(1, 35) = 5.30, p = .03, \eta^2 = .13$). Further inspection indicated that the relation between 2D:4D and discounting was not significant in the dominant status condition ($r = -.03, p = .91$). However, there was a significant negative correlation between 2D:4D and level of discounting in the subordinate status condition ($r = -.60, p = .004$; see Figure 4.2). This finding is consistent with hypothesis 2. We found the same pattern of results for each discounting item separately. We found no relationships between 2D:4D and discounting in the dominant status condition ($r_{1\text{ week}} = -.27, p = .28; r_{1\text{ month}} = .02, p = .94; r_{3\text{ months}} = -.06, p = .82; r_{6\text{ months}} = .12, p = .63; r_{1\text{ year}} = .04, p = .86$), but negative relationships between 2D:4D and discounting in the subordinate condition ($r_{1\text{ week}} = -.58, p = .006; r_{1\text{ month}} = -.46, p = .04; r_{3\text{ months}} = -.59, p = .005; r_{6\text{ months}} = -.54, p = .01; r_{1\text{ year}} = -.55, p = .01$).

FIGURE 4.2

Level of Discounting as a function of 2D:4D in the subordinate and dominant status position.



1.4 DISCUSSION

We manipulated the outcome of two types of contests in two studies and examined the relationship between 2D:4D and subsequent economic decision making, namely money discounting. We found that a subordinate position raises discount rates, consistent with our reasoning that the present utility of money is higher for men in this position. Moreover, this effect was especially pronounced for men with a low 2D:4D. There was a significant negative relationship between 2D:4D and level of discounting in a subordinate status position, but no significant relationships emerged in the dominant status position. We found this pattern for two different manipulations of status and two different measures of discounting, testifying to the robustness of the results.

The contribution of our paper is fourfold. First, our findings add to the vision of Wilson & Daly (2004) that future discounting varies adaptively, and suggest that money discounting may be more vulnerable to ephemeral social experiences than has been appreciated. Second, these are the first experimental studies to show that low 2D:4D is a marker for a high status drive, as the effect of status position on discounting levels is especially pronounced for men with a low 2D:4D. As our data point to a higher status drive in low 2D:4D participants, we provide support for the conclusion of Hönekopp et al. (2006) that 2D:4D in men may be a negative correlate of frequent exercise which then relates to achievement in sports and athletics. Moreover, our findings are consistent with recent research showing that individuals with high saliva testosterone levels have a strong preference for a dominant status position or a strong aversion to a subordinate status position (Josephs et al. 2006). Third, in accordance with Van den Bergh & Dewitte (2006) and Millet & Dewitte (2007a), our findings also stress the importance of contextual variables that may moderate associations between 2D:4D and aspects of phenotype or personality. Such moderation effects may elucidate puzzling inconsistencies in recent 2D:4D research. Fourth, we show that it may be important to further investigate the relationship between digit ratio and different types of economic behavior. It has recently been shown that digit ratio is related to decisions in a public good game (Millet & Dewitte 2006) and in an ultimatum game (Van den Bergh & Dewitte 2006). Our study adds to this line of research by showing another relationship between 2D:4D and economic behavior. Therefore, both their and our findings suggest that a combination of more biological inspired literature with economic literature may be a promising avenue for future research (Robson 2001).

With respect to future research, we call for replications of our general claim that low 2D:4D in men is associated with (1) a higher sensitivity to status cues and (2) a stronger urge to engage in status enhancing or status maintaining strategies in circumstances in which the status position is threatened. Our data may also point at a process that eventually leads low 2D:4D men to reach higher status positions. When men with a low 2D:4D find themselves in a subordinate status position, they may react strongly, for instance by discounting the future. This may make them more willing to abandon the present activity or to exit the current situation. In the end, this process may increase their chances of finding an activity in which they have the capabilities to outperform their peers, which eventually should increase their social status. The findings that low 2D:4D in men is related to high status in sports (Manning & Taylor 2001) and music (Manning 2002; Sluming & Manning 2000) is consistent with this perspective.

MANUSCRIPT V:

DIGIT RATIO MODERATES THE IMPACT OF A VIOLENT MUSIC VIDEO ON AGGRESSIVE AND COOPERATIVE BEHAVIOR⁹

ABSTRACT

Digit ratio (2D:4D) is a sexually dimorphic trait. Evidence suggests that more masculine, lower digit ratios (index fingers, 2D, compared to ring fingers, 4D) are influenced by higher prenatal testosterone levels. Testosterone and aggression are related and, accordingly, evidence suggests that 2D:4D is related to aggression. As it has been shown that violent media have an impact on aggressive behavior, we predict that the relationship between 2D:4D and aggression should be stronger when exposed to a violent than to a non-violent music video. We show that 2D:4D and aggression (as measured by two different measures) are related, but only after exposure to the violent video (study 1). A similar relationship holds for cooperative decision making (study 2). Consistent with recent literature, 2D:4D is negatively related to fair allocations in the neutral condition, but positively after exposure to a violent video. We call for future 2D:4D research which focuses on plausible interactions between 2D:4D and context cues rather than on linear relations.

⁹ Study 1 in this manuscript is adapted from Millet, K., & Dewitte, S. (2007). Digit ratio (2D:4D) moderates the impact of an aggressive music video on aggression. *Personality and Individual Differences*, 43, 289-294.

1.1 INTRODUCTION

Violence is omnipresent in modern media such as video games, music videos, movies, computer networks etc. (Anderson et al. 2003). There is no doubt that media violence may have harmful effects. Several field studies and laboratory experiments show that e.g. violent music videos have an impact on antisocial and aggressive behavior or on the acceptance of such behavior (see e.g. Anderson, Carnagey & Eubanks 2003). The same applies to violence in video games and other types of media (see e.g. Anderson & Bushman 2001). From a public policy point of view, reducing the impact of violent media on behavior is desirable (Grier 2001). However, it remains difficult to determine whether and to what extent modern society should take action to reduce high rates of exposure to media violence, and if so, what public policies would likely be the most effective. Formulating recommendations and restrictions to restrain entertainment industries requires a further understanding of the impact of violent media on aggressive behavior. Adopting a risk factor approach may be particularly beneficial when attempting to determine public policies regarding exposure to media violence (Gentile & Anderson 2006). A risk factor approach acknowledges many risk factors for a certain behavior. Each factor elevates the risk for that behavior, although it is not a sufficient cause. With enough risk factors, it becomes very likely that an individual will behave e.g. inappropriately aggressive at a certain moment (Gentile & Anderson 2006). For example, cigarette smoking is not a necessary and sufficient cause of lung cancer, even though it is a major cause of it. Exposure to violent media is only one risk factor. The influence of violent media is best viewed as one of the many potential factors that influence the risk for violence (Huesmann & Taylor 2006). None of the risk factors are "necessary and sufficient" causes of extreme aggression. Accordingly, an important question pertains to the generality of the effect of violent media on aggression: who is most susceptible to media violence influences?

In our paper, we follow the argument of Huesmann (2006) that “the case against media violence, like the case against other potential public health threats, must be made by integrating the evidence from multiple approaches to research.” (p. 394). We explore the role of digit ratio in the reactivity to violent music videos. Following recent literature, evidence suggests that the ratio between the length of index (or second digit, 2D) and ring (or fourth digit, 4D) finger or “2D:4D” reflects the influence of prenatal testosterone during development. A higher 2D:4D indicates a lower level of prenatal testosterone exposure (see

e.g. Csatho et al. 2003; Manning 2002; Manning, Scutt, Wilson & Lewis-Jones 1998; Williams, Greenhalgh & Manning 2003). Moreover, studies that associate 2D:4D with variables hypothesized to be related to high prenatal androgens provide converging evidence (see e.g. van Anders, Vernon & Wilbur 2006). In addition, recent research has suggested that prenatal testosterone levels are associated with later aggressiveness in both non-human primates (Tomaszycki, Gouzoules & Wallen 2005) and humans (Bailey & Hurd 2005; Benderlioglu & Nelson 2004; Cohen-Bendahan et al. 2005). Further, persons associated with the mass media often allege that observed violence affects the behavior of only certain persons who are highly aggressive by nature (Bushman & Geen 1990). Therefore we want to explore the role of digit ratio in the reactivity to aggressive music videos on aggression (study 1) and a negative correlate of aggression: cooperative behavior (study 2).

1.2 STUDY 1

Bailey and Hurd (2005) showed a negative relationship between male 2D:4D and physical aggression (using Buss and Perry's (1992) aggression questionnaire). Benderlioglu and Nelson (2004) provided evidence that low female 2D:4D was associated with reactive aggression when sufficient provocation was present. As it has been shown that both violent media and 2D:4D have an impact on aggression (e.g. Anderson et al. 2003; Bailey and Hurd 2005, respectively), we hypothesize that the effect of exposure to a violent music video on physical aggression scores should be attenuated for individuals with a high 2D:4D. In other words, we expect a stronger relationship between 2D:4D and aggression measures after exposure to an aggressive than to a non-aggressive video. We do not make a priori predictions about interactions between 2D:4D and sex, as the findings in the literature are not unequivocal.

1.2.1 Method

Ninety-six undergraduate students (47 men) between 18 and 24 years of age were exposed to a violent or non-violent 4-minutes music video of the same band (resp. "Rosenrot" and "Kein Lust" from the Metal-band Rammstein). Next, to check our manipulation, we asked on a visual analog scale: (a) "To what extent has physical aggression been shown in the

video?” (0: not at all; 100: very much); (b) “How aggressive does this video look in general?” (0: not aggressive at all; 100: very aggressive). We used the average of both variables ($r = .82$) to obtain a manipulation check. Subsequently, we presented 5 provoking situations which were selected from the Aggression Provocation Questionnaire, a questionnaire designed to assess one’s tendency to act aggressively when presented with a hypothetical set of provoking situations (O’Connor, Archer & Wu 2001; see appendix C). For each situation, participants were asked to indicate (on a 5-point Likert scale) how angry, irritated, and frustrated they would feel. Internal reliability of the resulting 15 answers was adequate ($\alpha = .77$), therefore we calculated one sum score with a higher score indicating a higher *provoked aggressive tendency*. Afterwards, participants completed the 9-item physical aggression scale of Buss and Perry’s (1992) aggression questionnaire (on a 7-point Likert scale) as it has been shown in previous research that male 2D:4D was related to these physical aggression scores (Bailey and Hurd 2005). Internal reliability of the items was high ($\alpha = .85$), so we calculated one sum score indicating *physical aggression*. Subsequently, participants’ right-hand was scanned to measure finger lengths. Participants placed their hand palm on the glass plate of a scanner and we ensured that details of major creases could be seen on the scans. Finger lengths were measured from the ventral proximal crease to the fingertip by means of the Adobe® Photoshop 7 measure tool. When there was a band of creases at the base of the digit we measured from the most proximal crease (cfr. Millet and Dewitte’s (2006) procedure). To check for reliability, a second independent rater also measured finger lengths. Both measurements of 2D and 4D were highly correlated ($r_{2D} = .98$; $r_{4D} = .99$).

1.2.2 Results and discussion

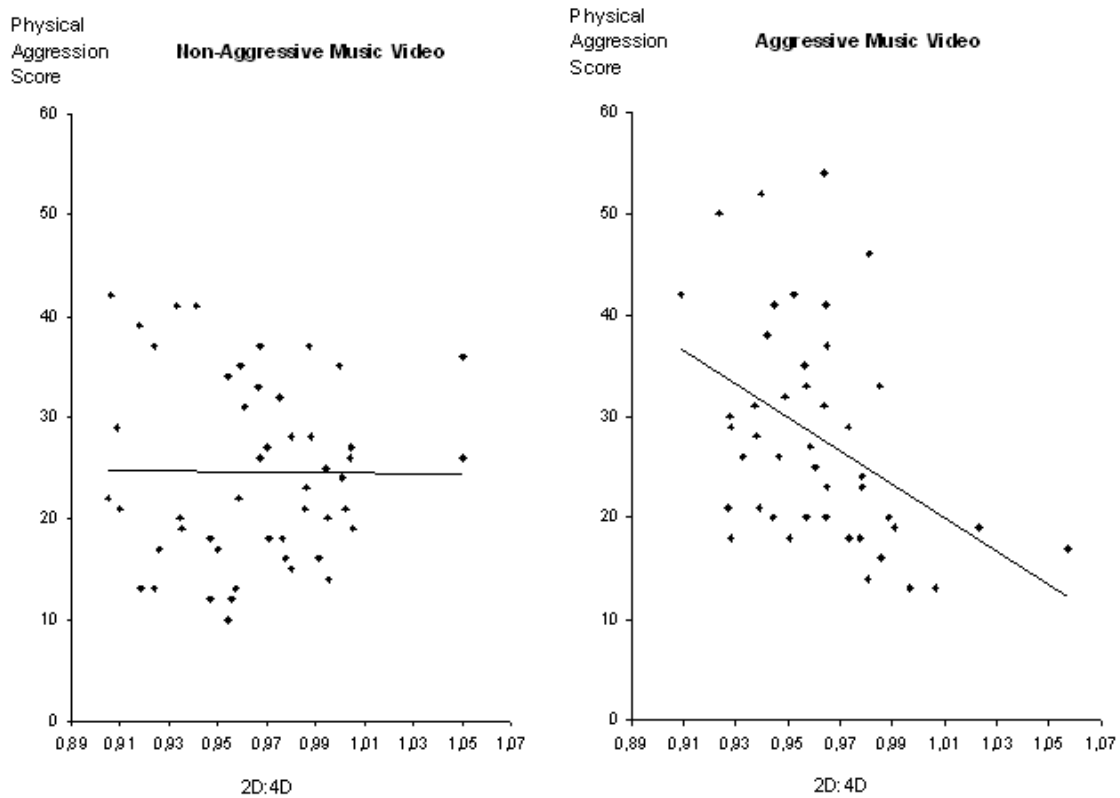
The manipulation check indicated that the violent video ($M = 78.31$, $SD = 18.02$) was perceived as more aggressive than the non-violent video ($M = 45.41$, $SD = 21.53$; $t(94) = 8.10$, $p < .001$). In accordance with previous literature (e.g. Lippa 2006; Manning 2002; Romano, Leoni & Saino 2006), 2D:4D was significantly lower for men ($M = .956$ and $S.D. = .027$) than for women ($M = .968$ and $S.D. = .033$; $t(94) = 2.08$, $p < .05$). After removing two outliers (Barnett and Toby 1984; Hawkins 1980)¹⁰, we conducted an ANOVA with gender,

¹⁰Within gender and condition, a Mahalanobis distance was calculated for each participant (based on 2D:4D and aggression) to determine outlying participants. Mahalanobis distances follow a Chi-Square distribution, in this case with 1 degree of freedom. Participants with a distance higher than the .995 fractile were considered outliers. We identified the same 2 outliers with both dependent measures of aggression.

condition, 2D:4D and all their interactions as independent variables and with respectively physical aggression and provoked aggressive tendency as dependent measures. Men scored higher on physical aggression than women ($F(1, 86) = 4.09, p < .05, \eta^2 = .05$). Further, we obtained a significant main effect of 2D:4D ($F(1, 86) = 5.62, p < .05, \eta^2 = .06$): 2D:4D was negatively related to physical aggression ($r = -.23$). We also found a significant main effect of Video ($F(1, 86) = 6.38, p < .05, \eta^2 = .07$), indicating that participants reacted more aggressively after exposure to the violent ($M = 27.80, SD = 10.79$) than to the non-violent video ($M = 24.61, SD = 8.97$). More importantly, both main effects were qualified by the interaction between 2D:4D and condition ($F(1, 86) = 6.11, p < .05, \eta^2 = .07$). The correlation between 2D:4D and the physical aggression score was not significant in the non-violent condition (Spearman's correlation coefficient, $r = -.03, p = .85$), but there was a negative correlation between 2D:4D and physical aggression score in the violent condition ($r = -.46, p < .001$; see Figure 1). Further, the interaction between 2D:4D and gender was marginally significant ($F(1, 86) = 3.78, p = .06, \eta^2 = .04$). In general, the correlation between 2D:4D and the physical aggression score was not significant for women (Spearman's correlation coefficient, $r = -.06, p = .67$), but there was a negative correlation between 2D:4D and physical aggression score for men ($r = -.32, p < .05$). When we do not take the conditions into consideration, we replicate the finding of Bailey and Hurd (2005) that physical aggression scores are related to 2D:4D in men, but not in women. No other effects on physical aggression scores approached significance (all $F_s < 0.13, p > .70$). Concerning the provoked aggressive tendency measure, we obtained very similar results. We again obtained a significant main effect of 2D:4D ($F(1, 86) = 4.78, p < .05, \eta^2 = .05$). We also found a significant main effect of Video ($F(1, 86) = 4.99, p < .05, \eta^2 = .06$). More importantly, both main effects were qualified by the interaction between 2D:4D and condition ($F(1, 86) = 4.98, p < .05, \eta^2 = .06$). The correlation between 2D:4D and provoked aggressive tendency was not significant in the non-violent condition (Spearman's correlation coefficient, $r = .06, p = .70$), but there was a negative correlation between 2D:4D and provoked aggressive tendency in the violent condition ($r = -.32, p < .05$). No other effects on provoked aggressive tendency approached significance (all $F_s < 1.61, p > .20$).

FIGURE 5.1

Physical Aggression Score as a function of 2D:4D in the non-violent and violent music video condition.



Our data provide new insights into two separate lines of research. We replicate the main effects on aggression of violent videos (Johnson, Jackson and Gatto, 1995) on the one hand and of low 2D:4D (Bailey and Hurd 2005) on the other hand. More importantly, we show that for individuals with a high 2D:4D (an index of low prenatal testosterone exposure), the link between media violence and corresponding reactions is dramatically attenuated.

1.3 STUDY 2

In this study we want to replicate the findings of study 1, but with a different measure. We focus on the effect of digit ratio in the reactivity to violent music videos on cooperative decision making in a dictator game. One player, the “dictator”, determines an allocation (split) of a fixed amount of money to himself and one other, the “recipient”. The recipient in this

case simply receives, so the recipients' role is entirely passive. Dictator and recipient do not know each other's identity. We choose a dictator game as this extends our knowledge of the relationship between 2D:4D and "fair" decision making to another type of game than fair decision making in public good and ultimatum games. Acting cooperatively in the public good game and higher minimal acceptance levels in an ultimatum game reflect a strong preference for the fair share and are both related to a low 2D:4D in a neutral context (resp. Millet & Dewitte 2006 and Van den Bergh & Dewitte 2006). Higher levels of cooperation (i.e. higher allocation levels of the dictator) in the dictator game reflect also a strong preference for the fair share. Therefore, we predict a *negative* relationship between 2D:4D and cooperation in the neutral condition (Hypothesis 1). However, we expect the opposite effect in the violent music video condition. It has been shown that violent media have an impact on cooperative decision making (Sheese & Graziano 2005). Participants in their study were less likely to cooperate in a prisoner's dilemma game after playing a violent video game than after a nonviolent game. Moreover, the evidence of study 1 shows that a violent music video has a more pronounced impact on participants with a low 2D:4D. Therefore, after exposure to a violent music video, we expect lower cooperation levels in participants with a low 2D:4D. Consequentially, we predict a *positive* relationship between 2D:4D and cooperation in the violent music video condition (Hypothesis 2). Both hypotheses combine to the prediction that aggression cues will moderate the effect of 2D:4D on cooperation.

1.3.1 Method

One hundred twenty-one undergraduate students (51 men) between 18 and 29 years of age were exposed to a violent or non-violent 4-minutes music video of the same band (resp. "Rosenrot" and "Kein Lust" from the Metal-band Rammstein; cfr. Study 1). Next, to check our manipulation, we asked on a visual analog scale: (a) "To what extent has physical aggression been shown in the video?" (0: not at all; 100: very much); (b) "How aggressive does this video look in general?" (0: not aggressive at all; 100: very aggressive). We used the average of both variables ($r = .78$) to obtain a manipulation check. Subsequently, we introduced a dictator game. Although the use of real money is desirable for obvious reasons, there is, as of yet, no clear evidence that the allocation of real vs. hypothetical money influences money allocation in such type of economic game experiments. On the contrary, Ben-Ner & Levy (2005) compared behavior in economic dictator game experiments played

with actual money (amounts given by "dictator" subjects) with behavior in hypothetical dictator game experiments where subjects indicate what they would give, although no money was actually exchanged. They found that average amounts transferred in both types of experiment were remarkably similar. Therefore, we employed a hypothetical dictator game. Participants were allocated to the "dictator" position and had to answer the following question on a visual analog scale: "Suppose you are entitled to allocate 10 euro between you and an arbitrary other in the lab that you do not know (e.g. If you give 5 euro to the other, you keep 5 euro for yourself. If you give 3 euro to the other, you keep 7 euro for yourself.). How much would you give to this other? (0: 0 euro; 100: 10 euro)." Afterwards, participants' right-hand was scanned to measure finger lengths. Participants placed their hand palm on the glass plate of a scanner and we ensured that details of major creases could be seen on the scans. Finger lengths were measured from the ventral proximal crease to the fingertip by means of the Adobe® Photoshop 7 measure tool. When there was a band of creases at the base of the digit we measured from the most proximal crease (cfr. study 1). To check for reliability, a second independent rater also measured finger lengths. Both measurements of 2D and 4D were highly correlated ($r_{2D} = .99$; $r_{4D} = .99$).

1.3.2 Results and discussion

The manipulation check indicated that the violent video ($M = 82.96$; $SD = 11.17$) was perceived as more aggressive than the non-violent video ($M = 35.88$, $SD = 23.77$; $t(119) = 14.05$, $p < .001$). In accordance with previous literature, 2D:4D was significantly lower for men ($M = .948$ and $S.D. = .030$) than for women ($M = .964$ and $S.D. = .029$; $t(119) = 2.90$, $p < .01$). After removing two outliers (Barnett and Toby 1984; Hawkins 1980)¹¹, we conducted an ANOVA with gender, condition, 2D:4D and all their interactions as independent variables and with contribution in the dictator game as a dependent measure. We found a significant main effect of Video ($F(1, 111) = 8.14$, $p < .01$, $\eta^2 = .07$), indicating that participants contributed less after exposure to the violent ($M = 34.15$, $SD = 20.28$) than after exposure to the non-violent video ($M = 36.49$, $SD = 19.00$). More importantly, this main effect was qualified by the interaction between 2D:4D and condition ($F(1, 111) = 8.00$, $p < .01$, $\eta^2 =$

¹¹Within gender and condition, a Mahalanobis distance was calculated for each participant (based on 2D:4D and cooperation) to determine outlying participants. Mahalanobis distances follow a Chi-Square distribution, in this case with 1 degree of freedom. Participants with a distance higher than the .995 fractile were considered outliers.

.07). In accordance with hypothesis 1, the correlation between 2D:4D and contribution level was negative in the non-violent condition ($r = -.31, p < .05$), replicating the findings of Millet & Dewitte (2006) and Van den Bergh & Dewitte (2006). However, in accordance with hypothesis 2, there was a positive relationship between 2D:4D and contribution level in the violent condition ($r = .24, p < .06$). No other effects on cooperation approached significance (all F s $< .43, p > .51$).

We replicated the effect of violent media on cooperative decision making (Sheese & Graziano 2005) and generalize the “game”-effect to exposure to music videos. Violent media may have a negative impact on social behavior. Moreover, we replicated the moderating effect of 2D:4D on the link between exposure to a violent music video and a negative correlate of aggression, namely cooperation in a dictator game, which we also found in Study 1. We show that, in a neutral context, 2D:4D is negatively related to cooperative “fairness-concerned” decisions in a dictator game. This is consistent with previous literature (Millet & Dewitte 2006 and Van den Bergh & Dewitte 2006). However, we show that this relationship is inverted when participants are exposed to an aggressive music video. When participants with a low 2D:4D are cued with aggression by violent media, they are more likely to abandon fair decision making and to act in an aggressive manner. Consequentially, our study demonstrates that a subtle cue related to aggression is able to impact economic decision-making.

1.4 DISCUSSION

In the two presented studies, we manipulated exposure to violent music videos and examined the relationship between 2D:4D and respectively aggression and cooperation. We showed that the link between violent media and corresponding reactions is dramatically attenuated for individuals with a high 2D:4D (an index of low prenatal testosterone exposure). This has several implications. Until now, most research has been devoted to exploring relationships between 2D:4D and other variables and typically yielded modest correlations. It remains unclear how important 2D:4D really is in explaining human behavior. In our opinion, an important avenue for future research is focusing on interactions with situational cues. To our knowledge, only one such study has appeared (Van den Bergh and Dewitte 2006), which showed that the effect of sex cues on economic decision making was much stronger among

men with a low 2D:4D, or in other words, that the correlation between 2D:4D and economic decision making dramatically differed depending on the presence of sex cues. Our study reports another interaction. Both studies have in common that the correlation between 2D:4D and behavioral variables are much stronger in certain circumstances. We add support to the remark of Van den Bergh and Dewitte (2006) that context effects may elucidate puzzling inconsistencies or may be responsible for the fact that some results are hard to replicate. Accordingly, we call for future research with a focus on interactions between 2D:4D and context cues which may attenuate or strengthen the link between 2D:4D, other personality variables, and relevant human behavior. In addition, it would also be of interest to identify the mediators between 2D:4D and behavior. It has recently been shown by Klinesmith, Kasser and McAndrew (2006) that males who interacted with a gun showed a greater increase in testosterone levels and more aggressive behavior than did males who interacted with a toy. Mediation analyses suggested that part of the effect of guns on aggressive behavior was due to increases in testosterone levels. Assuming that violent music videos also increase testosterone levels, a higher susceptibility to circulating testosterone in low 2D:4D participants may be the driving factor behind our (and related) effects. Identifying mediators (such as an increase in testosterone levels) is an avenue for future research. Also the mechanism behind the effect of violent media on aggression needs further exploration. An important research question concerns the link between activation of aggressive concepts and aggressive action itself. For the moment it is not clear whether just an aggression prime such as a picture of a gun (see Anderson et al. 1998) induces more aggressive cognitions and according behavior in low 2D:4D people. One possibility is that subtle aggression primes induce aggressive cognitions just as much for everyone, but lead only to more aggressive actions in people with a low 2D:4D. More research is needed on the question when aggressive cognitions lead to aggressive behavior and under what circumstances this effect is most likely to occur.

Finally, as we are the first to show that 2D:4D moderates the effect of a violent music video on aggressive and non-cooperative behavior, caution is needed in the interpretation of our results. Nevertheless, we think that these studies add to the literature on which public policy may focus for future research and inspiration. One interesting route for future research is to look at the typical consumer type that purchases violent media. Although we showed that the impact of violent media seems to be especially pronounced for people with a low 2D:4D, the question remains whether people with a low 2D:4D are also most interested in these types

of media. Further investigation into the typical consumer characteristics of people interested in and affected by violent media seems to be necessary to take appropriate policy measures and to apply effective social marketing strategies.

GENERAL DISCUSSION

This dissertation attempted to illustrate, in five different manuscripts, that biologically inspired research may give additional value to traditional research on both economic and consumer behavior. In this discussion I summarize for both sections the main findings of the different manuscripts and subsequently propose for each some ideas for future research projects.

A Costly Signaling Perspective

In the first two manuscripts we investigated altruistic and non-conformist consumer behavior from the perspective of costly signaling theory, a framework developed in biology for the purpose of explaining animal behavior. In manuscript I, we found support for the idea that the underlying quality behind unconditional altruism might be general intelligence. Those who contributed more than their fair share to a public good were more intelligent, as measured by two relatively independent measures of general intelligence. We also showed that those who possess a dispositional tendency to value joint benefits more than their own, scored higher on an intelligence test. These findings are consistent with a costly signaling perspective. As general intelligence seems to be an indicator of future resources, someone with high cognitive skills may be able to donate more in advance than someone with less cognitive skills. As such, the cost of altruistic behavior could be quality-dependent. In manuscript II, we follow the same line of argumentation and show both on scale measurements and on behavior that non-conformist consumer behavior is positively related to general intelligence. Moreover, we also showed that the most intelligent people in our study did not care whether they conformed or not to the prevalent norm in the group although less intelligent people did. Doing things that others find strange or acting differently from your social environment notwithstanding the social pressure, requires strength (i.c. intelligence). Although it is difficult to resist the pressure of social norms, our data suggest that this is not as difficult for highly as for less intelligent people.

We indicated already some routes for future research in the discussions of manuscripts I and II. As we mentioned before, altruistic behavior may serve as a general fitness indicator,

and not only as indicator of general intelligence. The same reasoning also applies to non-conformity. One potential variable of interest is body symmetry or so-called fluctuating asymmetry (FA). FA is a potentially important phenotypic marker of good genes (Thornhill & Gangestad 1999). FA reflects nondirectional deviation from perfect bilateral symmetry in traits that are, on average, bilaterally symmetric (e.g. hands, legs, cheeks, etc.). FA reflects the ability to deal with stresses, both genetic and environmental, during development. A higher degree of symmetry is believed to indicate a better coping system for environmental factors and more developmental stability: Disruptions of growth and development caused by parasites and pathogens perturb our symmetry and leave a permanent trace in terms of right-left differences. It requires a sound metabolism and a good deal of physiological precision to grow perfectly symmetrical features. Therefore, the extent of symmetry may indicate phenotypic and genotypic quality. Consistently, there is abundant evidence that FA is increased by mutations, parasitic infections and environmental stress (e.g. Cartwright 2000; Leary & Allendorf 1989; Manning & Chamberlain 1994). Moreover, Prokosch et al. (2005) cite evidence that FA predicts negatively (i.e., body symmetry predicts positively): health, fecundity, quality of fitness-related traits, social dominance, and mating success across many species, including humans. In addition, recent lines of research showed that body symmetry is substantially positively (i.e. FA negatively) correlated with scores on a Raven Progressive Matrices Test (Luxen & Buunk 2006; Prokosch et al. 2005). Prokosch et al. (2005) consequentially conclude that that there is substantial overlap between morphodevelopmental stability (as manifest in body symmetry) and neurodevelopmental stability (as manifest in general intelligence, measured by a raven progressive matrices test). These findings may suggest a positive relationship between general fitness indicators (different from general intelligence) and both altruism and non-conformity. If future research shows similar relationships between respectively altruism or non-conformity and FA, these behaviors might serve as reliable costly signals of 'general fitness' rather than of the more specific trait that we focused on, namely general intelligence.

Besides the question about the generality of the quality signaled by altruism and non-conformity, there are still many research questions left to answer. Although we showed evidence that general intelligence is related to altruistic behavior, we did not prove that altruistic behavior effectively serves as a costly signal. To find further evidence for altruistic behavior as a costly signal of general intelligence or other fitness indicators, future research should provide additional checks, for instance by manipulating the cost of altruistic behavior.

Costly signaling theory predicts that when the cost of the behavior (e.g. altruism) is higher, the link between the quality (e.g. intelligence) and the behavior should become more reliable. This means that in an experimental study the relation between altruistic behavior and intelligence should be stronger in the high than in the low cost condition. The same reasoning applies to non-conformist behavior. We predict that the relationship between non-conformity and general intelligence is stronger when the cost of a non-conformist act is higher. As we already mentioned in our manuscript, we assume that as social pressure increases, the frequency of non-conformist acts decreases. Being among the few ones who act differently in circumstances of high social pressure then may serve as an even more reliable signal of high intelligence. Therefore, the frequency of behavior may indicate the strength of the “non-conformist” signal. Thus, one objective for future research may lie in the manipulation of the threat that engaging in non-conformist behavior entails. When the threat of non-conformist choice behavior becomes larger, we expect that fewer people would choose the unconventional option and thus the difference in intelligence between both groups (those who choose the conformist option and those who do not) would become larger. Recently, it has been shown that people were more likely to conform when they were exposed to a threat, that is, when they have an active self-protection motivational state (Griskevicius et al. 2006). After all, a threat induces uncertainty, which induces people to follow the group. As a consequence the cost of non-conformity becomes larger in this situation. As we supported the argumentation that the cost of non-conformity is not as high for highly intelligent people, we predict that the effect of manipulated threat (high vs. low) is higher for less than for highly intelligent people, or in other words, that the relationship between general intelligence and non-conformity becomes larger under threatening circumstances (e.g. during economic recessions).

Another implication, which has not been investigated up to now, is the ‘cost-dependent perception’ of the behavior as a signal of a certain quality. The application of costly signaling theory to altruistic behavior implies that an observer has more certainty about the actor’s quality as the cost of the altruistic act becomes larger. After all, the higher the cost, the more difficult it becomes for people with low levels of the underlying quality to afford the cost associated with the signaling behavior. One option is to give information to participants of altruistic or non-conformist acts and to manipulate elements in the information which have an impact on the perceived cost of the behavior. Altruistic or non-conformist behavior should be perceived as more intelligent in the high than in the low cost condition.

Related to this, investigating reputational benefits of different types of costly behavior executed under different cost circumstances may be an appealing route for further research.

Digit Ratio & Economic Behavior

The second section of my dissertation focused on the role of 2D:4D in economic decision making. First, we focused on the relationship between status and 2D:4D. In manuscript III, we found - in contrast to our hypothesis - that a low 2D:4D was related to norm-consistent cooperative behavior. This finding is consistent with recent findings by Van den Bergh & Dewitte (2006) that men with lower digit ratios state higher minimum acceptance levels in an ultimatum game and that people with a low 2D:4D tend to give more in a dictator game in a neutral context (study 2 of manuscript V). People with a low 2D:4D seem to have a preference for fairness in economic decision making. This brings us to the question whether 2D:4D is also related to reactions to fairness- or norm-violations in cooperative decision making and whether these effects generalize to fair decision making in general. It has been shown that people punish defectors in a public good game, even at a cost to themselves (Fehr & Gächter 2002). Exactly because of this cost, such a behavior has been called ‘altruistic punishment’ and has recently been extensively investigated in behavioral economics. As the level of punishment is dependent on the level of defection, and as people caring for fair behavior (cooperators) are more likely to punish (Fehr & Gächter 2002), we predict that altruistic punishment is related to a low 2D:4D. In addition, it would be interesting to investigate whether low 2D:4D people would care more for justice in general and how they would react to perceived unfairness. When the proposition holds true that they are more susceptible to injustice and react more strongly to perceived unfairness, various avenues are open for future research in consumer behavior. After all, perceived fairness has been considered as an important factor in consumer decision making (e.g. fair negotiations, see Buchan, Croson, & Johnson 2004). Conflicts between firms and dissatisfied consumers often revolve around the perceived fairness of a transaction. Accordingly, the concept of perceived justice has been applied in marketing contexts to study consumer responses to dissatisfaction (see e.g. Blodgett et al. 1993). Although relatively unexplored, Bechwati & Morrin (2003) state that consumer vengeance (i.e. the desire to get even with e.g. a firm in response to a perceived wrong doing) is an important behavioral phenomenon as “it takes only a few very disgruntled consumers to initiate a potentially devastating chain of events

affecting a firm's brand" (p. 449). Therefore, as 2D:4D is also related to aggression under certain circumstances (manuscript V), taking into account the moderating role of 2D:4D on consumer vengeance may be a fruitful area of future research.

As characteristics other than status considerations seemed to come into play in our study in manuscript III (see above), we decided to investigate the relationship between 2D:4D and status in a different way. In manuscript IV, we manipulated participant's perceived status by giving bogus feedback on the outcome of a contest. In two studies using different status manipulations, we examined the relationship between 2D:4D and subsequent economic decision making, namely money discounting. We proposed that a threatened status position should affect low 2D:4D men to a larger extent, resulting in a greater need to restore status. As financial resources are one of the most important sources of power and status for humans (see e.g. Powers & Reiser 2005) and the need for a certain good increases discounting in that domain (see e.g. Giordano et al. 2002), we argued that low 2D:4D men would discount more when they got low status feedback, which was supported by our data. Our data may point at a process that eventually leads low 2D:4D men to reach higher status positions. When men with a low 2D:4D find themselves in a subordinate status position, they may react strongly, for instance by discounting the future. This may make them more willing to abandon the present activity or to exit the current situation. Consequentially, people with a low 2D:4D may obtain high status positions in any domain, because they may shift domains until they find one in which they can excel.

One other route for future research is manipulating the perceived status meaning of a certain behavior. When some behavior has a high status valence, we expect low 2D:4D people to adopt this behavior more eagerly than high 2D:4D men. Nevertheless, when the same behavior has a low status valence, low 2D:4D men should try to avoid that type of behavior. Huberman et al. (2004) showed that applause induces 'irrational' behavior (over-investing in a game) for status-seeking participants. Therefore, one possibility is to use a public good game (cfr. manuscript I and III) and to evaluate altruistic behavior before one comes into the game: the altruistic choice either is received with applause or booing. When low 2D:4D participants effectively have a stronger urge to obtain status than high 2D:4D participants, we should find that low 2D:4D participants react more strongly to the manipulation. The difference in altruistic behavior between the applause and the boo evaluation condition should be larger for them than for high 2D:4D people. Another way to test implications of this

hypothesis might be manipulating the visibility of 'high reputation' behavior. It has been shown that giving in a public good game might increase someone's reputation when the behavior is visible (Wedekind & Milinski 2000). We propose to run a public good game without provision point (each investment is doubled and equally divided among all participants). When the behavior is visible (in a 'public' condition), we expect that 2D:4D and the amount of investment in the public good would be negatively associated. After all, low 2D:4D participants would give more as their reputation is at stake. Nevertheless, in a private condition this relationship should be attenuated as status motives are not present anymore. We predict a different relationship than the one we showed in manuscript III as we made use there of a public good game with fixed provision point, which induces clear norms. Cooperative norms are not that salient anymore in a public good game without fixed provision point.

Other implications of our findings for future research lie in the generalization to other types of consumer behavior than money discounting. For example, as low 2D:4D people in a low status position want to get out of the low status position, they may have a higher willingness to pay for products which might signal a higher status, but not necessarily for all types of products. Another possibility might be that people with a low 2D:4D in a subordinate status position will just act more impulsively in general. After all, an alternative 'emotional' explanation may drive our results. Low 2D:4D people may have more negative feelings in a low status position than others, which makes them more vulnerable to temptations in general, and hence are more likely to engage in impulsive behavior in general (for the effect of bad mood on impulsive behavior, see e.g. Tice et al. 2001). Therefore, the same procedure with measures of affect and other types of impulsive behavior as dependent measures might be appropriate to test these hypotheses. Summarized, further research on the interaction between relative status position and 2D:4D might shed another light on some specific types of consumer impulsiveness.

The findings in manuscript V on the relationship between 2D:4D, violent media and aggression also opens several avenues for future research. It has already been extensively shown that exposure to violent behavior on film or television tends to increase aggressive behavior in the short term (see review e.g. by Bushman & Huesmann 2001). Our research fits into one of the five research questions on media violence that Anderson et al. (2003) identified: who is most susceptible to media violence influences? We showed in manuscript V that especially participants with a low 2D:4D are susceptible to violent music videos. Low

2D:4D people acted in a more aggressive and less pro-social way after exposure to an aggressive music video. This highlights the role of hormonal related predispositions in aggressive reactions elicited by environmental cues. Moreover, our research brings on another moderator into the public policy debate about the impact of media violence on aggressive behavior. For the moment, there is a lot of debate on the impact of violence in video games. Recent research findings show that violent video games have an impact on aggressive (Anderson 2001) and non-cooperative behavior (Sheese & Graziano 2005). One option for future research is to investigate whether the same moderation holds for the impact of violent video games on aggression. A following step, important from a public policy perspective, is to look whether 2D:4D also predicts purchase behavior of, and interest for violent video games or media. When especially low 2D:4D people are the segment of the market that consumes these products, a strong legislation may be recommendable. Another option for future research is to focus on other types of aggression cues. There is evidence that the picture of a weapon can make people behave more aggressively on average (see e.g. Carlson et al. 1990). Anderson et al. (1998) showed that the weapon aggression prime effect may be obtained by both words and pictures and increases the accessibility of aggressive thoughts. It seems important to look at the moderating role of 2D:4D on the impact of exposure to such type of aggression cues. An intriguing question is whether the accessibility of aggressive thoughts increases especially in low 2D:4D people or that the accessibility of these thoughts increases for everyone but may only result in the expression of aggressive behavior for low 2D:4D people. In addition, these findings may also apply to a more specific consumer context. Perceived unfair actions by a company may result in e.g. less consumer loyalty and more consumer vengeance towards the firm for especially low 2D:4D people. This may show up in more negative word-of-mouth, or higher complaint rates. Low 2D:4D people may be more susceptible to cases of injustice (cfr manuscript III) which might elicit more aggressive thoughts. Another possibility, as already mentioned above, is that a case of perceived injustice makes aggressive thoughts more accessible in general, but only results in consumer vengeance for low 2D:4D people.

To Conclude

The main aim of this dissertation was to illustrate the importance and the potential of a biologically inspired approach to the study of economic and consumer behavior. Therefore I wanted to convince the reader by both applying a biological theory and using a biological marker in the study of economic and consumer behavior. As a consequence, this starting point resulted in a rather atypical dissertation with a variety of research methods, types of behavior studied, and routes for future research. Still I hope that the reader shares my opinion that this approach seems fruitful, as it may inspire a lot of relatively novel research questions in the study of economic behavior and of social phenomena in general. Therefore, the most important project for the future is to enrich the adoption of this inspiring approach into traditional journals on economic and consumer behavior. I hope my dissertation is a small step in that direction.

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APPENDIX A

Adapted Social Value Orientation:

		A	B	C	D
(1)	You	480	540	480	480
	Other	80	280	480	540

		A	B	C	D
(2)	You	560	500	500	500
	Other	300	500	560	100

		A	B	C	D
(3)	You	520	520	520	580
	Other	520	580	120	320

		A	B	C	D
(4)	You	490	500	560	490
	Other	560	100	300	490

		A	B	C	D
(5)	You	490	560	500	500
	Other	90	300	500	560

		A	B	C	D
(6)	You	570	500	500	500
	Other	300	500	570	100

		A	B	C	D
(7)	You	510	510	510	560
	Other	510	560	110	300

		A	B	C	D
(8)	You	500	500	550	500

	Other	550	100	300	500
		A	B	C	D
(9)	You	480	540	490	490
	Other	100	300	490	540

APPENDIX B

Items of the Unconventionality Scale:

Participants had to indicate for each statement on a 7-point Likert scale: I do not agree at all (1) to I completely agree (7). The following items were offered in randomized order:

I am considered to be kind of eccentric. (+)

I know that my ideas sometimes surprise people. (+)

I do things that others find strange. (+)

I rebel against authority. (+)

I swim against the current. (+)

I would hate to be considered odd or strange. (-)

I enjoy being thought of as a normal "mainstream" person. (-)

I like to be viewed as proper and conventional. (-)

I like to be thought of as a normal kind of person. (-)

I try to avoid complex people. (-)

APPENDIX C

The 5 provoking situations drawn from the Aggression Provocation Questionnaire (O'Connor et al., 2001) that were used in this study.

1. It is Saturday evening and you are queuing to buy a lottery ticket. It's very busy and the shop is soon to close. You have already been waiting for 10 minutes. Just when it's your turn, someone else pushes in front of you.

2. You sit on a train quietly reading the newspaper. A couple of football supporters are sitting a few seats in front shouting, swearing and generally being obnoxious. Suddenly, one of them throws an empty beer can in the air and it accidentally hits you.

3. You are in a great hurry and right in front of you a car stops. A man gets out but he carries on talking to the driver, blatantly ignoring your calls for him to move. You cannot get past the car.

4. You find out from a friend that your partner has been unfaithful to you on one occasion, after a works Christmas party.

5. You are walking down the street on your way to an interview for a new job. As you turn the corner, a window cleaner nearby, accidentally spills soapy, hot water on your newly dry-cleaned suit.

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