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The effect of protective measures on risk-taking behavior and the moderating effect of sports.

Testing the Risk homeostasis theory by means of a computer game

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Abstract

This study investigates the risk homeostasis theory of Wilde (1982). This theory describes risk-taking behavior by addressing two levels of risk: the experienced risk level and the desired risk level. People are always trying to reach the desired risk level. Thus, if the experienced level of risk is below the desired level, people take compensatory actions (more risk-taking behavior) to reach the desired level. Additionally, the moderating effect of sports within risk homeostasis is studied. Studies have been done regarding the effect of sports on risk-taking in general, but no body of knowledge has been established on the moderating effect of sports in risk homeostasis. Based on the studies of sports on risk-taking in general, it is expected that there are some variables within sports and sportspeople that influence the moderating effect of sports on risk homeostasis. These are: intensity of sports, risk level of sports, position within sports and sporting style of the sportsperson.

A total of 69 participants were recruited. Participants were between 18 and 36 years old (*M* = 22,41, *SD* = 3,22). Data was gathered by means of two materials; a self-developed questionnaire and a computer game: the Spaceship game. The questionnaire focused on the sports-relevant information and the Spaceship game gathered the data needed for testing the risk homeostatic effect. In the game participants had to fly a spaceship through a galaxy while avoiding meteors. They received a certain amount of shields (representatively 0, 1, 3, 4 or 5) which represented their experienced risk level. During the game their speed, time to collision (TTC) and distance to closest meteor (DCM) were measured. It was hypothesized that an increase in protection (lower experienced level of risk) would lead to an increase in speed and a decrease in TTC and DCM, as participants would compensate for the low experienced risk level by showing more risk-taking behavior.

This study has found clear evidence for the risk homeostasis theory (Wilde, 1972). When the experienced level of risk was low, participants compensated this by showing more dangerous behavior in terms of speed, TTC and DCM. The moderating effect of sports shows interesting results. Sports participants show risk compensation, while non-sports participants do not. Also differences based on risk level, position and sporting style are found. Stronger risk compensation is reported in high(er) risk level sportspeople. Also sportspeople with a defensive position show stronger risk compensation than sportspeople with an offensive position. This also applies to sportspeople with a defensive sporting style versus sportspeople with an offensive sporting style.

The results of this study contribute to less controversy on the risk homeostasis theory. The perspective of sports on risk compensation has given new insights in sportspeople; there are differences between sportspeople and their risk compensation strategy. These insights can be applied in the protection measures for sportspeople.

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1. Introduction

1.1 Risk homeostasis

This study will investigate the risk homeostasis theory (RHT) of Wilde (1982); a theory that describes risk-taking behavior. According to Wilde (1982), there are two different levels of risk: the experienced risk level and the desired risk level. People are always looking for an optimal level of risk and try to reach this desired risk level. If the experienced level of risk in one's environment is below the desired level, people tend to take compensatory actions to reach this level, by participating in more risky behavior. So, people adapt their behavior to changes in the environment (Wilde, 1982). The risk homeostasis theory has been particularly studied in the field of traffic (e.g. Wilde, Robertson & Pless, 2002; Wilde, 1998; Aschenbrenner & Biehl, 1994; Jackson & Blackman, 1994; Grant & Smiley, 1993). It proposes that the implementation of preventive interventions (safety measures), for example ABS in cars, will automatically lower people's perceived risk. This lower level of perceived risk in turn leads to more increased risky behavior (Wilde et al., 2002). Safety measures may therefore have contradictory effects and lead to more risky behavior and more accidents, while they are meant to reduce accidents.

Wilde (1982) compares the risk homeostatic effect within driver behavior with a thermostat (Figure 1). A thermostat always has a set point; the desired temperature, which in this case represents the desired risk level (target level). However, it might be cooler or hotter than this set point; the perceived temperature, which represents the perceived level of risk. Whenever there is a difference between the set point and the perceived temperature, a thermostat will take measures and starts heating or cooling in order to reach the desired temperature.

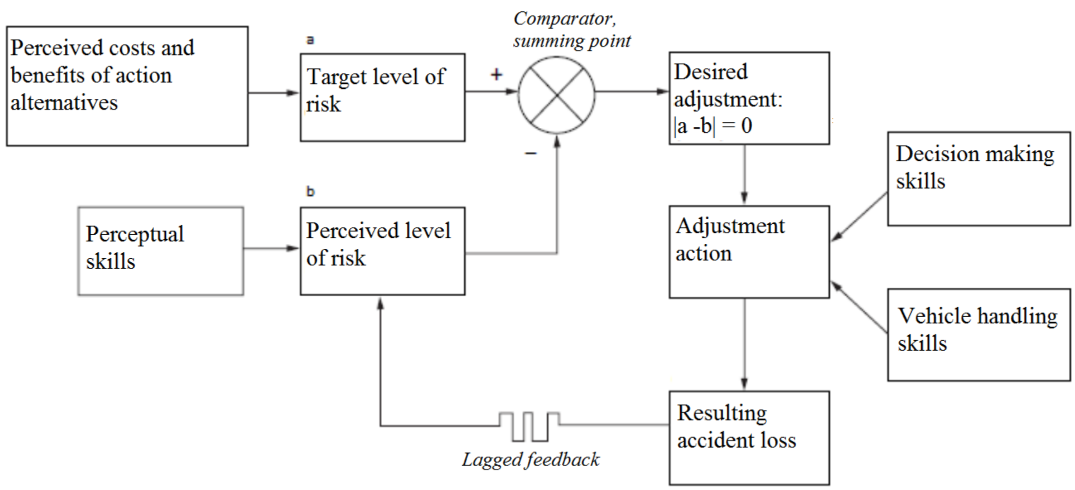

Figure 1. Risk homeostatic model on driving behavior (Wilde, 1982).

The desired level of temperature can differ per person and per context. So does the desired level of risk (Wilde, 1982). Based on a costs and benefits analysis people determine their desired level of risk. Four factors can be identified in this cost and benefits analysis:

1. The expected benefits of risk-taking behavior.
2. The expected costs of risk-taking behavior.
3. The expected benefits of safe behavior.
4. The expected costs of safe behavior.

When the expected benefits of risk-taking behavior and the expected costs of safe behavior are high, while the other two are low, it is to be expected that someone will show risk-taking behavior. However, if the perceived level of risk is already high people do not have to compensate, as there is a small difference or no difference at all between the perceived level and desired level of risk (Wilde, 1982).

If there is a significant difference between these two, people will start to adjust their behavior either by taking more risk or by taking less risk. This adjustment in behavior is influenced by two factors: (1) decision making skills and (2) vehicle handling skills. Eventually this will result in certain accident rates. This will influence the perceived level of risk of people. However, this might take some time as accident rates are not immediately available (lagged feedback). If the perceived level of risk changes, so does the set point of the 'thermostat'; which will result in safer or more risk-taking behavior (Wilde et al., 2002).

Wilde (1982) assumes that lowering the willingness to take risks among people is the only solution to lower the number of accidents. Therefore the target level of risk has to be influenced. Wilde et al. (2002) considers rewards and punishments as the most promising solution for reducing the target level of risk. For instance, rewarding drivers that have driven 'accident-free' by giving them a bonus and punishing risk-taking behavior by high fines.

1.1.1 Risk homeostasis: Support and critics

The risk homeostasis theory has been studied extensively. Supporting evidence as well as opposing evidence can be found in research. Both will be discussed below.

Research that supports the risk homeostasis theory, used by Wilde himself (Wilde, 1998; Wilde et al., 2002), is a change from left-hand driving to right-hand driving in Sweden. In 1968, left-hand driving changed to right-hand driving in Sweden. Shortly after this introduction the crash rates when down. According to Wilde (1998; 2002), this phenomenon represents the increased perceived level of risk. Due to this, the drivers compensated their driving behavior by taking less risk. However, after two years the drivers were used to the right-hand driving and the accidents rates were back to normal; the perceived level of risk was decreased and drivers compensated this by showing more risk-taking behavior (Wilde et al., 2002; Wilde, 1998). Additional support from real-life examples is provided by Aschenbrenner & Biehl (1994). They studied taxi drivers in Munich who received a cab equipped with anti-lock brakes (ABS). Their behavior changed once this safety measure was added: they showed more risk-taking behavior, thereby keeping the accident rates with cabs constant over time (Aschenbrenner & Biehl, 1994). The same evidence was found in Canada by Grant & Smiley (1993). One of the specific results was that the taxi drivers who had ABS slightly increased their speed.

Besides real-life studies, several researches have also been conducted in simulated environments. Jackson and Blackman (1994) introduced rewards and punishments as motivators for decreasing risk-taking behavior, thereby changing the desired level of risk. Results showed that an increase in costs of risk-taking behavior resulted in a decrease of accidents (Jackson & Blackman, 1994). Hoyes, Stanton and Taylor (1996) also conducted a driving simulator test. Their experiment manipulated the experienced level of risk: participants were exposed to environments with high risk and low risk. Results showed that less accidents occurred in the high risk environment (Hoyes et al., 1996). Due to a higher level of perceived risk, risk-taking behavior compensation was not needed. This resulted in safer behavior. Glendon, Hoyes, Haigney & Taylor (1996) also reviewed the risk homeostasis theory and found support for the theory, but also found that risk compensation can occur in very short-term time. This contradicts the risk homeostasis theory which states that risk compensation sometimes takes months or even years. This result might be explained by the immediate feedback of simulators on participants (Glendon et al., 1996; Hoyes et al., 1996).

The risk homeostasis theory has also been applied in some other domains. For instance the maritime industry. Baniela and Ríos (2010) have researched the controversial phenomenon within this industry. There are continuous improvements in safety within the maritime industry, but there is no decrease in shipping accidents. Baniela and Ríos (2010) have applied the risk homeostasis theory to see whether this could explain this phenomenon. Evidence was found that the benefits of risk-taking behavior in the maritime industry overrule the benefits of risk-taking behavior and the costs and benefits of safe behavior (Baniela and Ríos, 2010). Furthermore, research has been conducted in the healthcare domain. Maughan-Brown and Venkataramani (2012) researched risk-taking behavior among a circumcised population in South Africa. Male circumcision lowers the risk on HIV. Men who were circumcised and informed about the protective benefit showed safer behavior in sexual relationships. However, women who were informed about the protective benefit of male circumcision showed more risk-taking behavior in sexual relationships with circumcised men: they were more likely to forego condoms or even did not use them at all (Maughan-Brown & Venkataramani, 2012). Some researchers have also applied the risk homeostasis theory within work settings and found support for risk compensation (Sagan, 1997; Stetzer & Hofmann, 1996). At last, the effect of alcohol on gambling has been connected to the risk homeostasis theory (Breslin, Sobell, Capell & Vakili, 1999).

Besides supporting evidence for the risk homeostasis theory, there are also some critical findings. Evans (1986) used a wide variety of accident data to see whether he could support the theory. But all data that he researched was incompatible with the theory. He studied the reintroduction of a law in 1970 in some states in the United States. The law demanded motorcyclists to wear a helmet. According to the risk homeostasis theory this should lead to a lower rate of accidents shortly after the implementation and after a while the accident rates should be back to normal. The states that did not implement the law should have no changes in their accident rates. Data showed that the states that reintroduced the law had an increase of 28 percent in motorcyclist fatalities in comparison with the states that did not reintroduced the law (Evans, 1986). Also Evans (1986) questioned a more general assumption of the risk homeostasis theory; he found no evidence for the homeostatic effect that presumes that accident rates stay relatively stable over time.

Shannen and Szatmari (1994) have examined the injury rates before and after the introduction of seat-belt legislation in Britain. According to the risk homeostasis theory a difference would be expected as drivers with seat-belts would feel more protected and therefore would compensate showing more risk-taking behavior. Results indicated no (significant) differences in injury rates. However, it is not possible to determine what factors have influenced this. Evans (1986) addressed in his research the 'selective recruitment issues' with safety measures; safety measures may not decrease the number of accident rates due to the effect on a specific target group. For instance, the introduction of the mandatory seat belt law may not lead to decreases in accident rates because only safer drivers comply with this law.

Hoyes, Dorn, Desmond and Taylor (1996) tested the risk homeostasis theory in a simulated environment. The theory states that behavioral change only occurs when there is an utility to be gained. According to the theory intrinsic risk and utility should show a statistical interaction. Hoyes et al. (1996) found no support for this; data showed that participants took more risk when there was more at stake.

Besides the above findings there is a more critical issue of the risk homeostasis theory. Several researchers state that the theory is incapable of falsification (Elvik, 2004; Glendon et al., 1996; Hoyes & Glendon, 1993; Adams, 1988). The theory states that changes in safety can be attained by changing the target level of risk. This target level of risk differs per individual but the theory does not explain how each individual determines his or her target level or risk. It also does not mention how this target level or risk can be measured. Therefore if the number of accidents is reduced, the target level of risk must have changed. If the number of accidents has increased, the target level of risk must also have changed. If the numbers of accidents are stable, the target level of risk must have stayed equal. Therefore, the theory is always correct and cannot be falsified (Elvik, 2004; Glendon et al., 1996; Hoyes & Glendon, 1993; Adams, 1988). Glendon et al. (1996) do mention that a well-designed laboratory experiment might be able to control all the potential factors that influence homeostasis and therefore might be able to falsify (or support) the theory in a correct empirical way.

1.2 Risk homeostasis and sports

As said, the risk homeostasis theory has been applied in some other domains besides traffic. One of them being sports. In sports people are often exposed to (high) risks. Therefore, with many sports protective measures are taken, mostly by wearing specific kind of clothing, e.g. with rugby, ice-hockey, soccer and hockey. It seems to make perfect sense that this protective clothing enables sportspeople to take more risks. Research shows that wearing protective clothing does indeed give sportspeople more confidence, results in more risky behavior, and in turn, results in more accidents (Hagel & Meeuwisse, 2004; Stuart, Smith, Malo-Ortiguera et al., 2002; Finch, McIntosh, McCrory, 2001).

Napier, Findley and Self (2007) researched the effect of a safety measure in skydiving: the Cypres Automatic Activation Device (AAD). This device automatically opens the (reserve) parachute after a specific time. Logically, this device decreased the so-called no pull/low pull fatalities. However, there was an increase in so-called open canopy fatalities. The overall number of fatalities remained relatively stable (Napier, Findley & Self, 2007). Risk homeostasis has also been studied in skiing. Results show that 33 percent of all skiers and snowboarders reported to take more risk when wearing a helmet (Ruedl, Abart, Ledochowski, Burtscher & Kopp, 2012; Scott, Buller, Andersen et al., 2007). However, other research on alpine skiing did not show higher rates of accidents for those who wear a helmet (Ruedl, Brunner, Kopp & Burtscher, 2011; Hagel, Pless, Goulit, Platt & Robitaille, 2005).

More common sports such as volleyball, cycling, baseball and soccer have also been investigated with regard to the risk homeostasis theory (Hagel & Meeuwisse, 2004). In baseball, one can use a soft-core ball and a standard ball. The rates of injury were higher when playing with a soft-core ball. It was speculated that one might think the ball is less dangerous and the chance on getting an injury is smaller (Janda, Bir, Viano et al., 1998). Furthermore, research by Kontos (2004) showed that a lower perceived risk level among soccer players was correlated with a higher injury rate due to more risk-taking behavior. However, research on for instance cycling shows no support for the risk homeostasis theory. Compliance among helmeted bicyclists was reported to be higher than compliance among non-helmeted bicyclists

(Farris, Spaite, Criss et al., 1997). Altogether, various researches have been conducted to test the risk homeostasis theory in sports. Until now it has resulted in contradictory results.

These contradictory results might be explained by the differences between different sport(s) and sportspeople. Depending on for instance risk level, it could be explained why risk homeostasis was found in skydiving and not in cycling; these sports attract different kind of sportspeople and these sportspeople might differ in their desired risk level (Zuckerman & Stelmack, 2004). As this study does not lend itself for real-life sport tests, the effect of risk homeostasis within (a certain) sport(s) cannot be measured. However, it is far more interesting to compare risk homeostasis within different sportspeople. This can be studied in any controlled environment. Two effects will be researched: First the effect of sports on risk-taking behavior in general will be measured. Second, the actual moderating effect of sports on risk homeostasis will be measured. Until now, the first effect has given a lot of controversial results, which will be described in the following paragraphs. For the second effect, no established body of knowledge exists yet. As risk-taking is a prominent part of the risk homeostasis theory, researching the first effect (sports on risk-taking) can give valuable insights regarding the second effect (moderating effect of sports on risk homeostasis) and will give a more complete picture of the risk-taking behavior of sportspeople.

For both effects, different groups of sportspeople will be identified to see whether there is a difference in their risk-taking behavior and their risk compensation strategy (risk homeostasis). These different groups of sportspeople will be categorized based on four different elements within their sports: intensity, risk level of sport, position and sporting style.

1.2.1 Intensity

Several studies have investigated the differences between sports participants versus non-sports participants on risk-taking behavior (outside the field). Garry & Morrissey (2000) found that sports participants in general show more risk-taking behavior than non-sports participants. Martha & Griffet (2007) however, found that sports participants report lower risk-taking and higher risk perception. Other research found mixed findings; both increases and decreases of risk-taking behavior in sports participants (Peck, Vida & Eccles, 2007). A possible explanation for these contradictory results might be that the intensity of participation in sports influences the effect. A sportsperson that practices 7 hours a week might be more prone to endure in his sport-related risk-taking behavior than a sportsperson that practices only 1 hour a week. Additionally, this effect might also endure in his or her risk compensation strategy.

1.2.2 Risk level

The above inconclusive results may be also explained by the different risk levels of sports. Three different levels of risk can be distinguished in sports; high risk, medium risk and low risk. The risk level can be determined by means of the injury rate per 1000 hours (Zuckerman & Stelmack, 2004). Walking can for instance be classified as a low risk sport while indoor soccer can be classified as a high risk sport (TNO, 2015).

It is supported that depending on the sport, risk-taking behavior and risk compensation of the sportsperson differs both in the field, as well as outside the field (Zuckerman & Stelmack, 2004). Research shows that sportspeople who participate in high risk sports score far higher on sensation seeking than sportspeople participating in medium risk or low risk sports (Zuckerman & Stelmack, 2004). The mixed findings of the above mentioned researches (Martha & Griffet, 2007; Peck et al., 2007; Garry & Morrisey, 2000) may be explained by their lack of accounting the risk level of the sport(s) in their researches. Therefore, the risk level of sports will be also included and studied in this research. It is expected that depending on the risk level of sports, a sportsperson shows more of less risk-taking behavior outside the field and uses a different risk compensation strategy.

1.2.3 Position

Garry & Morrissey (2000) made an attempt to study the differences in risk-taking behavior between team sports participators vs. non-team sports participators. This resulted in no conclusive results and further research was advised as differences are expected based on positions played within a team sport (Garry & Morrissey, 2000). Some other studies have been conducted in the meanwhile regarding this topic. These studies were all conducted within the field, so no general effect of position on risk-taking was measured. Headrick et al. (2011) compared defenders, midfielders and forwards in soccer. The study showed that the distance to the goal has an effect on tactics and style of players. Players closer to the goal tend to have a bigger distance between themselves and the ball when dribbling, so a higher risk on losing the ball. This effect was especially strong for forwards. Defenders, even when they were close to the goal, kept the ball closer to themselves when dribbling (Headrick et al., 2011). A comparable study showed the same results for basketball players (Cordovil et al., 2009). These results support the fact that forwards show more risk-taking behavior as they have a larger distance between themselves and the ball and therefore a larger risk on losing the ball to the opponent. Whether this behavior also endures in other situations and has an effect on risk compensation will be researched as well.

1.2.4 Sporting style

Some sports are not characterized by specific positions such as defender, midfielder or forward. Think for instance of boxing or dancing. However, sports and practitioners of sports can be characterized by having a style that is more offensive or more defensive. To not exclude the participants that do not have a specific position within sports, another element will be studied: sporting style. Sporting style will be determined by a subjective judgment of participants themselves. It will be researched whether sporting style has an effect on risk-taking behavior and risk compensation.

1.3 Present study

The goal of this study is to investigate whether the risk homeostasis theory is supported or falsified. The theory of Wilde (1982) is controversial. Different results have been found until know. This research will investigate this controversy and will gain more insights in the phenomenon of risk-taking behavior and the effects of safety measures and risk perception on risk-taking behavior. The dependent variable of this study will be risk-taking behavior and the independent variable will be the level of protection/safety. It is expected that higher levels of safety will lead to more risk-taking behavior as there is a bigger gap between the experienced risk level and the desired risk level.

This study will also examine the moderating effect of sports on risk homeostasis. There is no established body of knowledge yet on this subject. Therefore, the effect of sports on risk-taking behavior (without including the independent variable of protection/safety) will be measured first. Until now, many contradictive evidence exists. Gaining insight in the risk-taking behavior of participants can also give help to interpret their risk compensation strategy. With regard to these two effects it is expected that the intensity, risk level, position and sporting style influences the risk-taking behavior and risk compensation strategy of sportspeople.

The *main research question* of this study is: What is the effect of protective measures on risk-taking behavior (risk homeostasis) and what is the moderating effect of sports?

The following hypotheses will be tested:

Hypothesis 1: Higher levels of protection will lead to more risk-taking behavior.

Hypothesis 2a: More participation in sports (in hours) leads to more risk-taking behavior.
Hypothesis 2b: Depending on the participation in sports (in hours), a different risk-compensation strategy can be expected within different groups of sportspeople.

Hypothesis 3a: Sportspeople who participate in high risk sports will show more risk-taking behavior, compared to sportspeople who participate in medium risk and low risk sports.
Hypothesis 3b: Depending on the risk level of the sport (low, medium or high), a different risk-compensation strategy can be expected within different groups of sportspeople

Hypothesis 4a: Sportspeople with an offensive position (forward, offensive midfielder), show more risk-taking behavior than sportspeople with a defensive position (defensive midfielder, defender and goalkeeper).

Hypothesis 4b: Depending on the position played within a sport (defensive versus offensive), a different risk-compensation strategy can be expected within different groups of sportspeople.

Hypothesis 5a: Sportspeople who perceive their sporting style as more offensive show more risk-taking behavior than sportspeople who perceive their sporting style as more defensive.

Hypothesis 5b: Depending on the perceived sporting style (more defensive versus more offensive), a different risk-compensation strategy can be expected within different groups of sportspeople.

This research will result in valuable new scientific insights. Both the risk homeostasis theory as well as the effect of sports on risk-taking have resulted until now in contradictory results. Besides new scientific knowledge, this research is also socially relevant as protective measures are often implemented in society to reduce accidents. If evidence is found for the possible negative effects of protective measures, this can have big societal changes regarding safety measures.

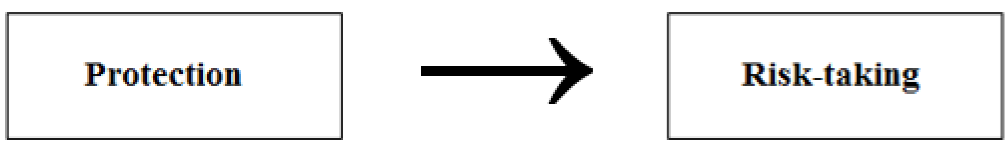

Figure 2. Hypothesis 1

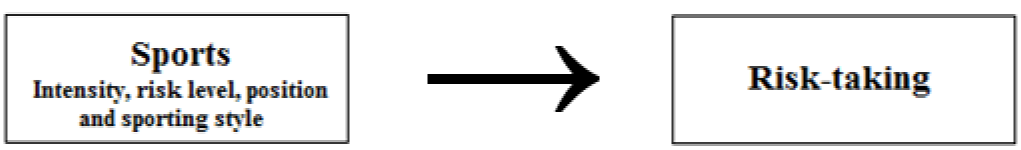

Figure 3. Hypotheses 2a, 3a, 4a and 5a

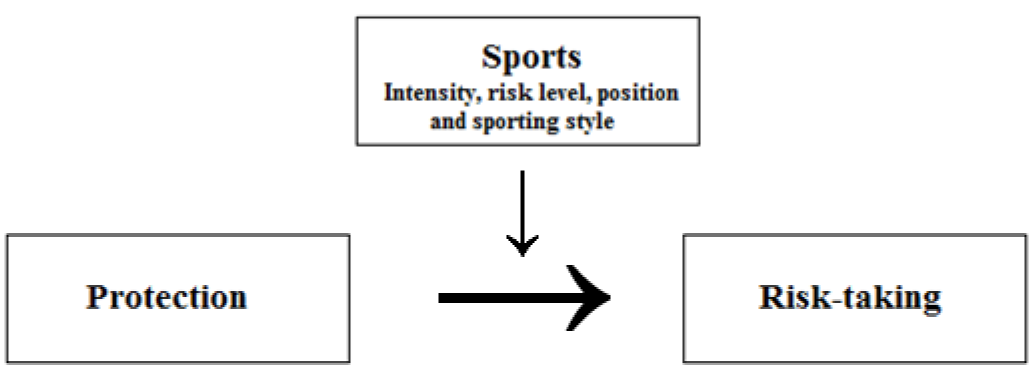

Figure 4. Hypotheses 2b, 3b, 4b and 5b

2. Methods

2.1 Participants

For the present study, a group of 69 participants was recruited. Participants were between 18 and 36 years old (*M* = 22,41, *SD* = 3,22). The majority of the participants were female; 58 compared to 11 males. Participants' highest completed education level varied from higher general secondary education to postgraduates. Most participants either completed pre-university secondary education (*N* = 33) or were undergraduate (*N* = 23).

Participants were recruited by means of Sona; the Leiden University research participation program. An advertisement was placed and a total of 62 students subscribed of whom 51 showed up. The other 18 participants were recruited within the social environment of the researchers and by means of distributing flyers at the faculty of social sciences.

Exclusion criteria of the study was the presence of a neurological condition or experience in the past with the Spaceship game. During the study as well as afterwards, no technical problems occurred. All data was complete. This resulted in a final sample of 69 participants.

2.2 Materials

Data was gathered by means of two materials; a self-developed questionnaire and a computer game: the Spaceship game. The questionnaire was made by use of the Online Survey Software Qualtrics. It consisted out of one general question, three demographic questions and six sport-related questions (see Appendix A). All questions were in English. This questionnaire was used as an instrument to gather all relevant information about participation in sports. The questionnaire was filled out on the computer.

The Spaceship game was used as an instrument to measure the level of risk-taking behavior. Participants had to navigate through a galaxy while avoiding the meteors. By the use of the up and down arrow keys participants had control of the vertical movement of the spaceship. By means of the left and right arrow keys participants had control of the speed of the spaceship. There were 13 different speed levels which represented the game's difficulty levels. The lowest speed level, which was automatically used at the moment of start, was set at 320 pixels per second. For each increase in level, 50 pixels per second were added. The maximum speed (difficulty level 13) was 920 pixels per second. At the left upper corner protection shields were displayed. Each time the spaceship collided with a meteor, one protection shield was lost.

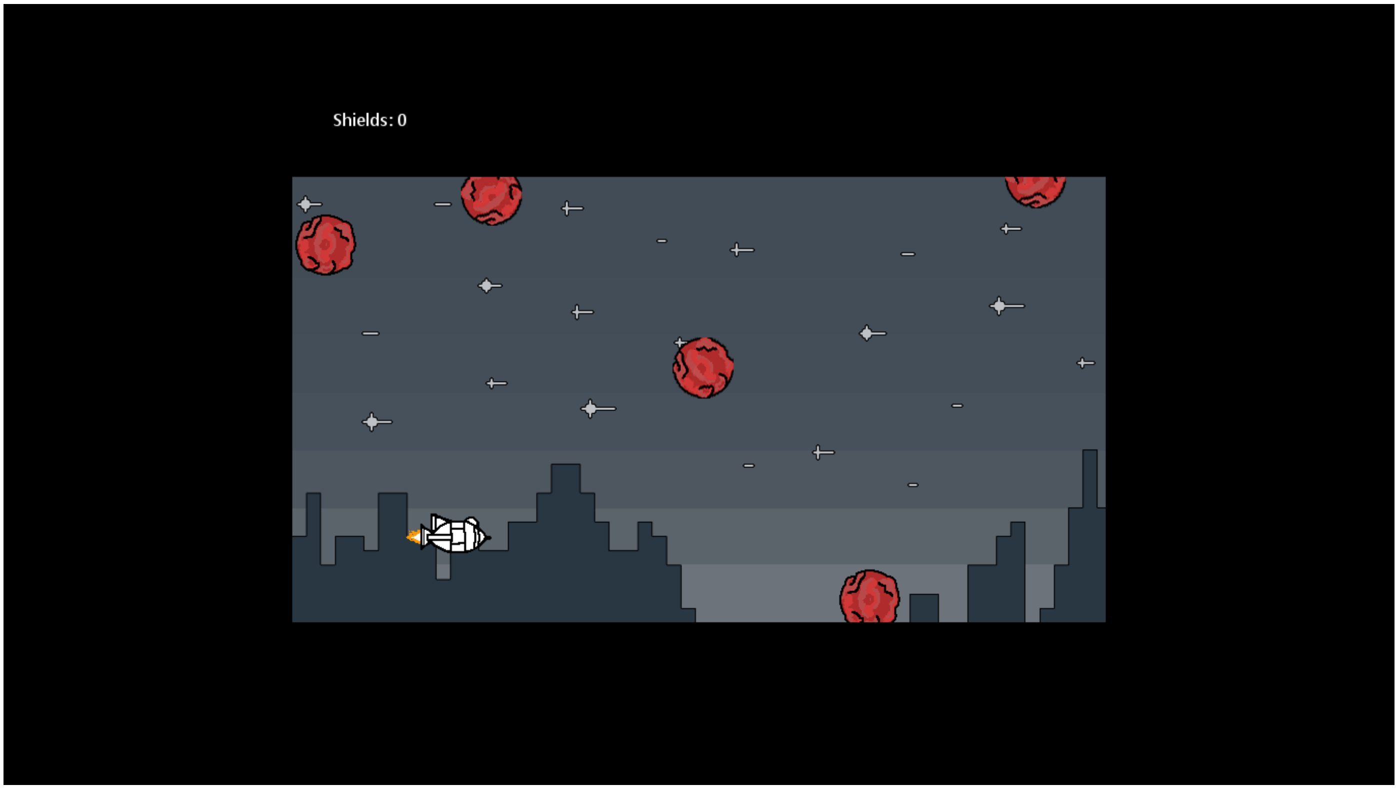

Figure 5. Screenshot of the Spaceship game.

The game consisted out of a preview, in which participants watched a short example of the game. Subsequently they started with a test round, in which they were randomly assigned 0 or 3 shields. After that, participants played five rounds in which they were assigned in random order 0, 1, 3, 4 and 5 shields. This variety in number of shields represented the perceived level of risk. A high number of shields represented a low level of risk and a low number of shields represented a high level of risk. As soon as all protection shields were lost a new session started. A maximum duration of four minutes was set for each session. Those who had managed to navigate through the galaxy without losing all shields were automatically stopped after four minutes.

An extensive amount of data was gathered from the game. The amount of protection shields was used as an indicator of perceived level of risk. Furthermore, three parameters were calculated and served as indicators for risk-taking behavior; speed, time to collision (TTC) and the distance kept to the closest meteor (DCM). The TTC defines the time until the spaceship would have collided with a meteor if it had not changed its vertical position. Risk-taking behavior is higher when the speed is higher, the TTC is smaller and the DCM is shorter. Further explanation and the calculation of these risk parameters can be found in Appendix B.

2.3 Design

The experiment had five within-subject conditions; the five different sessions. These conditions each had a different amount of protection shields; 0, 1, 3, 4 or 5. In total every participant received 13 protection shields. The shields were assigned in a random order to the participant. Both the participant as well as the researchers did not know the order of the assigned protection shields. The experiment can be defined as a double-blind randomized design with five within-subject conditions.

2.4 Procedure

The experiments were conducted in one of the computer rooms at the Faculty of social sciences, Wassenaarseweg 52 in Leiden. The computers all had a 21 inch display. The study was conducted in four testing days. Each day at least two researchers were present. The experiment lasted around 45 minutes, depending on the working speed of the participant.

Upon arrival, all participants were given an information letter and an informed consent (Appendices C and D). The information letter gave general information about what the participants were going to do and reassured the participant that all data was coded in an anonymous way. Also participants were informed that their participation was voluntarily and that they could stop whenever they want. After reading the information letter and signing the informed consent, the Spaceship game was put on by one of the researchers. The spaceship itself contained detailed instructions for participants on how to navigate the spaceship (See Appendix E). They were also instructed that they would gain points during the game. However, these were invisible to the participants. The points they gained depended on the difficulty level and the total ‘flying’ time. The three best players were granted a prize (50, 30 and 10 euros). At the end of the game they were instructed to raise their hand so the questionnaire could be put on. After completing the questionnaire participants could come and collect their credits or money (2 credits or 6,50 euros). They also got a debriefing letter (Appendix F) with more specific information about the research. A week after the experiments the winning participant numbers were announced by e-mail.

2.5 Analyses

All analyses were conducted by using IBM SPSS Statistics 21. The data of the questionnaire was re-coded in SPSS. This resulted in four variables: (1) hours of sporting per week, (2) level of risk of the (main) sport, (3) position within (main) sport and (4) sporting style. Variable 1 was computed as a categorical variable with 7 categories: 0 hours, 0-1 hours, 1-2 hours, 2-3 hours, 3-4 hours, 4-6 hours and more than 6 hours. Variable 2 was computed as a categorical variable with three categories: low risk, medium risk and high risk. Each sport was assigned to a risk category based on the injury rate per 1000 hours of sport. This classification was made by use of the statistics from the annual OBiN (Ongevallen en Bewegen in Nederland) questionnaires from 2000 till 2014 (TNO, 2015). Participants that did not participate in a sport were not included in the analysis of hypothesis 3a and 3b. The risk level of the participants that participated in more than one sport was defined by their 'main sport' (the sport they spend most hours per week on). If this was equal for two (or more) sports, the main sport was defined by their years of experience. Variable 3 was computed as a categorical variable with 2 categories: defensive (which includes goalkeeper, defender and defensive midfielder) and offensive (which includes offensive midfielder and forward). Variable 4 was also computed as a categorical variable with 2 categories: more offensive and more defensive. The last two variables included the option 'not applicable' in the questionnaire. Participants that selected this option were not included in the analyses.

The data from the videogame was registered each millisecond in the file 'steplog'. Several parameters were registered: participant number, number of the session, time, score (points), level of difficulty, amount of shields, the position of the spaceship on the y-axis, the meteor closest to the spaceship on both the y-axis and the x-axis and the collisions. The same parameters were registered in the file 'eventlog' at the specific moments of collision. The data from steplog was used to calculate three risk parameters: speed, time to collision (TTC) and distance kept to the closest meteor (DCM) (See Appendix B).

To test hypothesis 1 several repeated measures ANOVA's were conducted. This test automatically corrects for cumulative type-1 errors and is therefore more reliable than conducting multiple paired sampled t-tests. The repeated measures ANOVA's tested whether there were significant differences in the means (speed, TTC and DCM) between the conditions and within the conditions. Before starting the analysis for hypothesis 1, assumptions for the repeated measures ANOVA were checked. These can be found in the results section.

For hypothesis 2a, 3a, 4a and 5a (effect of different elements of sports on risk-taking behavior) a MANOVA was initially planned to use. The assumptions for this test were checked beforehand, resulting in many limitations. Therefore the hypotheses were tested using three separate ANOVA's; one for speed, one for TTC and one for DCM. Reports on the assumption checks for MANOVA can also be found in the results section.

For hypothesis 2b, 3b, 4b and 5b the split file function was used in SPSS. Subsequently several repeated measures ANOVA's were conducted for the different group of sportspeople. Also an regression line was added for the different groups to indicate the coefficient of determination (R^2).

3. Results

3.1 *Hypothesis 1*: Higher levels of protection will lead to more risk-taking behavior.

Assumptions repeated measures ANOVA

The dependent variables (speed, TTC and DCM) are all measured on a continuous scale. Furthermore, the within-subjects factor is categorical with two or more levels. The third assumption, no significant outliers in any level of the within-subjects factor, were tested using boxplots. Outliers were found but these were not removed as they are all related to the phenomenon that is being researched.

The fifth assumption, a normal distribution for the dependent variables for each level of the within-subjects factor, was measured using the normal Q-Q plots. Shapiro Wilks test was not consulted due to the reduced reliability in large sample sizes (N > 50). All normal Q-Q plots showed a normal distribution of the dependent variables. The sixth assumption, the assumption of sphericity, will be checked during the analysis.

3.1.1 Between comparison

Speed

Mauchly's test indicated that the assumption of sphericity was met, $X^2(9)$, = 11.508, p = .243. The multivariate tests were all significant (p < .001) and the univariate result also shows that there is a significant difference in mean speed between the different conditions, $F(4, 272) = 17.44$, $p < .001$. Therefore, post-hoc bonferroni corrected pairwise comparisons were conducted. The pairwise comparisons showed significant differences between the condition with 0 shields and the conditions with 3 shields (p < .001), the condition with 0 shields and the condition with 4 shields (p < .001) and the condition with 0 shields and the conditions with 5 shields (p < .001). Two other significant effects were found between the condition with 1 shield and the condition with 4 shields (p = .005) and the condition with 1 shield and the condition with 5 shields (p < .001). Figure 6 shows that the significant effects indicate an increase in speed is related to an increase in lives.

	Value	*F*	*p*
Pillai's Trace	.445	13.045	.000
Wilks' Lambda	.555	13.045	.000
Hotelling's Trace	.803	13.045	.000
Roy's Largest Root	.803	13.045	.000

Table 1. Multivariate tests between conditions – Speed

	N	*M*	*SD*
0 shields	69	432.49	112.42
1 shield	69	467.36	121.77
3 shields	69	503.39	139.59
4 shields	69	521.22	160.73
5 shields	69	528.61	142.35

Table 2. Descriptive statistics between conditions – Speed

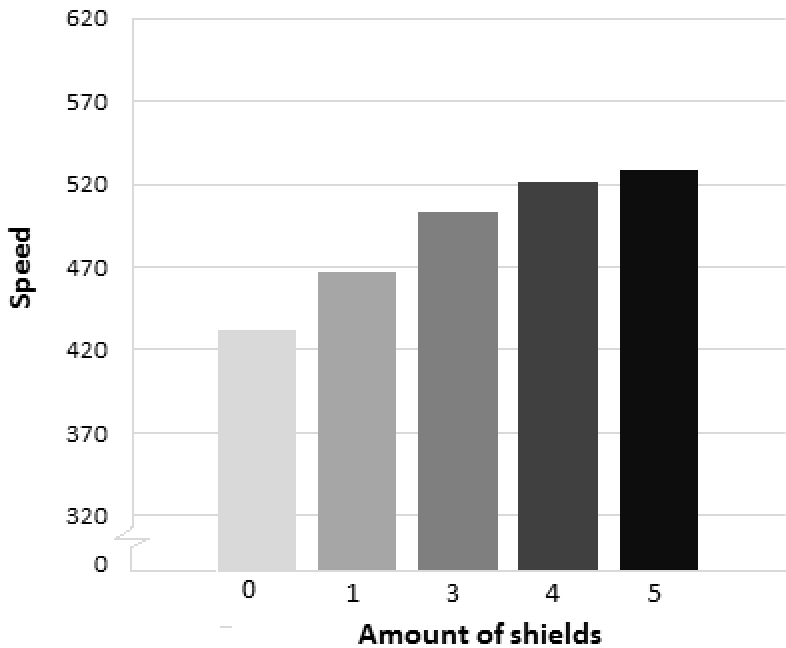

Figure 6. Means plot for speed in the different conditions

TTC

All multivariate tests were significant, $p < .001$. Mauchly's test indicated that the assumption of sphericity was not met, $X^2(9)$, = 18.855, $p = .026$. Therefore, degrees of freedom were corrected by using the Huynh-Feldt estimates of sphericity ($\varepsilon = .886$). The results show that there is a significant difference in mean TTC between the different conditions, $F(3.766, 252.349) = 17.415$, $p < .001$. Therefore, post-hoc bonferroni corrected pairwise comparisons were conducted. The pairwise comparisons showed significant differences between the condition with 0 shields and the condition with 1 shield ($p = .026$), the condition with 0 shields and the condition with 3 shields ($p < .001$), the condition with 0 shields and the condition with 4 shields ($p < .001$) and the condition with 0 shields and the condition with 5 shields ($p < .001$). Two other significant effects were found between the condition with 1 shield and the condition with 4 shields

(p = .012) and the condition with 1 shield and the condition with 5 shields ($p < .001$). The graph below shows that the significant effects indicate an decrease in TTC is related to an increase in lives.

	Value	*F*	*p*
Pillai's Trace	.438	12.472	.000
Wilks' Lambda	.562	12.472	.000
Hotelling's Trace	.780	12.472	.000
Roy's Largest Root	.780	12.472	.000

Table 3. Multivariate tests between conditions – TTC

	N	*M*	*SD*
0 shields	68	1.06	.27
1 shield	68	.97	.23
3 shields	68	.91	.25
4 shields	68	.88	.27
5 shields	68	.85	.23

Table 4. Descriptive statistics between conditions – TTC

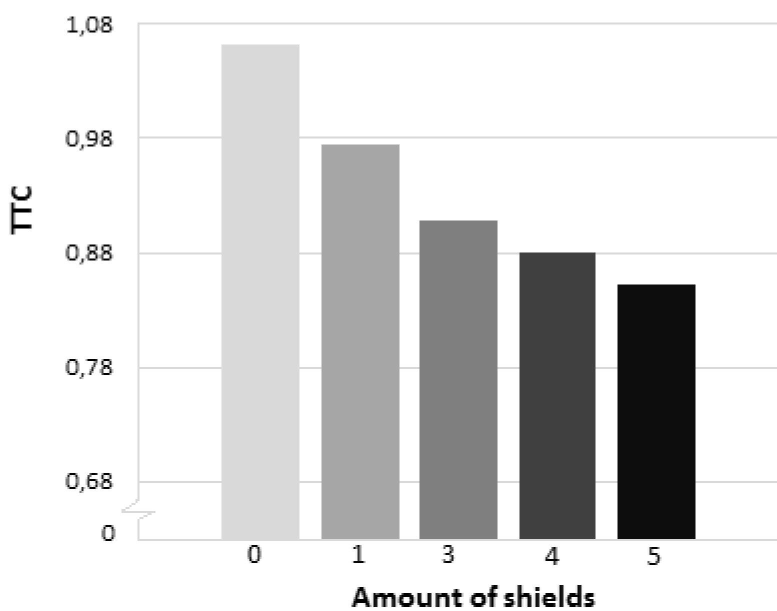

Figure 7. Means plot for TTC in all conditions

DCM

All multivariate tests were significant, $p < .001$. Mauchly's test indicated that the assumption of sphericity was not met, $X^2(9)$, = 321.123, $p < .001$. Therefore, degrees of freedom were corrected by using the Greenhouse-Geisser estimates of sphericity (ε = .336). The results show that there is a significant difference in mean DCM between the different conditions, $F(1.345, 91.462) = 21.662$, $p < .001$. Therefore, post-hoc bonferroni corrected pairwise comparisons were conducted. The pairwise comparisons showed significant differences between the condition with 0 shields and the condition with 1 shield ($p = .002$), the condition with 0 shields and the condition with 3 shields ($p < .001$), the condition with 0 shields and the condition with 4 shields ($p < .001$) and the condition with 0 shields and the condition with 5 shields ($p < .001$). Three other significant effects were found between the condition with 1 shield and the condition with 4 shields ($p = .011$), the condition with 1 shield and the condition with 5 shields ($p = .001$) and the condition with 3 shields and the condition with 5 shields ($p = .023$). The graph below shows that the significant effects indicate an decrease in DCM is related to an increase in lives.

	Value	*F*	*p*
Pillai's Trace	.318	9.996	.000
Wilks' Lambda	.619	9.996	.000
Hotelling's Trace	.615	9.996	.000
Roy's Largest Root	.615	9.996	.000

Table 5. Multivariate tests between conditions – DCM

	N	*M*	*SD*
0 shields	69	261.89	71.55
1 shield	69	231.33	27.65
3 shields	69	223.97	15.95
4 shields	69	221.08	12.56
5 shields	69	218.80	11.48

Table 6. Descriptive statistics between conditions – DCM

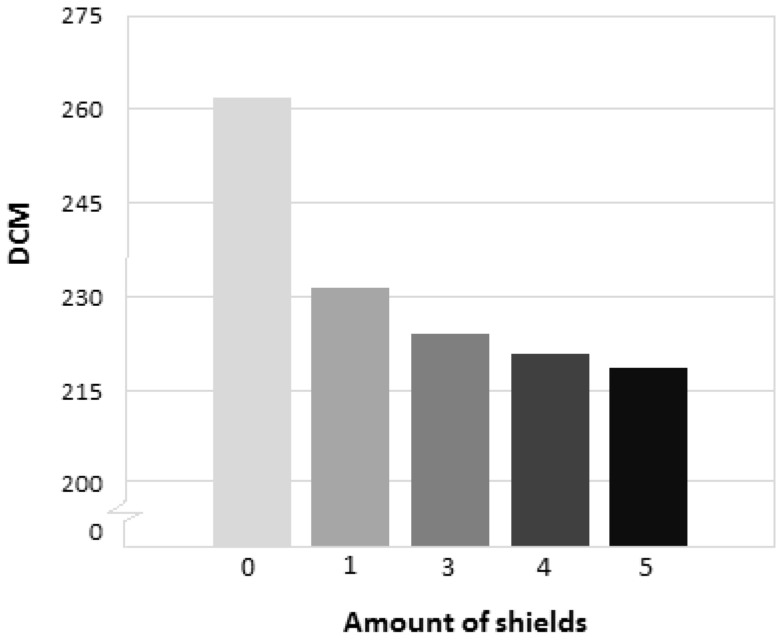

Figure 8. Means plot for DCM in all conditions

3.1.2 Within comparisons – One shield condition

Repeated measure ANOVA's were also conducted within each condition to see whether the decrease in lives during one session causes risk homeostasis. For TTC and DCM the first shield of every condition was left out as this data was clouded. The formula used to measure these risk parameters uses the distance to meteorites. However, at the very beginning of the game the meteorites still have to 'fly in' on the screen. Therefore, the TTC and DCM of the first shields are not reliable and may not be included in the within comparisons. Overall, this means that the one shield condition only includes speed. The condition of zero shields is not included as there is no comparison to make with other shields.

Speed

The multivariate approach shows that all tests are significant, $p < .001$ (Table 7). Two conditions were compared, therefore the assumption of sphericity is not relevant. The univariate approach shows that the two conditions significantly differed from each other, $F(1, 68) = 51.994$, $p < .001$. Having zero shields left ($M = 524.69$) results in more speed than having one shield left ($M = 440.20$).

	Value	*F*	*p*
Pillai's Trace	.433	51.994	.000
Wilks' Lambda	.567	51.994	.000
Hotelling's Trace	.765	51.994	.000
Roy's Largest Root	.765	51.994	.000

Table 7. Multivariate tests within 1 shield condition – Speed

	N	*M*	*SD*
1/1 shields	69	440.20	110.43
0/1 shields	69	524.69	164.87

Table 8. Descriptive statistics within 1 shield condition – Speed

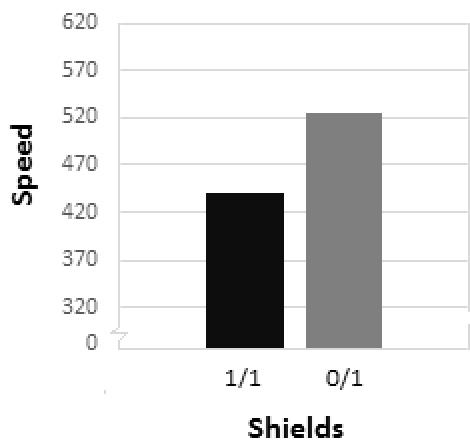

Figure 9. Means plot within 1 shield condition – Speed

3.1.3 Within comparisons – Three shields conditions

Speed

The multivariate approach shows that all tests are significant, $p < .001$ (Table 9). Mauchly's test indicated that the assumption of sphericity was not met, $X^2(5)$, = 62.85, $p < .001$. Therefore, degrees of freedom were corrected by using the Greenhouse-Geisser estimates of sphericity (ε = .611). The results show that there is a significant difference in mean speed within the three shield condition, $F(1.83, 104.61) = 49.58$, $p < .001$. Post-hoc Bonferroni-corrected pairwise comparisons showed significant differences between 3 shields left and 2 shields left ($p < .001$), 3 shields left and 1 shield left ($p < .001$), 3 shields left and 0 shields left ($p < .001$). There was also a significant effect between 2 shields left and 1 shield left (p =

.001) and 2 shields left and 0 shields left (*p* = .001). There was no significant effect between 1 shield left and 0 shields left (*p* = 1.000).

	Value	*F*	*p*
Pillai's Trace	.239	8.774	.000
Wilks' Lambda	.761	8.774	.000
Hotelling's Trace	.313	8.774	.000
Roy's Largest Root	.313	8.774	.000

Table 9. Multivariate tests within 3 shields condition – Speed

	N	*M*	*SD*
3/3 shields	58	458.06	113.27
2/3 shields	58	556.83	171.11
1/3 shields	58	596.79	185.98
0 shields	58	608.20	179.44

Table 10. Descriptive statistics within 3 shields condition – Speed

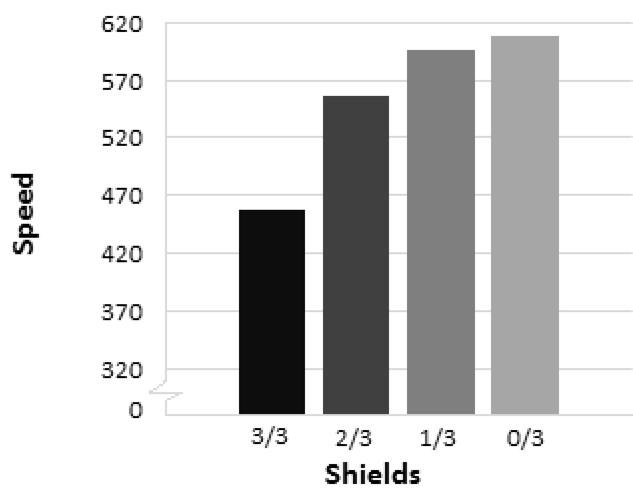

Figure 10. Means plot within 3 shields condition – Speed

TTC

The multivariate approach shows that all multivariate tests are not significant, *p* = .126 (Table 11). Mauchly's test indicated that the assumption of sphericity was met, $X^2(2)$, = 0.211, *p* = .900. The univariate approach also shows that there is no significant difference in mean TTC within the three shield condition, $F(2, 114) = 2.239$, $p = .111$. Therefore, no post-hoc tests were executed. Differences were too small to graphically display.

	Value	*F*	*p*
Pillai's Trace	.071	2.148	.126
Wilks' Lambda	.929	2.148	.126
Hotelling's Trace	.077	2.148	.126
Roy's Largest Root	.077	2.148	.126

Table 11. Multivariate tests within 3 shields condition – TTC

	N	*M*	*SD*
2/3 shields	58	.75	.34
1/3 shields	58	.68	.31
0/3 shields	58	.69	.29

Table 12. Descriptive statistics within 3 shields condition – TTC

DCM

Mauchly's test indicated that the assumption of sphericity was met, $X^2(2)$, = 2.874, $p = .238$. Both the multivariate approach ($p = .640$) and the univariate approach showed no significant results, F (2, 114) = 0.362, $p = .697$. Therefore, no post-hoc tests were executed. Differences were too small to graphically display.

	Value	*F*	*p*
Pillai's Trace	.016	.450	.640
Wilks' Lambda	.984	.450	.640
Hotelling's Trace	.016	.450	.640
Roy's Largest Root	.016	.450	.640

Table 13. Multivariate tests within 3 shields condition – DCM

	N	*M*	*SD*
2/3 shields	58	203.31	16.43
1/3 shields	58	202.83	16.21
0 shields	58	205.08	12.37

Table 14. Descriptive statistics within 3 shields condition – DCM

3.1.4 Within comparisons: Four shields condition

Speed

The multivariate approach shows significant results, $p < .001$ (Table 15). Mauchly's test indicated that the assumption of sphericity was not met, $X^2(9)$, = 113, $p < .001$. Therefore, degrees of freedom were corrected by using the Greenhouse-Geisser estimates of sphericity (ε = .515). The univariate results show that there is a significant difference in mean speed within the four shield condition, $F(2.059, 115.31) = 36.817$, $p < .001$. Post-hoc Bonferroni-corrected pairwise comparisons showed significant differences between 4 shields left and all three other shield conditions (all $p < .001$). No other significant effects were found.

	Value	*F*	*p*
Pillai's Trace	.566	17.276	.000
Wilks' Lambda	.434	17.276	.000
Hotelling's Trace	1.304	17.276	.000
Roy's Largest Root	1.304	17.276	.000

Table 15. Multivariate tests within 4 shields condition – Speed

	N	*M*	*SD*
4/4 shields	57	473.79	142.83
3/4 shields	57	578.07	195.87
2/4 shields	57	586.18	178.60
1/4 shields	57	594.91	184.60
0/4 shields	57	595.49	183.13

Table 16. Descriptive statistics within 4 shields condition – Speed

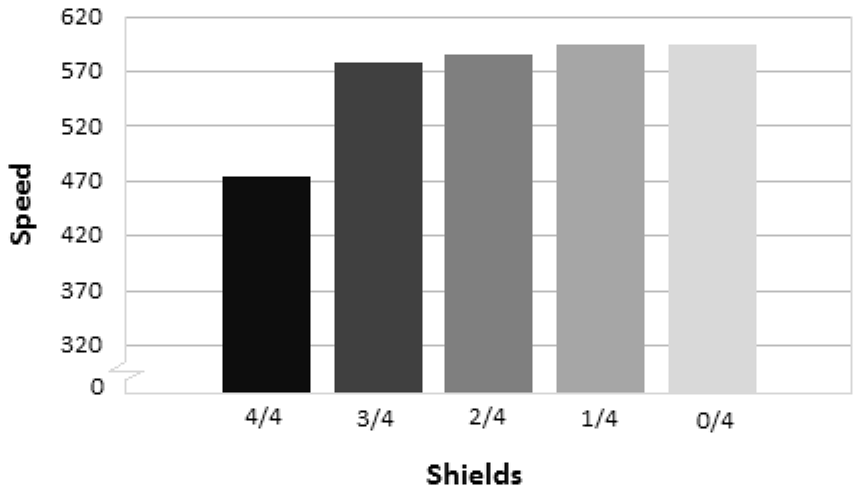

Figure 11. Means plot within 4 shields condition – Speed

TTC

Multivariate tests show no significant results, p =.816 (Table 16). Mauchly's test indicated that the assumption of sphericity was not met, $X^2(5)$, = 16.53, p = .005. Therefore, degrees of freedom were corrected by using the Huynh-Feldt estimates of sphericity (ε = .838). The univariate results also show that there is no significant difference in mean TTC within the four shield condition, F (2.642, 147.965) = 0.231, p = .852. Therefore, no post-hoc tests were executed. Differences were too small to graphically display.

	Value	*F*	*p*
Pillai's Trace	.017	.313	.816
Wilks' Lambda	.983	.313	.816
Hotelling's Trace	.017	.313	.816
Roy's Largest Root	.017	.313	.816

Table 17. Multivariate tests within 4 shields condition – TTC

	N	*M*	*SD*
3/4 shields	57	.74	.28
2/4 shields	57	.73	.29
1/4 shields	57	.71	.27
0/4 shields	57	.73	.27

Table 18. Descriptive statistics within 4 shields condition – TTC

DCM

Multivariate tests show no significant results, p = .825 (Table 19). Mauchly's test indicated that the assumption of sphericity was met, $X^2(5)$, = 4.149, p = .528. The univerariate results show also that there is no significant difference in mean DCM within the four shield condition, $F(3, 171) = 0.263$, p = .852. Therefore, no post-hoc tests were executed. Differences were too small to graphically display.

	Value	*F*	*p*
Pillai's Trace	.016	.301	.825
Wilks' Lambda	.984	.301	.825
Hotelling's Trace	.016	.301	.825
Roy's Largest Root	.016	.301	.825

Table 19. Multivariate tests within 4 shields condition – DCM

	N	*M*	*SD*
3/4 shields	58	207.95	17.37
2/4 shields	58	206.97	14.49
1/4 shields	58	207.33	17.08
0/4 shields	58	209.24	14.52

Table 20. Descriptive statistics within 4 shields condition – DCM

3.1.5 Within comparisons: Five shields condition

Speed

Multivariate tests showed all tests were significant, $p < .001$ (Table 21). Mauchly's test indicated that the assumption of sphericity was not met, $X^2(14)$, = 214.66, $p < .001$. Therefore, degrees of freedom were corrected by using the Greenhouse-Geisser estimates of sphericity (ε = .501). The univariate results also show that there is a significant difference in mean speed within the five shield condition, $F(2.51, 155.29) = 36.09$, $p < .001$. Therefore, post-hoc bonferroni corrected pairwise comparisons were conducted. The pairwise comparisons showed significant differences between 5 shields left and all the other shield conditions (all $p < .001$). Also a significant effect was found between 4 shields left and 2 shields left (p = .001).

	Value	*F*	*p*
Pillai's Trace	.556	14.500	.000
Wilks' Lambda	.444	14.500	.000
Hotelling's Trace	1.250	14.500	.000
Roy's Largest Root	1.250	14.500	.000

Table 21. Multivariate tests within 5 shields condition – Speed

	N	*M*	*SD*
5/5	63	456.74	119.29
4/5 shields	63	555.47	172.89
3/5 shields	63	576.11	183.92
2/5 shields	63	585.34	181.86
1/5 shields	63	590.94	172.34
0/5 shields	63	592.98	184.65

Table 22. Descriptive statistics within 5 shields condition – Speed

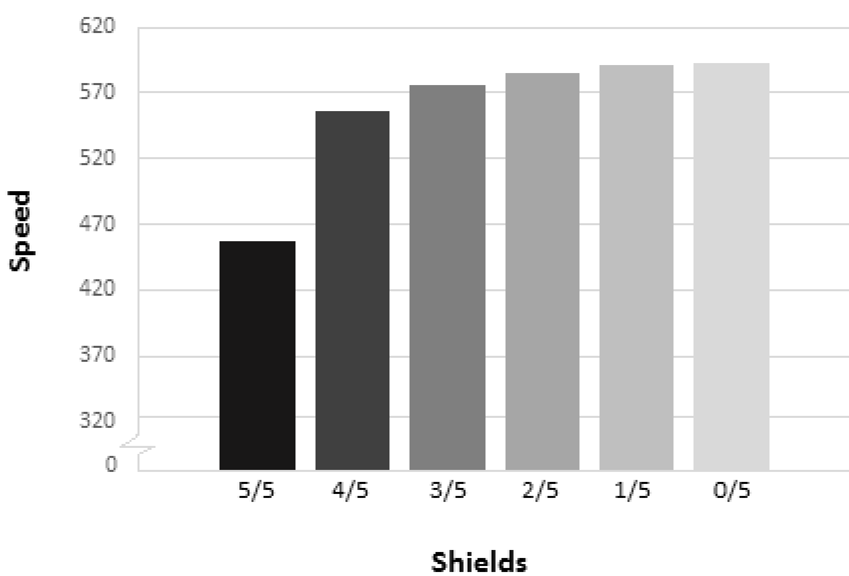

Figure 12. Means plot within 5 shields condition – Speed

TTC

Multivariate tests showed all tests were significant, p = .006 (Table 23). Mauchly's test indicated that the assumption of sphericity was not met, $X^2(9)$, = 33.66, p < .001. Therefore, degrees of freedom were corrected by using the Huynh-Feldt estimates of sphericity (ε = .783). The results show that there is a significant difference in mean TTC within the five shield condition, $F(3.317, 205.666) = 4.23$, $p = .005$. Therefore, post-hoc bonferroni corrected pairwise comparisons were conducted. The pairwise comparisons showed significant differences between 4 shields left and 2 shields left ($p = .011$), 4 shields left and 1 shield left ($p = .038$) and 4 shields left and 0 shields left ($p = .02$). Differences were too small to graphically display.

	Value	*F*	*p*
Pillai's Trace	.214	4.027	.006
Wilks' Lambda	.786	4.027	.006
Hotelling's Trace	.273	4.027	.006
Roy's Largest Root	.273	4.027	.006

Table 23. Multivariate tests within 5 shields condition – TTC

	N	*M*	*SD*
4/5 shields	63	.79	.28
3/5 shields	63	.74	.28
2/5 shields	63	.73	.27
1/5 shields	63	.71	.24
0/5 shields	63	.70	.28

Table 24. Descriptive statistics within 5 shields condition – TTC

DCM

Multivariate tests show no significant effects, $p = .812$ (Table 25). Mauchly's test indicated that the assumption of sphericity was met, $X^2(9)$, = 16.274, $p = .061$. The univariate results also show that there is no significant difference in mean DCM within the five shield condition, $F(4, 248) = 0.455$, $p = .768$. Therefore, no post-hoc tests were executed. Differences were too small to graphically display

	Value	*F*	*p*
Pillai's Trace	.026	.394	.812
Wilks' Lambda	.974	.394	.812
Hotelling's Trace	.027	.394	.812
Roy's Largest Root	.027	.394	.812

Table 25. Multivariate tests within 5 shields condition – DCM

	N	*M*	*SD*
4/5 shields	63	207.89	13.90
3/5 shields	63	205.25	18.84
2/5 shields	63	207.48	12.93
1/5 shields	63	205.43	14.42
0/5 shields	63	205.65	17.47

Table 26. Descriptive statistics within 5 shields condition – DCM

3.2 Preparatory analyses risk-taking and risk homeostasis hypotheses

MANOVA

Before the MANOVA's were conducted for the hypotheses 2a, 3a, 4a and 5a, assumptions were checked. The dependent variables (speed, TTC and DCM) are all on interval or ratio level. The independent variables (sport in hours, risk level sport, objective position and subjective position) are all categorical and have two or more independent groups. Furthermore, there is independence of observations and there is an adequate sample size; in each group of the independent variables there are more cases than the number of dependent variables (>3).

Univariate outliers and multivariate outliers were not identified as these are related to the phenomenon that is being researched.

Next, multivariate normality was tested. SPSS does not offer a test for multivariate normality, therefore multiple normality tests (Shapiro-Wilks) had to be performed. Normality of each of the dependent variables for each group of the independent variable was tested. Almost all Shapiro-Wilks tests were not significant, indicating normality of the data. Only one Shapiro-Wilks test was significant: the mean of DCM in the 'more defensive' group (variable 4, hypothesis 3b), $p = .005$. Multiple transformations of the mean of DCM resulted in no changes regarding normality. The one-way MANOVA is fairly robust to deviations of normality. Therefore, the mean of DCM was included in the analyses. The non-normality will be taken into account when reporting the results. .

Multicollinearity was tested by calculating the correlations between the three dependent variables. The tests show that Speed and TTC are highly (negatively) correlated with each other ($r = -.957$, $p < .001$), while speed and DCM are not correlated at all ($r = 0.06$, $p = .638$). Also TTC and DCM are not correlated ($r = -.016$, $p = .897$). Therefore, speed was taken out of the MANOVA. The effect of the independent variables on speed will be independently calculated by an separate ANOVA.

Homogeneity of variance-covariance matrices was tested using Box's M test of equality of covariance. For the first variable (hours of sport) there was homogeneity of variance-covariances matrices, as assessed by Box's test of equality of covariance matrices ($p = .844$). Also the second variable (risk level of sport) showed homogeneity of variance-covariance matrices ($p = .509$), as well as the other two variables (position: $p = .388$ and style: $p = .926$). The assumption of homogeneity of variance-covariance matrices is met.

The linear relationship between each pair of dependent variables (now only TTC and DCM) for each group of the independent variable was executed by using scatterplots. The plots showed that there was no clear linear relationship between DCM and TTC for each group of the independent variable. Also the linear relationship between speed and DCM was checked (In case there would be a linear relationship, TTC could be excluded from the MANOVA instead of speed). However, there was also no linear relationship between speed and DCM. Multiple transformations, both for DCM, TTC and speed did not result in a linear relationship.

Due to the violation of the linearity assumption the two dependent variables were separated from each other; resulting in three separate ANOVA's to test each of the hypotheses. As the assumptions for MANOVA also include most assumptions of a one-way ANOVA, no additional preparatory analyses have to be conducted. The homogeneity of variances, using Levene's test, will be checked during the analysis.

Repeated measures ANOVA

Hypotheses 2b, 3b, 4b and 5b were tested using repeated measures ANOVA's. The dependent variables (speed, TTC and DCM) are all measured on a continuous scale. Furthermore, the within-subjects factor is categorical with two or more levels. The third assumption, no significant outliers in any level of the within-subjects factor, were tested using boxplots. Outliers were found but these were not removed as they are all related to the phenomenon that is being researched.

The fifth assumption, a normal distribution for the dependent variables for each level of the within-subjects factor, was measured using the normal Q-Q plots and Shapiro Wilks test. All dependent variables showed normal distribution. The sixth assumption, the assumption of sphericity, will be checked during the analysis.

***3.3 Hypothesis 2a*: More participation in sports (in hours) leads to more risk-taking behavior.**

An one-way ANOVA was conducted with the mean of speed as dependent variable and the hours of sport as the independent variable. Two other one-way ANOVA's were conducted with the mean of TTC and the mean of DCM as dependent variables. The means and standard deviations of these dependent variables for each group of the independent variable can be found in Table 27.

		Speed		TTC		DCM	
	N	*M*	*SD*	*M*	*SD*	*M*	*SD*
0 hours	11	457.15	92.61	.99	.16	217.33	6.28
0-1 hours	10	468.26	112.98	.97	.24	221.02	5.94
1-2 hours	7	511.97	128.08	.90	.22	216.53	6.22
2-3 hours	15	544.33	129.44	.85	.20	227.63	23.30
3-4 hours	7	444.09	76.27	1.15	.19	220.02	8.61
4-6 hours	9	527.28	81.96	1.02	.18	220.80	8.00
> 6 hours	10	485.58	102.53	.87	.13	221.97	9.78

Table 27. Descriptive statistics for Speed, TTC and DCM for the independent variable hours of sport.

Speed

The assumption of homogeneity of variances was met, as assessed by Levene's test for equality of variances (p = .388). The mean speed was significantly different for the different groups on the independent variable, $F(6, 62) = 2.262$, $p = .049$. As the hypothesis implies a specific difference between the groups of the independent variables (more participation in sports is accompanied by more speed), post-hoc Tuckey's test are not suitable. Instead, custom contrasts were ran to see whether support was found for the hypothesis. Six different contrasts were entered in SPSS, these can be found in table 28. Bonferroni-corrected alpha levels of .00833 were used (.05/6).

Contrast	0 hours	0-1 hours	1-2 hours	2-3 hours	3-4 hours	4-6 hours	> 6 hours
1	-1	1	0	0	0	0	0
2	0	-1	1	0	0	0	0
3	0	0	-1	1	0	0	0
4	0	0	0	-1	1	0	0
5	0	0	0	0	-1	1	0
6	0	0	0	0	0	-1	1

Table 28. Contrasts for speed on the different groups for hours of sport.

Results showed that only the fourth contrast, 2-3 hours sports a week versus 3-4 hours sports a week, had a significant difference. Speed in the 3-4 hour group (*M* = 444.09) was significantly lower than speed in the -3 hour group (*M* = 544.33), a mean decrease of -147.819, 95% CI [-281.976, -13.662], *p* = .004.

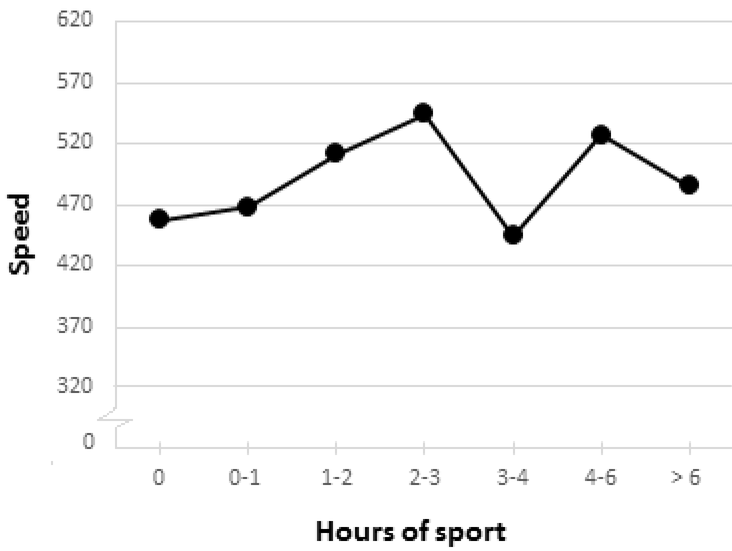

Figure 13. Means plot hours of sport – Speed

TTC

The assumption of homogeneity of variances was met (*p* = .334). Results show that the mean TTC is significantly different between the groups of the independent variable, *F*(6, 62) = 2.608, *p* = .026. Identical custom contrasts were ran, only now with TTC as dependent variable. Also for TTC, the only significant contrast was the fourth contrast. The TTC of the 3-4 hour group (*M* = 1.15) was significantly higher than the TTC of the 2-3 hour group (*M* = .85), an increase of 0.295, 95% CI [.056, .534], *p* = .001.

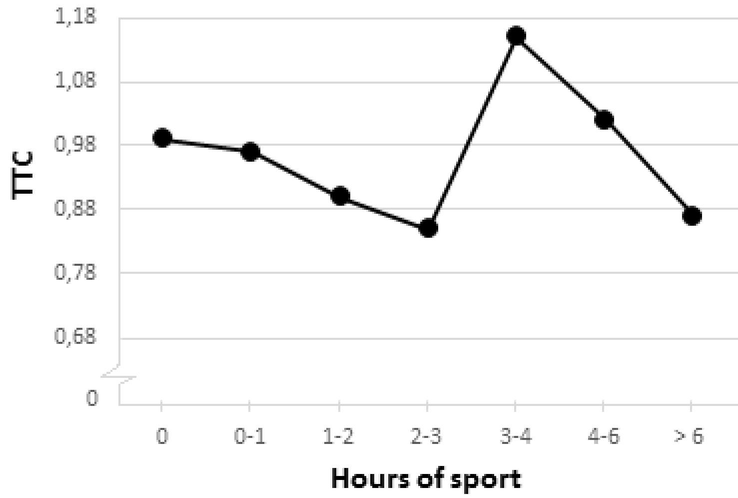

Figure 14. Means plot hours of sport – TTC

DCM

Levene's statistic was significant (*p < .001*) indicating that the assumption of homogeneity of variances was violated. Therefore, the results of the Welch ANOVA were used to see whether there was a significant difference on the different means for DCM in the different groups. Welch's ANOVA indicated that there was no significant difference between the groups, *Welch's F*(6, 25.460) = .929, *p* = .491. Therefore, no further tests were conducted.

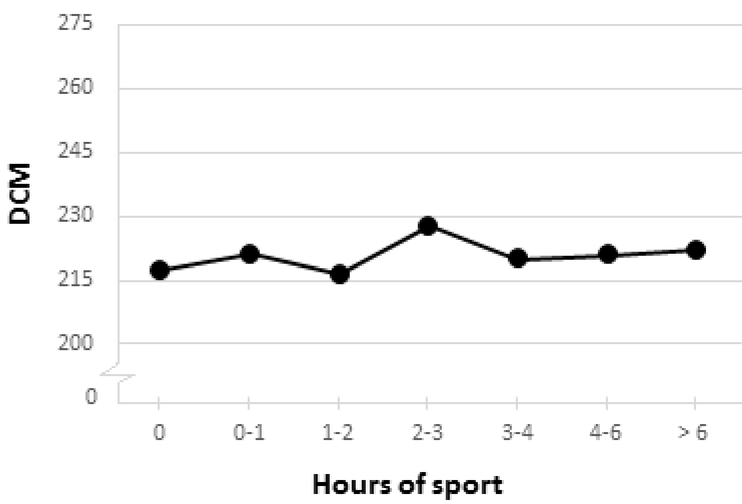

Figure 15. Means plot hours of sport – DCM

3.4 *Hypothesis 2b*: Depending on the participation in sports (in hours), a different risk-compensation strategy can be expected within different groups of sportspeople.

As the hours of sports variable has seven categories, there are a lot of different groups. Due to the extensive amount of data, the descriptive statistics of the seven different groups on speed, TTC and DCM can be found in Appendix G.

Speed

Due to the few significant effects in the previous section, the variable ‘hours of sport’ was re-categorized into two groups: non-sports participants versus sports participants. This re-categorization provides bigger sample sizes in the different groups, making the results more reliable. Also it provides an interesting comparison between two diverse groups: non-sports participants versus sports participants.

	Total			Non-sports participants			Sports participants		
	N	*M*	*SD*	*N*	*M*	*SD*	*N*	*M*	*SD*
0 shields	69	432.49	112.42	11	436.19	150.38	58	431.79	105.39
1 shield	69	467.36	121.77	11	441.03	92.11	58	472.35	126.65
3 shields	69	503.39	139.60	11	490.79	172.63	58	505.78	134.10
4 shields	69	521.22	160.73	11	479.89	139.25	58	529.06	164.39
5 shields	69	528.61	142.35	11	486.35	83.99	58	536.62	150.08

Table 29. Descriptive statistics for speed for the independent variable non-sports participants versus sports participants.

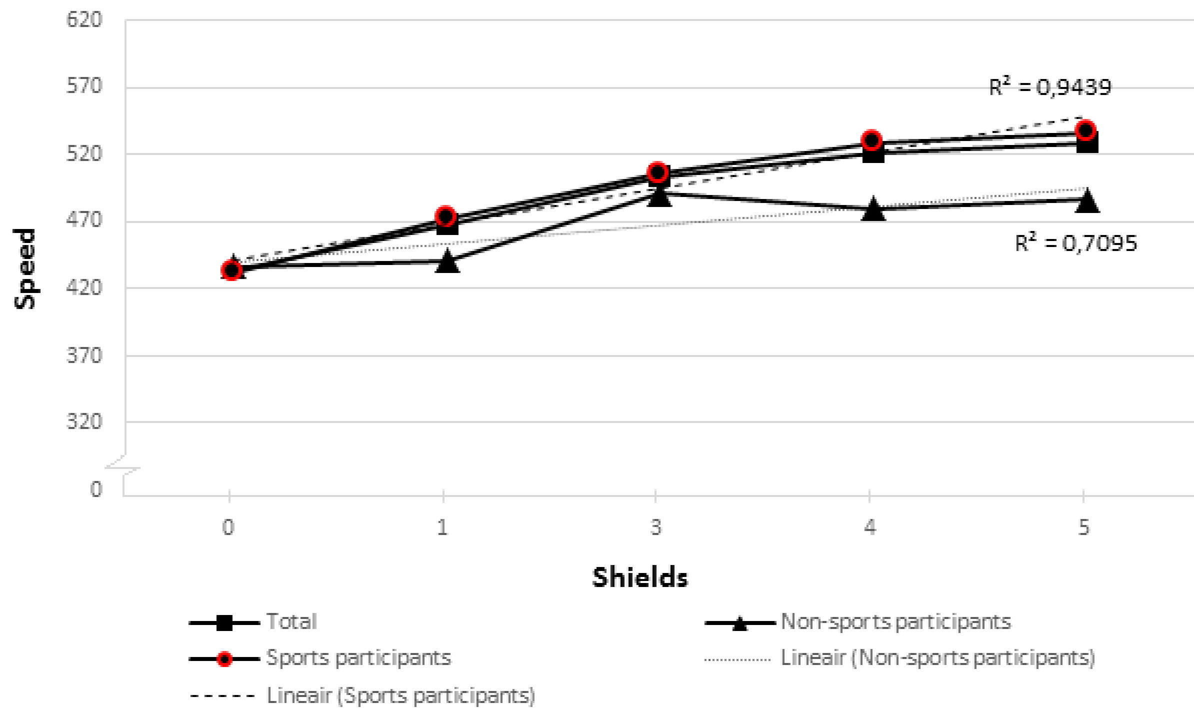

Figure 16. Means plot different groups hours of sport – Speed

The coefficient of determination for non-sports participants is R^2 = .7095 and for sports participants R^2 = .9439. Repeated measures ANOVA's were conducted for each group of the independent variable separately. This was done to see whether there was a significant risk homeostasis effect in (one of) the groups and to see whether there are differences in the risk-compensation strategy between the groups.

Repeated measures ANOVA – Non-sports participants

Mauchly's test indicated that the assumption of sphericity was violated, $X^2(9)$, = 17.922, p = .039. Therefore, degrees of freedom were corrected by using the Greenhouse-Geisser estimates of sphericity (ε = .529). The multivariate tests were not significant, p = .063 (Table 30). The univariate result also shows no significant effect, F (2.117, 21.167) = 1.129, p = .345.

	Value	*F*	*P*
Pillai's Trace	.679	3.704	.063
Wilks' Lambda	.321	3.704	.063
Hotelling's Trace	2.116	3.704	.063
Roy's Largest Root	2.116	3.704	.063

Table 30. Multivariate tests non-sports participants – Speed

Repeated measures ANOVA – Sports participants

Mauchly's test indicated that the assumption of sphericity was violated, $X^2(9)$, = 26.455, p = .002. Therefore, degrees of freedom were corrected by using the Huyn-Feldt estimates of sphericity (ε = .836). The multivariate tests were all significant, $p < .001$. The univariate result also shows a significant effect, $F(3.579, 204.021) = 17.108$, $p < .001$. Post-hoc Bonferroni-corrected pairwise comparisons show several significant differences between the different conditions. The 0 shield condition significantly differs from the 3, 4 and 5 shields condition (all $p < .001$). Also the 1 shield condition significantly differs from the 4 shields condition ($p = .015$) and the 5 shields condition ($p = .002$).

	Value	*F*	*P*
Pillai's Trace	.482	12.573	.000
Wilks' Lambda	.518	12.573	.000
Hotelling's Trace	.931	12.573	.000
Roy's Largest Root	.931	12.573	.000

Table 31. Multivariate tests sports participants – Speed

TTC

	Total			Non-sports participants			Sports participants		
	N	*M*	*SD*	*N*	*M*	*SD*	*N*	*M*	*SD*
0 shields	69	1.06	.27	11	1.04	.28	58	1.07	.27
1 shield	69	.98	.23	11	1.02	.19	58	.97	.23
3 shields	69	.91	.25	11	.96	.30	58	.90	.24
4 shields	69	.88	.27	11	.94	.20	58	.87	.28
5 shields	69	.86	.24	11	.90	.16	58	.85	.25

Table 32. Descriptive statistics for TTC for the independent variable non-sports participants versus sports participants.

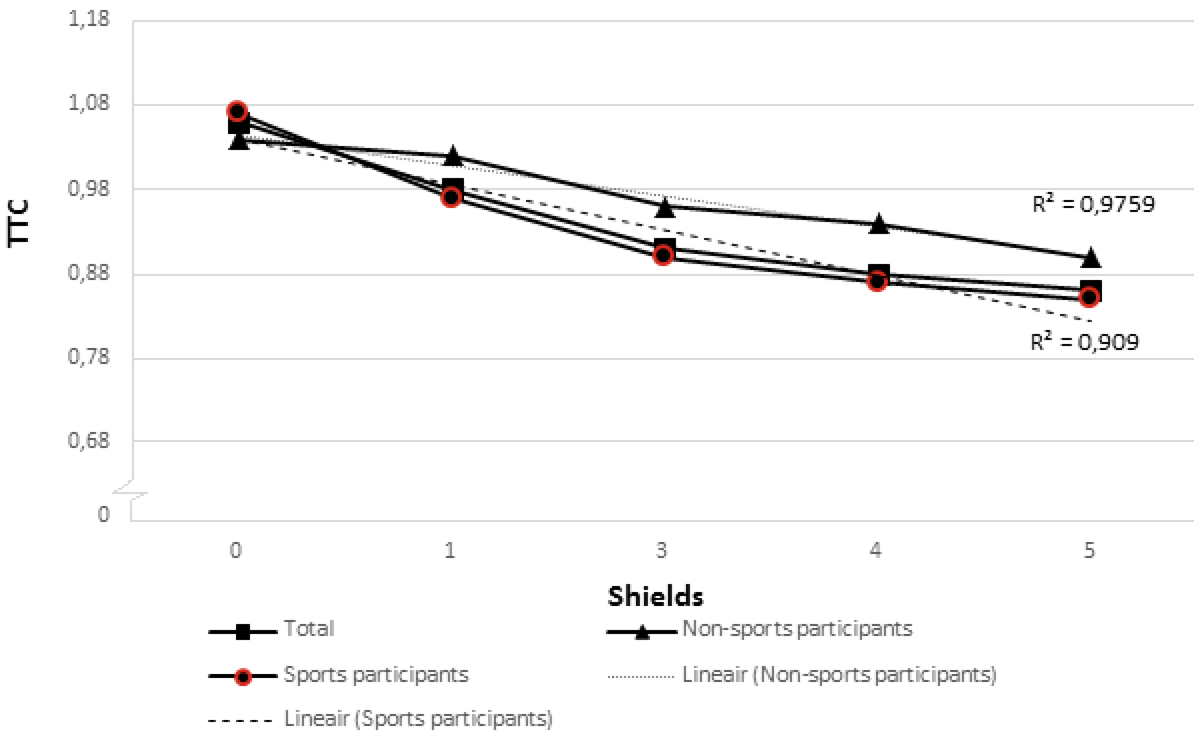

Figure 17. Means plot different groups hours of sport – TTC

The coefficient of determination for non-sports participants is R^2 = .9759 and for sports participants R^2 = .909. Repeated measures ANOVA's were conducted for each group of the independent variable separately. This was done to see whether there was a significant risk homeostasis effect in (one of) the groups and to see whether there are differences in the risk-compensation strategy between the groups.

Repeated measures ANOVA – Non-sports participants

Mauchly's test indicated that the assumption of sphericity was met, $X^2(9)$, = 13.312, p = .158. The multivariate tests were not significant, p = .191. The univariate result also shows no significant effect, $F(4, 36)$ = 1.482, p = .228.

	Value	*F*	*P*
Pillai's Trace	.590	2.155	.191
Wilks' Lambda	.410	2.155	.191
Hotelling's Trace	1.436	2.155	.191
Roy's Largest Root	1.436	2.155	.191

Table 33. Multivariate tests non-sports participants – TTC

Repeated measures ANOVA – Sports participants

Mauchly's test indicated that the assumption of sphericity was violated, $X^2(9)$, = 26.308, p = .002. Therefore, degrees of freedom were corrected by using the Huyn-Feldt estimates of sphericity (ε = .846). The multivariate tests were all significant, $p < .001$. The univariate result also shows a significant effect, $F(3.621, 206.408) = 16.006$, $p < .001$. Post-hoc Bonferroni-corrected pairwise comparisons show several significant differences between the different conditions. The 0 shield condition significantly differs from the 1 shield condition (p = .036) and the 3, 4 and 5 shields condition (all $p < .001$). Also the 1 shield condition significantly differs from the 4 shields condition (p = .029) and the *5* shields condition (p = .002).

	Value	*F*	*P*
Pillai's Trace	.454	11.235	.000
Wilks' Lambda	.546	11.235	.000
Hotelling's Trace	.832	11.235	.000
Roy's Largest Root	.832	11.235	.000

Table 34. Multivariate tests sports participants - TTC

DCM

	Total			Non-sports participants			Sports participants		
	N	*M*	*SD*	*N*	*M*	*SD*	*N*	*M*	*SD*
0 shields	69	261.89	71.55	11	237.20	28.36	58	266.57	76.33
1 shield	69	231.33	27.65	11	236.02	48.65	58	230.45	22.18
3 shields	69	223.97	15.95	11	222.64	15.52	58	224.22	16.15
4 shields	69	221.08	12.56	11	218.73	9.95	58	221.52	13.02
5 shields	69	218.80	11.48	11	214.67	4.90	58	219.58	12.21

Table 35. Descriptive statistics for DCM for the independent variable non-sports participants versus sports participants.

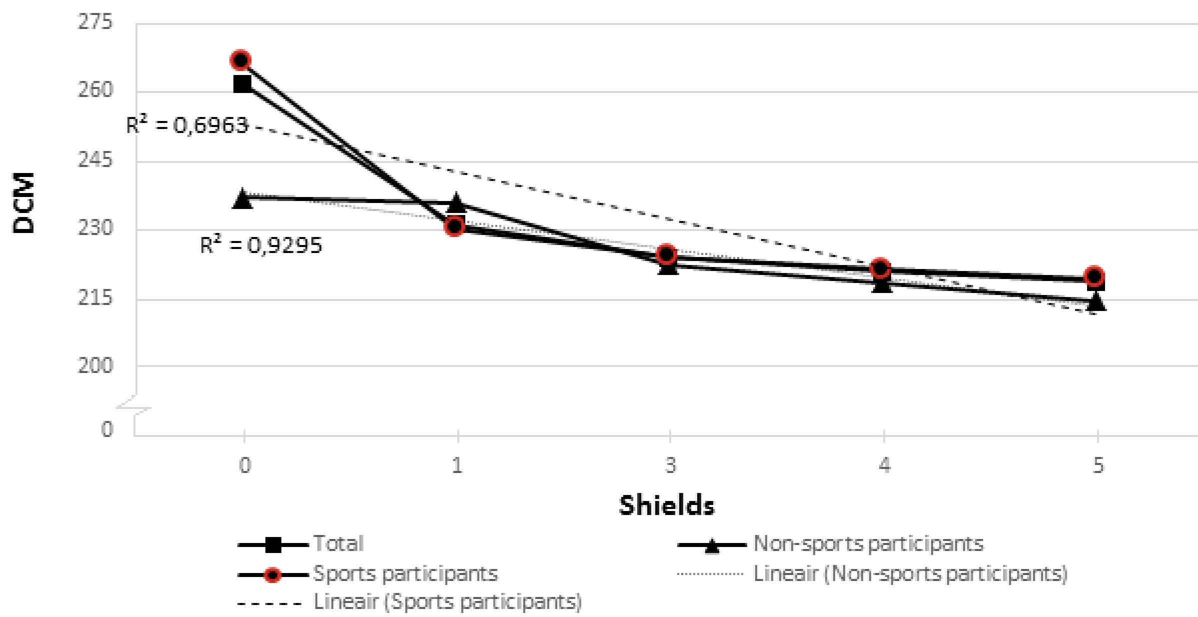

Figure 18. Means plot different groups hours of sport – DCM

The coefficient of determination for non-sports participants is R^2 = .9295 and for sports participants R^2 = .6963. Repeated measures ANOVA's were conducted for each group of the independent variable separately. This was done to see whether there was a significant risk homeostasis effect in (one of) the groups and to see whether there are differences in the risk-compensation strategy between the groups.

Repeated measures ANOVA – Non-sports participants

Mauchly's test indicated that the assumption of sphericity was violated, $X^2(9)$, = 30.795, p < .001. Therefore, degrees of freedom were corrected by using the Greenhouse-Geisser estimates of sphericity (ε = .455). The multivariate tests were not significant, p = .155. The univariate result also shows a non-significant effect, F(1.822, 18.216) = 1.771, p = .200.

	Value	*F*	*P*
Pillai's Trace	.571	2.333	.155
Wilks' Lambda	.429	2.333	.155
Hotelling's Trace	1.333	2.333	.155
Roy's Largest Root	1.333	2.333	.155

Table 36. Multivariate tests non-sports participants - DCM

Repeated measures ANOVA – Sports participants

Mauchly's test indicated that the assumption of sphericity was violated, $X^2(9)$, = 330.856, $p < .001$. Therefore, degrees of freedom were corrected by using the Greenhouse-Geisser estimates of sphericity (ε = .291). The multivariate tests were all significant, $p < .001$. The univariate result also shows a significant effect, $F(1.164, 66.344) = 21.105$, $p < .001$. Post-hoc Bonferroni-corrected pairwise comparisons show several significant differences between the different conditions. The 0 shield condition significantly differs from the 1 shield condition ($p = .001$) and the 3, 4 and 5 shields condition (all $p < .001$). Also the 1 shield condition significantly differs from the 4 shields condition ($p = .002$) and the *5* shields condition ($p < .001$).

	Value	*F*	*P*
Pillai's Trace	.390	8.623	.000
Wilks' Lambda	.610	8.623	.000
Hotelling's Trace	.639	8.623	.000
Roy's Largest Root	.639	8.623	.000

Table 37. Multivariate tests sports participants – DCM

3.5 *Hypothesis 3a*: **Sportspeople that participate in high risk sports will show more risk-taking behavior, compared to sportspeople who participate in medium risk and low risk sports.**

Three one-way ANOVA's were conducted with the means of speed, TTC and DCM as dependent variable and the risk level of sport as the independent variable (high, medium and low). The means and standard deviations of these dependent variables for each group of the independent variable can be found in Table 38.

		Speed		TTC		DCM	
	N	*M*	*SD*	*M*	*SD*	*M*	*SD*
Low	28	469.55	126.19	.98	.22	222.55	13.51
Medium	21	494.06	106.63	.93	.21	221.42	14.62
High	9	550.42	96.99	.85	.16	222.91	13.59

Table 38. Descriptive statistics for Speed, TTC and DCM for the independent variable risk level.

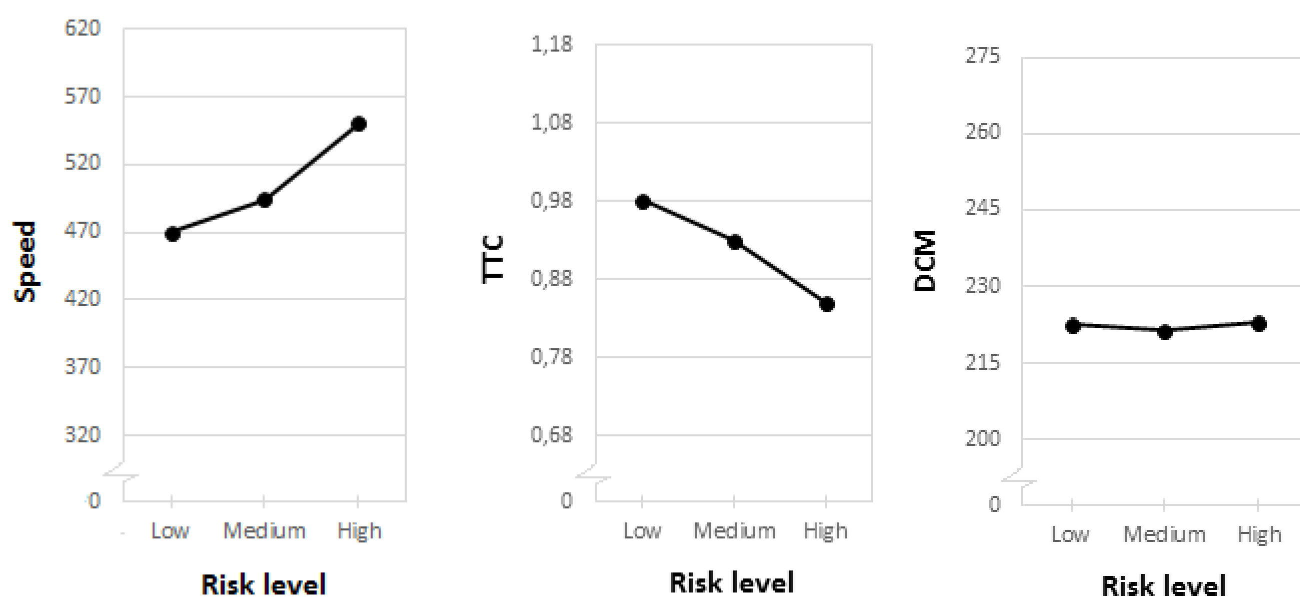

Figure 19. Means plot risk level – Speed, TTC and DCM

Speed

The assumption of homogeneity of variances was met, as assessed by Levene's test for equality of variances (p = .504). Results show that the mean speed does not significantly differ between the different groups on the independent variable, $F(2, 55) = 1.683$, p = .195.

TTC

Levene's test for equality of variances was not significant (p = .509), therefore the assumption of homogeneity of variances was met. The outcome shows that the mean TTC does not significantly differ between the different groups of the independent variable, $F(2, 55) = 1.415$, $p = .252$.

DCM

The assumption of homogeneity of variances was met, as assessed by Levene's test for equality of variances (p = .866). Results show that the mean DCM does not significantly differ between the different groups on the independent variable, $F(2, 55) = .054$, $p = .948$.

3.6 *Hypothesis 3b:* Depending on the risk level of the sport (low, medium or high), a different risk-compensation strategy can be expected within different groups of sportspeople.

Speed

	N	*M*	*SD*
0 shields	58	431.79	105.39
1 shield	58	472.35	126.65
3 shields	58	505.78	134.10
4 shields	58	529.06	164.39
5 shields	58	536.62	150.08

Table 39. Descriptive statistics for speed for the independent variable risk level (1)

	Low			Medium			High		
	N	*M*	*SD*	*N*	*M*	*SD*	*N*	*M*	*SD*
0 shields	28	408.52	99.45	21	455.96	106.41	9	447.80	117.22
1 shield	28	470.52	138.34	21	458.79	124.29	9	509.70	126.65
3 shields	28	477.80	147.69	21	520.70	111.57	9	557.99	134.10
4 shields	28	485.82	160.33	21	560.51	177.86	9	590.18	164.39
5 shields	28	501.09	152.56	21	559.53	155.87	9	593.70	150.08

Table 40. Descriptive statistics for speed for the independent variable risk level (2)

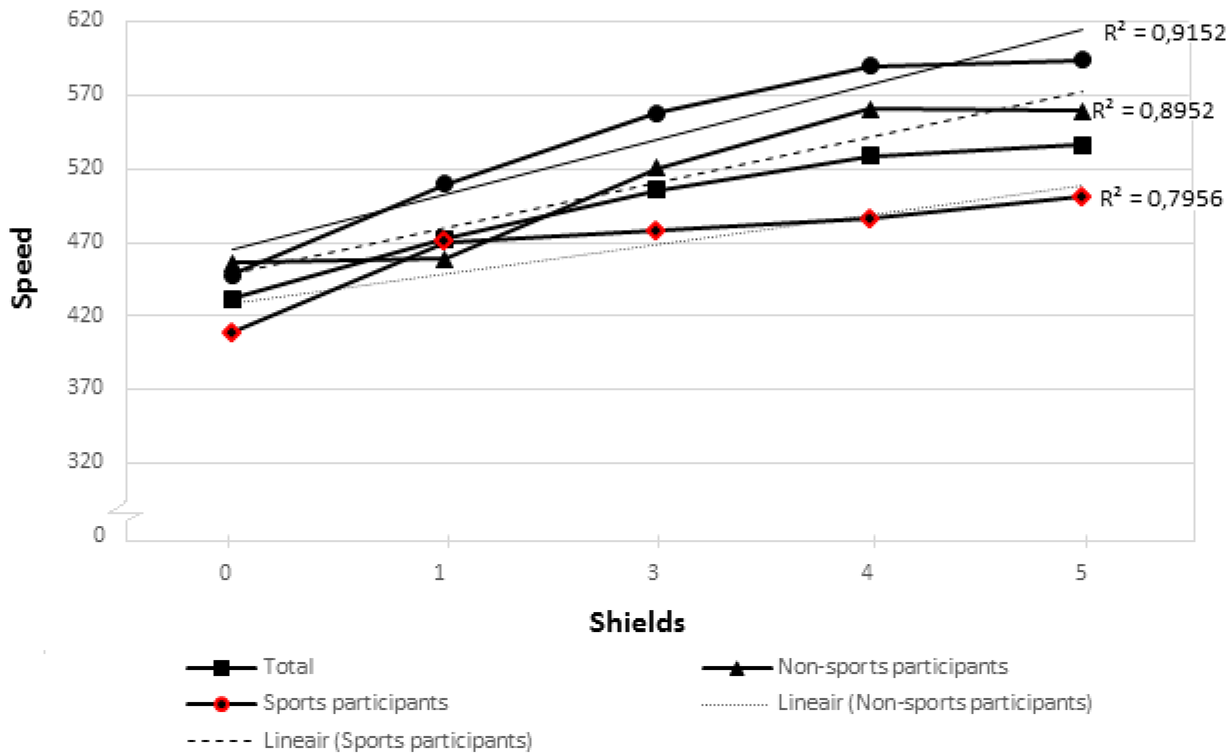

Figure 20. Means plot different groups risk level – Speed

The coefficient of determination for low risk is R^2 = .7956, medium risk R^2 = .8952 and high risk R^2 = .9152. Repeated measures ANOVA's were conducted for each group of the independent variable separately. This was done to see whether there was a significant risk homeostasis effect in (one of) the groups and to see whether there are differences in the risk-compensation strategy between the groups.

Repeated measures ANOVA – Low risk

Mauchly's test indicated that the assumption of sphericity was violated, $X^2(9)$, = 17.116, p = .047. Therefore, degrees of freedom were corrected by using the Greenhouse-Geisser estimates of sphericity (ε = .731). The multivariate tests were all significant, p = .002. The univariate result also shows a significant effect, F (2.925, 78.981) = 8.054, $p < .001$. Post-hoc Bonferroni-corrected pairwise comparisons showed three significant effects: the 0 shield condition significantly differs from the 1 shield condition (p = .01), the 4 shields condition (p = .002) and the 5 shields condition (p = .001).

	Value	*F*	*p*
Pillai's Trace	.505	6.128	.002
Wilks' Lambda	.495	6.128	.002
Hotelling's Trace	1.021	6.128	.002
Roy's Largest Root	1.021	6.128	.002

Table 41. Multivariate tests low risk – Speed

Repeated measures ANOVA – Medium risk

Mauchly's test indicated that the assumption of sphericity was met, $X^2(9)$, = 15.069, p = .09. The multivariate tests are all significant, p = .045. The univariate result also shows a significant effect, $F(4, 80) = 6.125$, $p < .001$. Post-hoc Bonferroni-corrected pairwise comparisons showed two significant effects: the 0 shields condition significantly differs from the 4 shields condition (p = .034) and the 5 shields condition (p = .023).

	Value	*F*	*p*
Pillai's Trace	.419	3.069	.045
Wilks' Lambda	.581	3.069	.045
Hotelling's Trace	.722	3.069	.045
Roy's Largest Root	.722	3.069	.045

Table 42. Multivariate tests medium risk – Speed

Repeated measures ANOVA – High risk

Mauchly's test indicated that the assumption of sphericity was met, $X^2(9)$, = 11.351, p = .267. All multivariate tests were significant, p = .015. The univariate result also shows a significant effect, F (4, 32) = 5.980, p = .001. Post-hoc Bonferroni-corrected pairwise comparisons showed two significant effects: the 0 shields condition significantly differs from the 4 shields condition (p = .024) and the 5 shields condition (p = .005).

	Value	*F*	*p*
Pillai's Trace	.884	9.503	.015
Wilks' Lambda	.116	9.503	.015
Hotelling's Trace	7.603	9.503	.015
Roy's Largest Root	7.603	9.503	.015

Table 43. Multivariate tests high risk – Speed

TTC

	N	*M*	*SD*
0 shields	58	1.07	.27
1 shield	58	.97	.23
3 shields	58	.90	.24
4 shields	58	.87	.28
5 shields	58	.85	.25

Table 44. Descriptive statistics for TTC for the independent variable risk level (1)

	Low			Medium			High		
	N	*M*	*SD*	*N*	*M*	*SD*	*N*	*M*	*SD*
0 shields	28	1.10	.23	21	1.02	.33	9	1.05	.23
1 shield	28	.96	.26	21	1.00	.22	9	.92	.20
3 shields	28	.97	.27	21	.86	.20	9	.80	.20
4 shields	28	.94	.28	21	.84	.29	9	.73	.23
5 shields	28	.91	.25	21	.81	.27	9	.74	.11

Table 45. Descriptive statistics for TTC for the independent variable risk level (2)

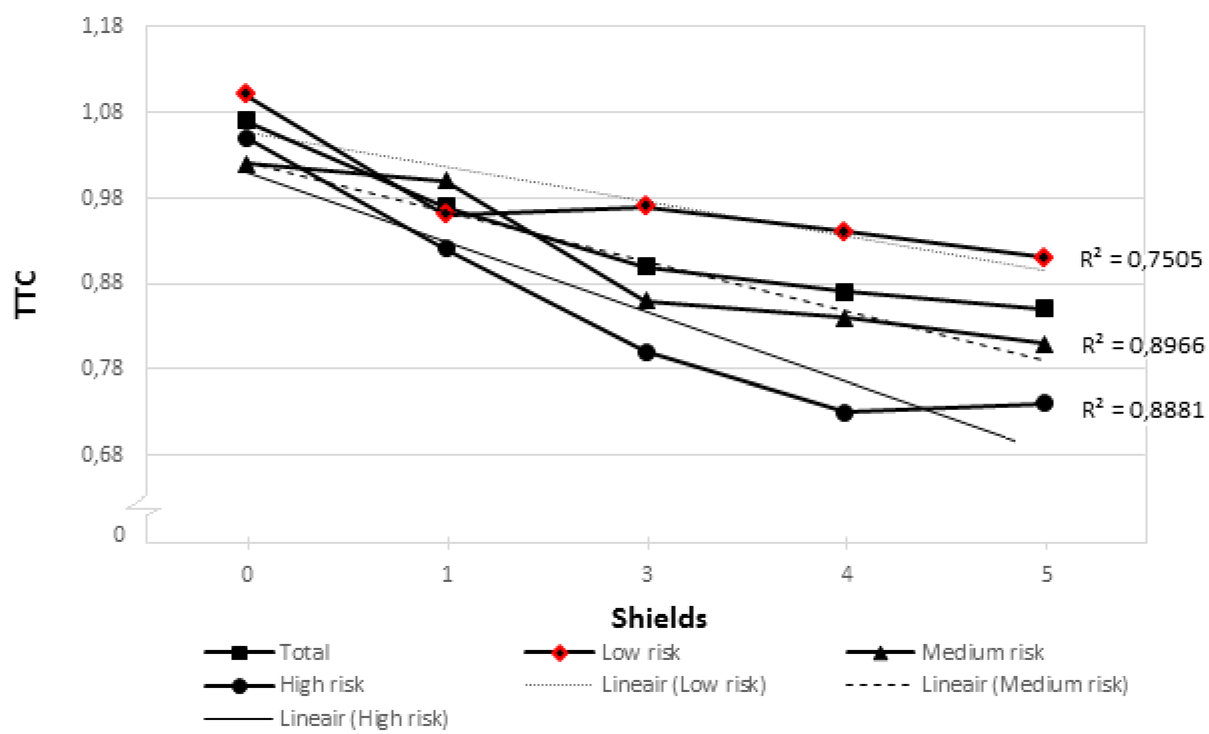

Figure 21. Means plot different groups risk level – TTC

The coefficient of determination for low risk is R^2 = .7505, medium risk R^2 = .8966 and high risk R^2 = .8881. Repeated measures ANOVA's were conducted for each group of the independent variable separately. This was done to see whether there was a significant risk homeostasis effect in (one of) the groups and to see whether there are differences in the risk-compensation strategy between the groups.

Repeated measures ANOVA – Low risk

Mauchly's test indicated that the assumption of sphericity was met, $X^2(9)$, = 8.763, *p* = .460. The multivariate tests were all significant, *p* = .003. The univariate result also shows a significant effect, *F* (4, 108) = 6.817, *p* < .001. Post-hoc Bonferroni-corrected pairwise comparisons showed three significant effects: the 0 shield condition significantly differs from the 1 shield condition (*p* = .017), the 4 shields condition (*p* = .004) and the 5 shields condition (*p* = .001).

	Value	*F*	*p*
Pillai's Trace	.474	5.411	.003
Wilks' Lambda	.526	5.411	.003
Hotelling's Trace	.902	5.411	.003
Roy's Largest Root	.902	5.411	.003

Table 46. Multivariate tests low risk - TTC

Repeated measures ANOVA – Medium risk

Mauchly's test indicated that the assumption of sphericity was violated, $X^2(9)$, = 21.148, *p* = .012 Therefore, degrees of freedom were corrected by using the Greenhouse-Geisser estimates of sphericity (ε = .702). The multivariate tests were all significant, *p* = .037. The univariate result also shows a significant effect, *F* (2.809, 56.180) = 5.610, *p* = .002. Post-hoc Bonferroni-corrected pairwise comparisons showed two significant effects: the 0 shield condition significantly differs from 5 shields condition (*p* = .027) and the 1 shield condition also significantly differs from the 5 shields condition (*p* = .048).

	Value	*F*	*p*
Pillai's Trace	.433	3.252	.037
Wilks' Lambda	.567	3.252	.037
Hotelling's Trace	.765	3.252	.037
Roy's Largest Root	.765	3.252	.037

Table 47. Multivariate tests medium risk - TTC

Repeated measures ANOVA – High risk

Mauchly's test indicated that the assumption of sphericity was met, $X^2(9)$, = 8.483, p = .501. All multivariate tests were not significant, p = .103. The univariate result however, shows a significant effect, F (4, 32) = 6.942, p < .001. Post-hoc Bonferroni-corrected pairwise comparisons showed one significant effect between the 0 shields condition and the 5 shields condition (p = .02).

	Value	*F*	*p*
Pillai's Trace	.735	3.465	.103
Wilks' Lambda	.265	3.465	.103
Hotelling's Trace	2.772	3.465	.103
Roy's Largest Root	2.772	3.465	.103

Table 48. Multivariate tests high risk - TTC

DCM

	N	*M*	*SD*
0 shields	58	266.57	76.33
1 shield	58	230.45	22.18
3 shields	58	224.22	16.15
4 shields	58	221.52	13.02
5 shields	58	219.58	12.21

Table 49. Descriptive statistics for DCM for the independent variable risk level (1)

	Low			Medium			High		
	N	*M*	*SD*	*N*	*M*	*SD*	*N*	*M*	*SD*
0 shields	28	267.80	77.07	21	263.41	79.03	9	270.13	76.18
1 shield	28	228.77	18.25	21	228.30	20.98	9	240.65	33.81
3 shields	28	223.64	15.03	21	225.86	17.57	9	222.22	17.61
4 shields	28	220.55	9.13	21	222.04	16.56	9	223.33	15.03
5 shields	28	220.63	14.11	21	219.46	11.73	9	216.62	5.65

Table 50. Descriptive statistics for DCM for the independent variable risk level (2)

Differences between the groups are too small to graphically display. The coefficient of determination for low risk is R^2 = .6485, medium risk R^2 = .685 and high risk R^2 = .8126. Repeated measures ANOVA's were conducted for each group of the independent variable separately. This was done to see whether there was a significant risk homeostasis effect in (one of) the groups and to see whether there are differences in the risk-compensation strategy between the groups.

Repeated measures ANOVA – Low risk

Mauchly's test indicated that the assumption of sphericity was violated, $X^2(9)$, = 177.55, $p < .001$ Therefore, degrees of freedom were corrected by using the Greenhouse-Geisser estimates of sphericity (ε = .278). The multivariate tests were all significant, $p = .007$. The univariate result also shows a significant effect, F (1.114, 30.077) = 11.899, $p = .001$. Post-hoc Bonferroni-corrected pairwise comparisons showed many significant effects. The 0 shields condition differs significantly from the 1 shield condition (p = .029), the 3 shields condition (p = .019), the 4 shields condition (p = .017) and the 5 shields condition (p = .008). The 1 shield condition significantly differs from the 4 shields condition (p = .029) and the 5 shields condition (p = .013).

	Value	*F*	*p*
Pillai's Trace	.432	4.556	.007
Wilks' Lambda	.568	4.556	.007
Hotelling's Trace	.759	4.556	.007
Roy's Largest Root	.759	4.556	.007

Table 51. Multivariate tests low risk – DCM

Repeated measures ANOVA – Medium risk

Mauchly's test indicated that the assumption of sphericity was violated, $X^2(9)$, = 129.184, $p < .001$ Therefore, degrees of freedom were corrected by using the Greenhouse-Geisser estimates of sphericity (ε = .281). The multivariate tests were all significant, $p = .062$. The univariate result also shows a significant effect, F (1.124, 22.479) = 5.393, $p = .026$. Post-hoc Bonferroni-corrected pairwise comparisons showed no significant effects.

	Value	*F*	*p*
Pillai's Trace	.393	2.754	.062
Wilks' Lambda	.607	2.754	.062
Hotelling's Trace	.648	2.754	.062
Roy's Largest Root	.648	2.754	.062

Table 52. Multivariate tests medium risk – DCM

Repeated measures ANOVA – High risk

Mauchly's test indicated that the assumption of sphericity was violated, $X^2(9)$, = 41.750, p < .001 Therefore, degrees of freedom were corrected by using the Greenhouse-Geisser estimates of sphericity (ε = .313). The multivariate tests were all not significant, p = .279. The univariate result also shows no significant effect, $F(1.253, 10.020) = 4.163$, p = .062. Post-hoc Bonferroni-corrected pairwise comparisons were checked as the univariate result was almost significant. No significant effects were found in the pairwise comparisons.

	Value	*F*	*p*
Pillai's Trace	.581	1.732	.279
Wilks' Lambda	.419	1.732	.279
Hotelling's Trace	1.386	1.732	.279
Roy's Largest Root	1.386	1.732	.279

Table 53. Multivariate tests high risk – DCM

3.7 Hypothesis 4a: Sportspeople with an offensive position, show more risk-taking behavior than sportspeople with a defensive position.

Three one-way ANOVA's were conducted with the means of speed, TTC and DCM as dependent variable and the position within sport as the independent variable (defensive and offensive). The means and standard deviations of these dependent variables for each group of the independent variable can be found in Table 54.

		Speed		TTC		DCM	
	N	*M*	*SD*	*M*	*SD*	*M*	*SD*
Defensive	6	471.87	89.45	.97	.20	222.47	7.81
Offensive	5	501.28	61.32	.89	.12	214.02	3.72

Table 54. Descriptive statistics for Speed, TTC and DCM for the independent variable position

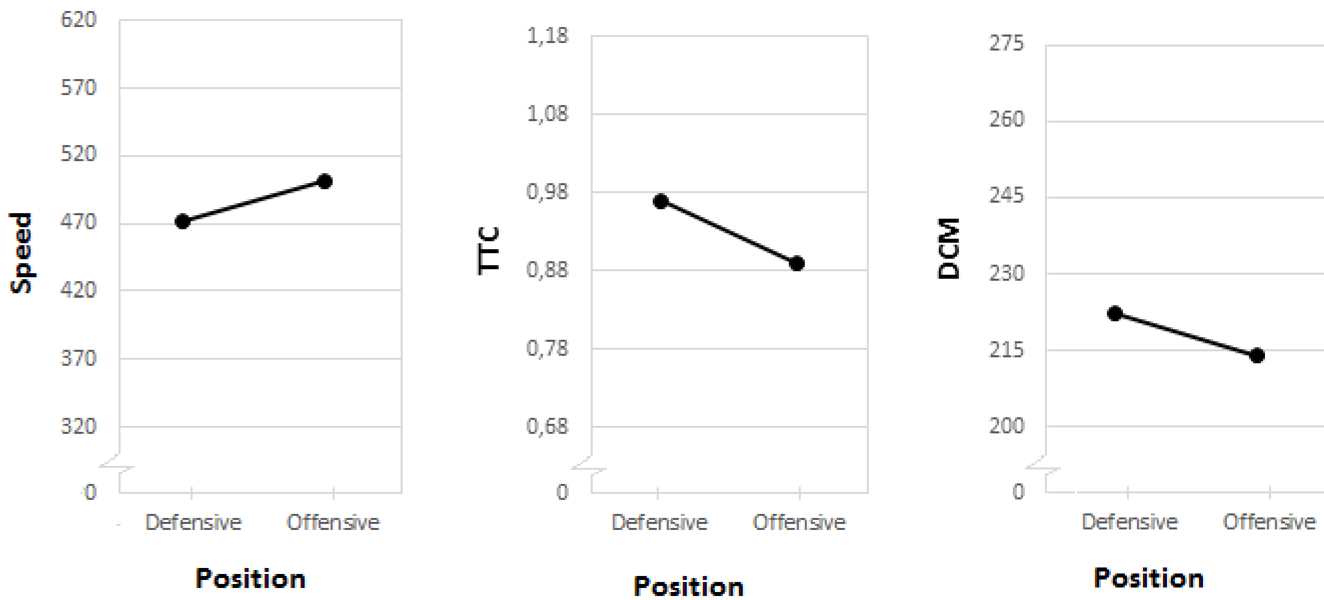

Figure 22. Means plot position – Speed, TTC and DCM

Speed

The assumption of homogeneity of variances was met, as assessed by Levene's test for equality of variances (p = .603). Results show that the mean speed does not significantly differ between the different groups on the independent variable, $F(1, 9) = .386$, $p = .550$.

TTC

The assumption of homogeneity of variances was met, as assessed by Levene's test for equality of variances (p = .309). Results show that the mean TTC does not significantly differ between the different groups on the independent variable, $F(1, 9) = .616$, $p = .453$.

DCM

The assumption of homogeneity of variances was met, as assessed by Levene's test for equality of variances (p = .195). Results show that the mean DCM does not significantly differ between the different groups on the independent variable, $F(1, 9) = 4.838$, $p = .055$.

3.8 *Hypothesis 4b*: Depending on the position played within a sport (defensive versus offensive), a different risk-compensation strategy can be expected within different groups of sportspeople.

Speed

	Total			Defensive			Offensive		
	N	*M*	*SD*	*N*	*M*	*SD*	*N*	*M*	*SD*
0 shields	11	459.74	87.91	6	439.57	110.48	5	483.94	52.18
1 shield	11	455.08	91.08	6	402,79	82.11	5	517.83	57.33
3 shields	11	516.47	81.99	6	520.57	100.96	5	511.54	63.35
4 shields	11	554.98	157.24	6	586.43	189.16	5	517.24	117.56
5 shields	11	536.65	129.29	6	560.42	170.76	5	508.14	58.76

Table 55. Descriptive statistics for speed for the independent variable position

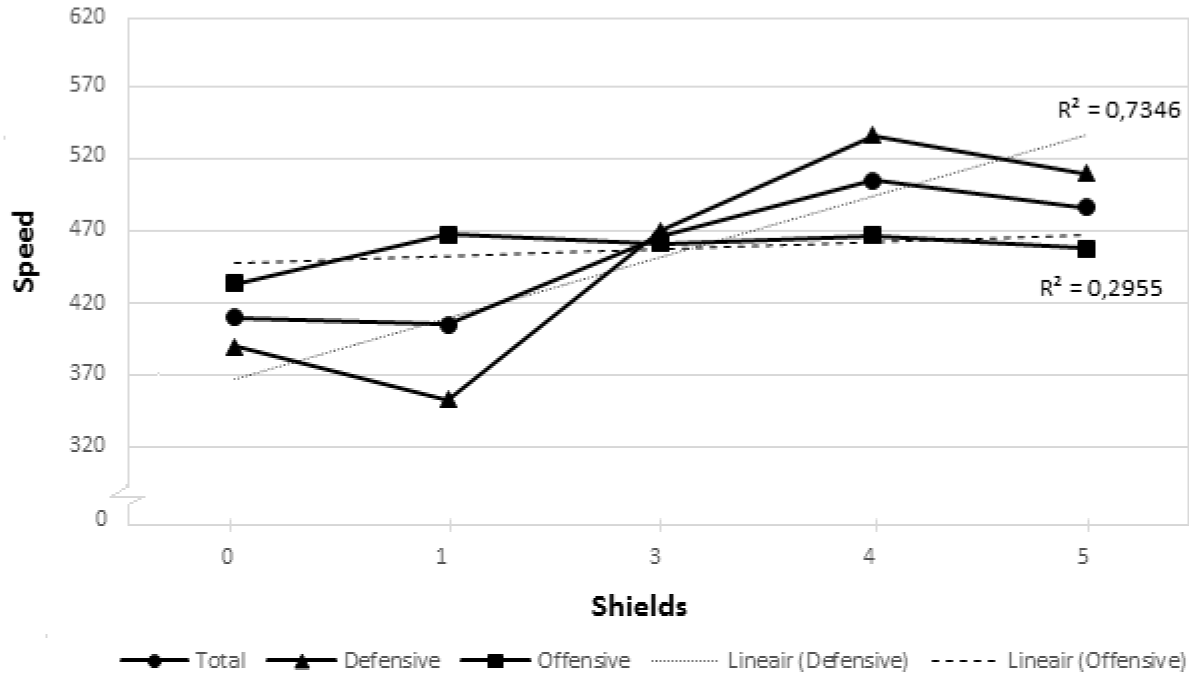

Figure 23. Means plot different groups position – Speed

The coefficient of determination for defensive is R^2 = .7346 and for offensive R^2 = .2955. Repeated measures ANOVA's were conducted for each group of the independent variable separately. This was done to see whether there was a significant risk homeostasis effect in (one of) the groups and to see whether there are differences in the risk-compensation strategy between the groups.

Repeated measures ANOVA – Defensive

Mauchly's test indicated that the assumption of sphericity was met, $X^2(9)$, = 11.307, p = .308. The multivariate tests were all non-significant, p =.300. The univariate result shows also that there is a non-significant difference in mean speeds within the defensive group, F (4, 20) = 2.843, p = .051.

	Value	*F*	*P*
Pillai's Trace	.837	2.565	.300
Wilks' Lambda	.163	2.565	.300
Hotelling's Trace	5.130	2.565	.300
Roy's Largest Root	5.130	2.565	.300

Table 56. Multivariate tests defensive – Speed

Repeated measures ANOVA – Offensive

The multivariate tests were not significant, p = .795. Also the univariate test was not significant; there are no significant means in speeds within the offensive group , F(4, 16) = .323, p = .859.

	Value	*F*	*P*
Pillai's Trace	.637	.438	.795
Wilks' Lambda	.363	.438	.795
Hotelling's Trace	1.752	.438	.795
Roy's Largest Root	1.752	.438	.795

Table 57. Multivariate tests offensive – Speed

TTC

	Total			Defensive			Offensive		
	N	*M*	*SD*	*N*	*M*	*SD*	*N*	*M*	*SD*
0 shields	11	1.03	.31	6	1.13	.40	5	.91	.10
1 shield	11	.98	.21	6	1.09	.22	5	.85	.10
3 shields	11	.83	.16	6	.83	.22	5	.84	.09
4 shields	11	.84	.28	6	.78	.31	5	.91	.25
5 shields	11	.84	.23	6	.82	.32	5	.87	.08

Table 58. Descriptive statistics for TTC for the independent variable position

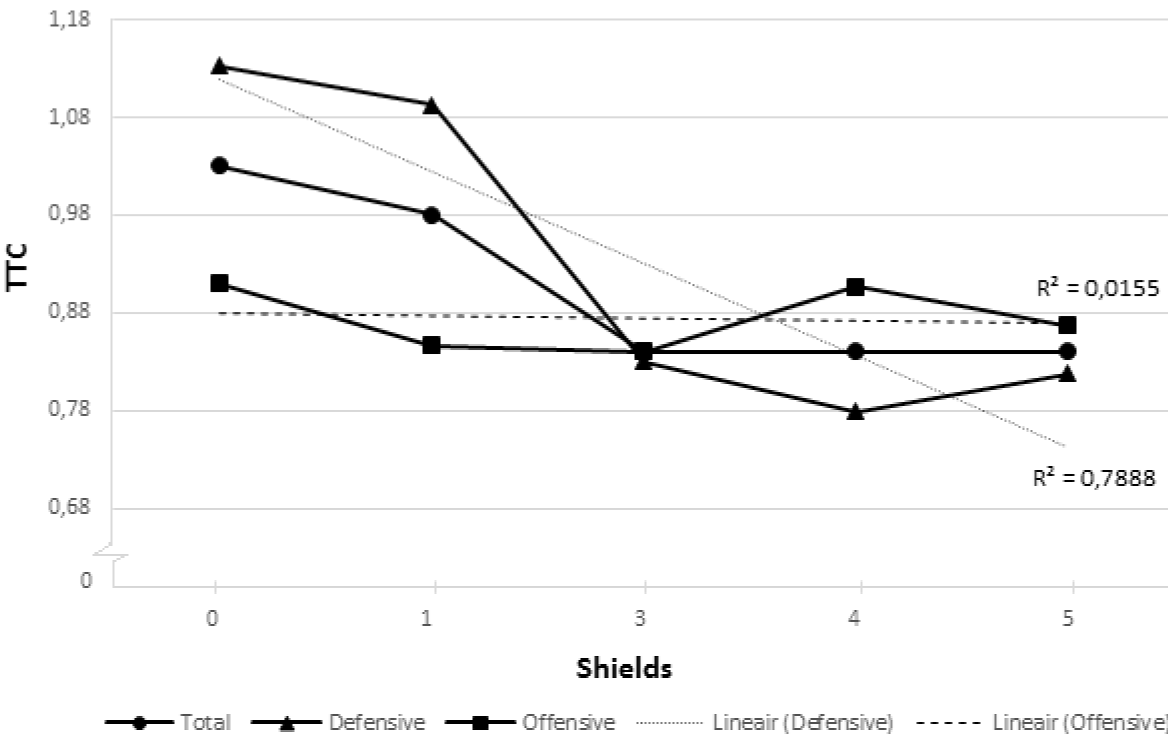

Figure 24. Means plot different groups position – TTC

The coefficient of determination for defensive is R^2 = .7888 and for offensive R^2 = .0155. To see whether there is an actual significant risk homeostasis effect in (one) of the groups, repeated measures ANOVA's were conducted for each group of the independent variable. This was done by using split file in SPSS.

Repeated measures ANOVA – Defensive

Mauchly's test indicated that the assumption of sphericity was met, $X^2(9)$, = 6.906, p = .688. The multivariate tests were all non-significant, p = .555. The univariate result shows also that there is a non-significant difference in mean speeds within the defensive group, $F(4, 20) = 2.655$, p = .063.

	Value	*F*	*p*
Pillai's Trace	.667	1.000	.555
Wilks' Lambda	.333	1.000	.555
Hotelling's Trace	2.001	1.000	.555
Roy's Largest Root	2.001	1.000	.555

Table 59. Multivariate tests defensive – TTC

Repeated measures ANOVA – Offensive

The multivariate tests were not significant, $p = .923$. Also the univariate test was not significant; there are no significant means in speeds within the offensive group, $F(4, 16) = .374$, $p = .824$.

	Value	*F*	*p*
Pillai's Trace	.417	.179	.923
Wilks' Lambda	.583	.179	.923
Hotelling's Trace	.716	.179	.923
Roy's Largest Root	.716	.179	.923

Table 60. Multivariate tests offensive – TTC

DCM

	Total			Defensive			Offensive		
	N	*M*	*SD*	*N*	*M*	*SD*	*N*	*M*	*SD*
0 shields	11	248.69	70.49	6	268.39	94.04	5	225.05	9.28
1 shield	11	221.36	7.26	6	223.04	8.21	5	219.35	6.17
3 shields	11	221.95	15.52	6	228.98	17.37	5	213.51	7.86
4 shields	11	221.59	14.14	6	228.76	15.50	5	212.98	5.43
5 shields	11	215.48	8.11	6	218.77	9.58	5	211.54	3.74

Table 61. Descriptive statistics for DCM for the independent variable position

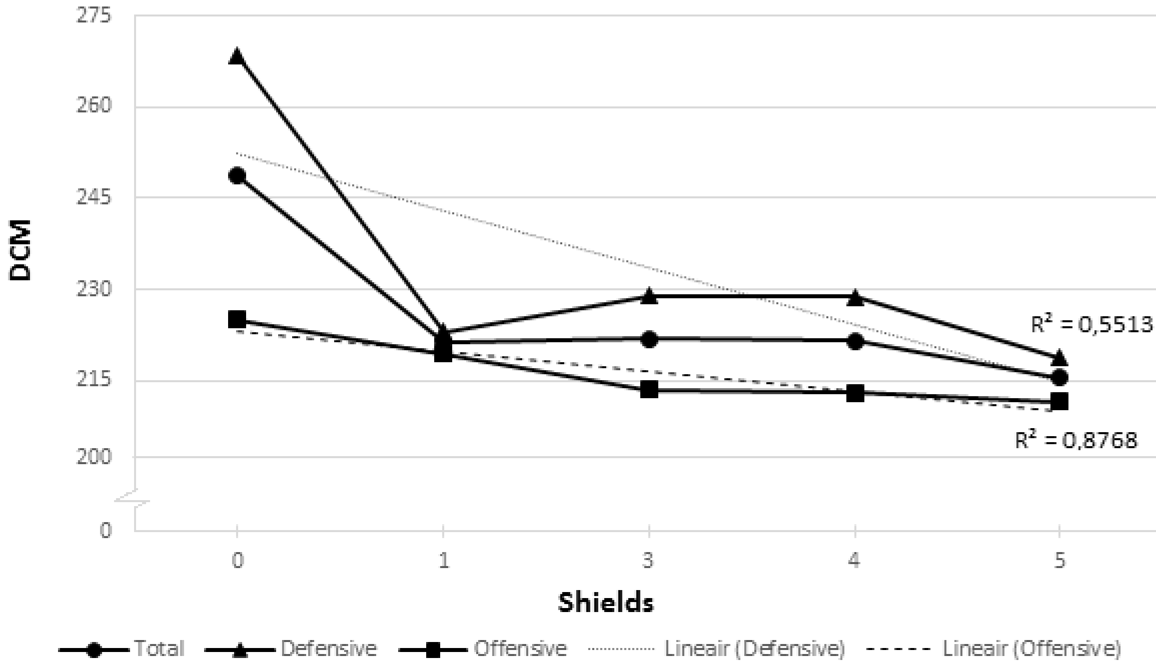

Figure 25. Means plot different groups position – DCM

The coefficient of determination for defensive is R^2 = .5513 and for offensive R^2 = .8768. To see whether there is an actual significant risk homeostasis effect in (one) of the groups, repeated measures ANOVA's were conducted for each group of the independent variable. This was done by using split file in SPSS.

Repeated measures ANOVA – Defensive

Mauchly's test indicated that the assumption of sphericity was violated, $X^2(9)$, = 49.368, *p* < *.001*. Therefore, degrees of freedom were corrected by using the Greenhouse-Geisser estimates of sphericity (ε = .266). The multivariate tests were all significant, *p* = .013. The univariate result however, shows a non-significant effect, *F*(1.064, 5.32) = 1.328, *p* = .303. Post-hoc Bonferroni-corrected pairwise comparisons showed no significant differences between the different conditions.

	Value	*F*	*p*
Pillai's Trace	.993	73.963	.013
Wilks' Lambda	.007	73.963	.013
Hotelling's Trace	147.927	73.963	.013
Roy's Largest Root	147.927	73.963	.013

Table 62. Multivariate tests defensive – DCM

Repeated measures ANOVA – Offensive

Mauchly's test indicated that the assumption of sphericity was violated, $X^2(9)$, = 20.940, p = .032. Therefore, degrees of freedom were corrected by using the Greenhouse-Geisser estimates of sphericity (ε = .587). The multivariate tests were all non-significant, p =.476. The univariate result however, shows a significant effect, $F(2.349, 9.396) = 5.133$, p = .028. Post-hoc Bonferroni-corrected pairwise comparisons showed however no significant differences between the different conditions.

	Value	*F*	*p*
Pillai's Trace	.891	2.053	.476
Wilks' Lambda	.109	2.053	.476
Hotelling's Trace	8.212	2.053	.476
Roy's Largest Root	8.212	2.053	.476

Table 63. Multivariate tests offensive – DCM

3.9 *Hypothesis 5a*: **Sportspeople who perceive their sporting style as more offensive show more risk-taking behavior than sportspeople who perceive their sporting style as more defensive.**

Three one-way ANOVA's were conducted with the means of speed, TTC and DCM as dependent variable and the sporting style (subjective) of participants (more defensive and more offensive) as independent variable. The means and standard deviations of these dependent variables for each group of the independent variable can be found in Table 64.

		Speed		TTC		DCM	
	N	*M*	*SD*	*M*	*SD*	*M*	*SD*
More defensive	18	489.41	133.41	.95	.24	224.02	15.88
More offensive	17	500.65	108.61	.92	.19	221.25	16.29

Table 64. Descriptive statistics for Speed, TTC and DCM for the independent variable sporting style.

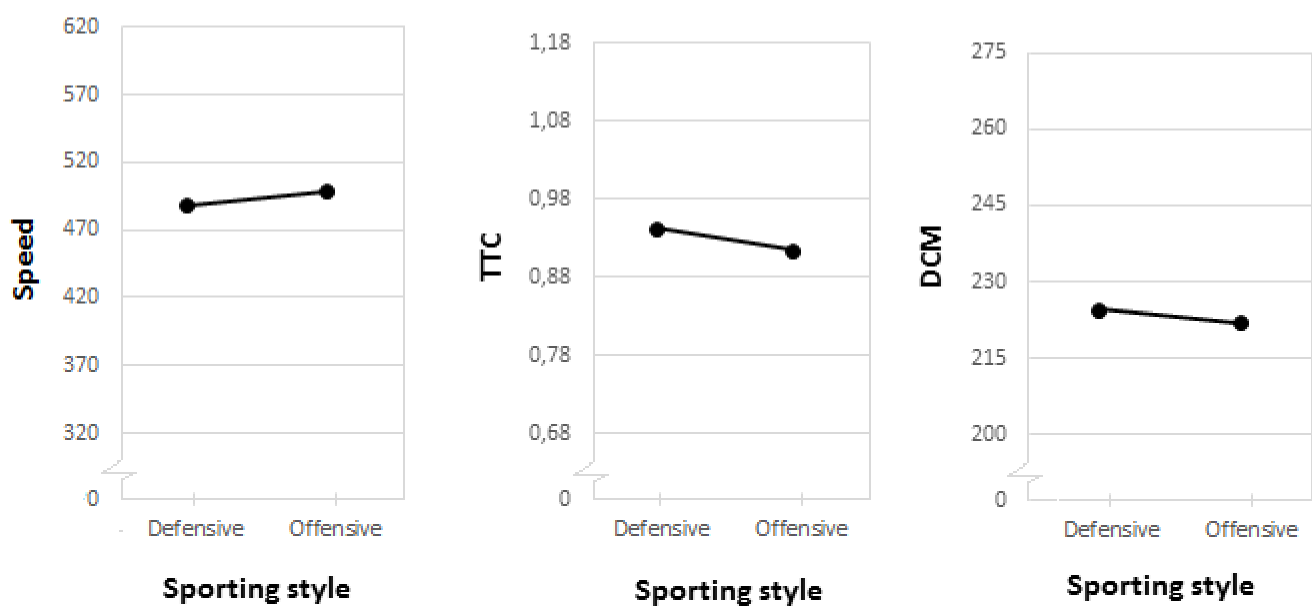

Figure 26. Means plot sporting style – Speed, TTC and DCM

Speed

Levene's test was nog significant (p = .400), therefore the assumption of homogeneity of variances was met. Results show that there was no significant difference between the two groups on mean speed, $F(1, 33)$ = .074, p = .787.

TTC

Levene's test was nog significant (*p* = .267), therefore the assumption of homogeneity of variances was met. Results show that there was no significant difference between the two groups on mean TTC, $F(1, 33) = .190$, $p = .666$.

DCM

Levene's test was not significant (*p* = .979), therefore the assumption of homogeneity of variances was met. Results show that there was no significant difference between the two groups on mean DCM, $F(1, 33) = .259$, $p = .614$.

3.10 *Hypothesis 5b*: Depending on the perceived sporting style (more defensive versus more offensive), a different risk-compensation strategy can be expected within different groups of sportspeople.

Speed

	Total			Defensive			Offensive		
	N	*M*	*SD*	*N*	*M*	*SD*	*N*	*M*	*SD*
0 shields	35	433.47	100.37	18	407.99	86.40	17	460.45	109.42
1 shield	35	481.42	137.81	18	461.24	148.42	17	502.78	126.52
3 shields	35	526.39	129.61	18	544.07	150.94	17	507.66	103.75
4 shields	35	535.55	169.11	18	530.06	184.51	17	541.37	156.61
5 shields	35	534.46	160.85	18	551.18	185.46	17	516.76	133.36

Table 65. Descriptive statistics for Speed for the independent variable sporting style

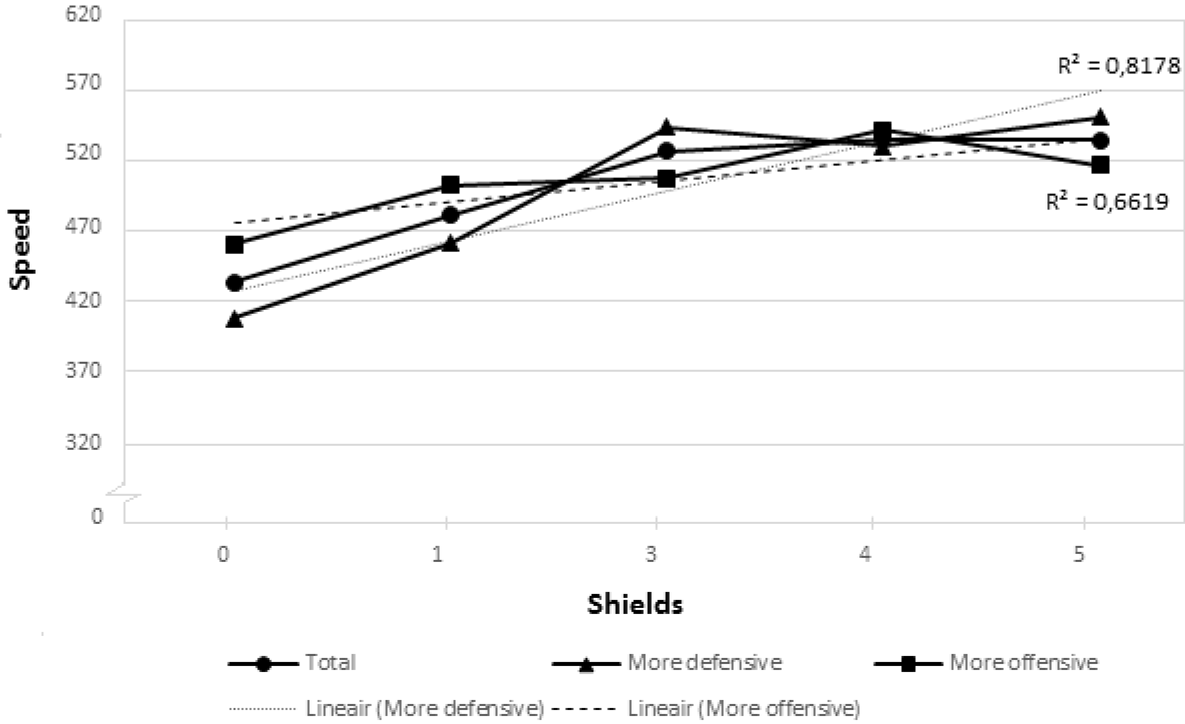

Figure 27. Means plot different groups sporting style – Speed

The coefficient of determination for more defensive is R^2 = .8178 and for more offensive R^2 = .6619 Repeated measures ANOVA's were conducted for each group of the independent variable separately. This was done to see whether there was a significant risk homeostasis effect in (one of) the groups and to see whether there are differences in the risk-compensation strategy between the groups.

Repeated measures ANOVA – More defensive

Mauchly's test indicated that the assumption of sphericity was met, $X^2(9)$, = 11.826, p = .226. The multivariate tests were all significant (p = .013). The univariate result shows also that there is significant difference in mean speeds within the more defensive group, $F(4, 68) = 8.780$, $p < .001$. Post-hoc Bonferroni-corrected pairwise comparisons showed three significant effects; the more defensive group significantly differs in means between the 0 shields condition and the 3 shields condition (p = .004), the 0 shields condition and the 4 shields condition (p = .014) and the 0 shields condition and the 5 shields condition (p = .008).

	Value	*F*	*p*
Pillai's Trace	.575	4.727	.013
Wilks' Lambda	.425	4.727	.013
Hotelling's Trace	1.35	4.727	.013
Roy's Largest Root	1.35	4.727	.013

Table 66. Multivariate tests more defensive – Speed

Repeated measures ANOVA – More offensive

The multivariate tests show no significant result, $p = .294$. Mauchly's test indicated that the assumption of sphericity was violated, $X^2(9)$, = 17.934, $p = .037$. Therefore, degrees of freedom were corrected by using the Greenhouse-Geisser estimates of sphericity ($\varepsilon = .719$). The univariate test also showed no significant effect, $F(2.875, 45.995) = 2.546$, $p = .07$.

	Value	*F*	*p*
Pillai's Trace	.298	1.380	.294
Wilks' Lambda	.702	1.380	.294
Hotelling's Trace	.425	1.380	.294
Roy's Largest Root	.425	1.380	.294

Table 67. Multivariate tests more offensive – Speed

TTC

	Total			More defensive			More offensive		
	N	*M*	*SD*	*N*	*M*	*SD*	*N*	*M*	*SD*
0 shields	35	1.06	.27	18	1.09	.25	17	1.03	.29
1 shield	35	.96	.25	18	1.02	.28	17	.90	.19
3 shields	35	.86	.22	18	.83	.26	17	.89	.19
4 shields	35	.87	.30	18	.89	.32	17	.85	.27
5 shields	35	.86	.28	18	.85	.32	17	.87	.23

Table 68. Descriptive statistics for TTC for the independent variable sporting style

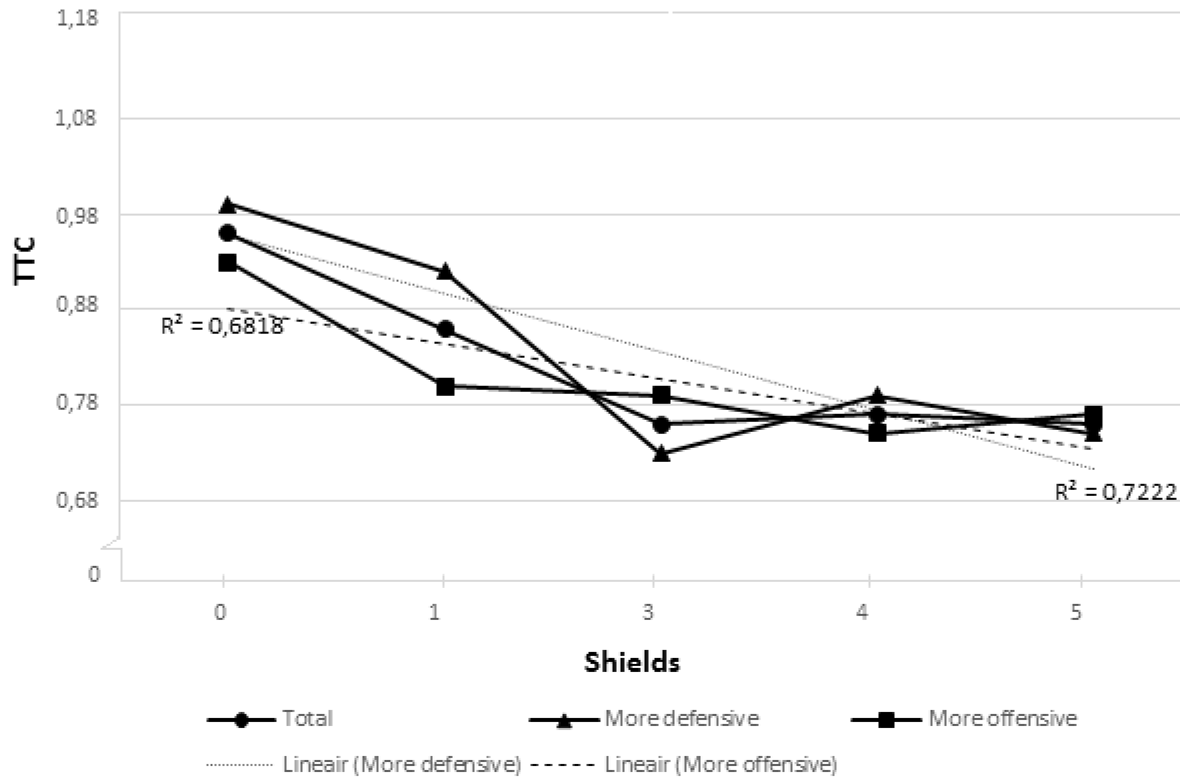

Figure 28. Means plot different groups sporting style – TTC

The coefficient of determination for more defensive is R^2 = .7222 and for more offensive R^2 = .6818. Repeated measures ANOVA's were conducted for each group of the independent variable separately. This was done to see whether there was a significant risk homeostasis effect in (one of) the groups and to see whether there are differences in the risk-compensation strategy between the groups.

Repeated measures ANOVA – More defensive

Mauchly's test indicated that the assumption of sphericity was met, $X^2(9)$, = 15.965, p = .069. The multivariate tests were all non-significant, p = .051. The univariate result shows also that there is a significant difference in mean speeds within the more defensive group, F (4, 68) = 6.482, p < .001. Post-hoc Bonferroni-corrected pairwise comparisons showed three significant effects; the 0 shields condition differs from the 3 shields condition (p = .03) and the 5 shields condition (p = .031). Also the 1 shield condition differs from the 3 shields condition (p = .047).

	Value	*F*	*P*
Pillai's Trace	.468	3.082	.051
Wilks' Lambda	.532	3.082	.051
Hotelling's Trace	.881	3.082	.051
Roy's Largest Root	.881	3.082	.051

Table 69. Multivariate tests more defensive – TTC

Repeated measures ANOVA – More offensive

The multivariate tests show no significant results, *p* = .282. Mauchly's test indicated that the assumption of sphericity was violated, $X^2(9)$, = 22.527, *p* = .008. Therefore, degrees of freedom were corrected by using the Greenhouse-Geisser estimates of sphericity (ε = .616). The univariate did show a significant effect, *F*(2.463, 39.401) = 3.144, *p* = .044. Post-hoc Bonferroni-corrected pairwise comparisons showed no individual significant differences between the shields for the offensive group.

	Value	*F*	*P*
Pillai's Trace	.304	1.420	.282
Wilks' Lambda	.696	1.420	.282
Hotelling's Trace	.437	1.420	.282
Roy's Largest Root	.437	1.420	.282

Table 70. Multivariate tests more offensive – TTC

DCM

	Total			More defensive			More offensive		
	N	*M*	*SD*	*N*	*M*	*SD*	*N*	*M*	*SD*
0 shields	35	266.65	82.25	18	278.95	100.49	17	253.62	57.41
1 shield	35	230.41	23.66	18	225.47	21.43	17	235.64	25.41
3 shields	35	224.44	16.20	18	225.97	16.31	17	222.82	16.42
4 shields	35	222.22	13.77	18	223.52	9.67	17	220.84	17.30
5 shields	35	220.16	14.10	18	222.52	16.12	17	217.66	11.56

Table 71. Descriptive statistics for DCM for the independent variable sporting style

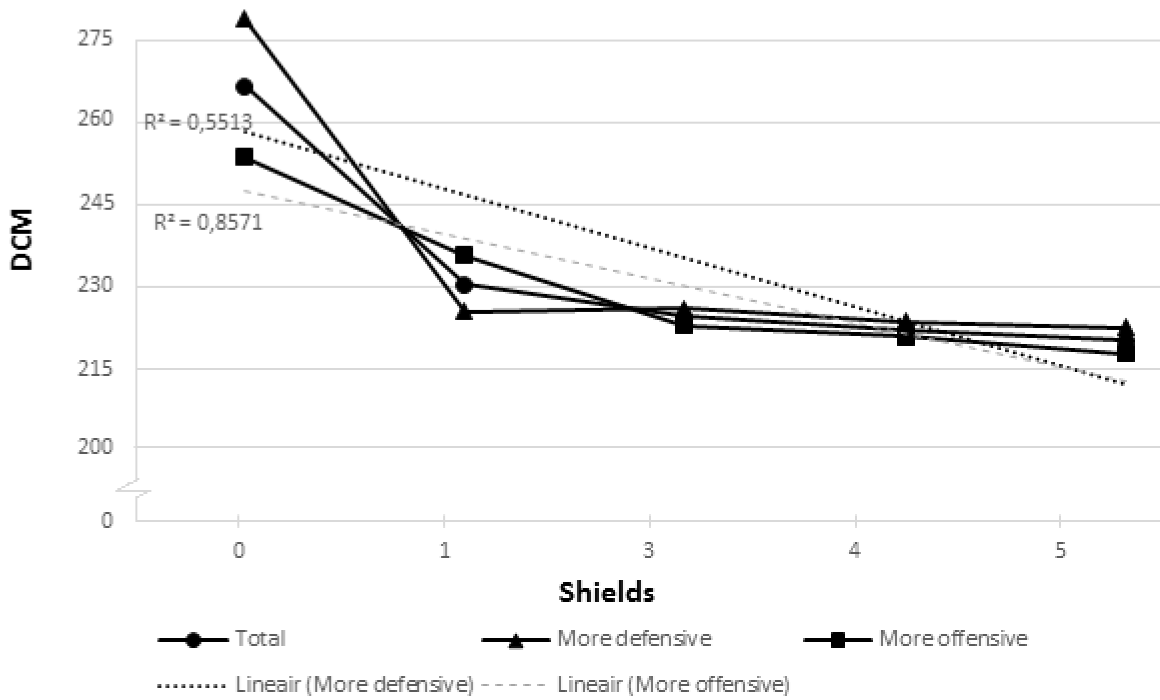

Figure 29. Means plot different groups sporting style – DCM

The coefficient of determination for more defensive is R^2 = .5513 and for more offensive R^2 = .8571. Repeated measures ANOVA's were conducted for each group of the independent variable separately. This was done to see whether there was a significant risk homeostasis effect in (one of) the groups and to see whether there are differences in the risk-compensation strategy between the groups.

Repeated measures ANOVA – More defensive

Mauchly's test indicated that the assumption of sphericity was violated, $X^2(9)$, = 148.087, p < .001. Therefore, degrees of freedom were corrected by using the Greenhouse-Geisser estimates of sphericity (ε = .261). The multivariate tests were all significant, p =.033. The univariate result also shows a significant effect, F(1.064, 17.779) = 6.507, p = .019. Post-hoc Bonferroni-corrected pairwise comparisons showed no significant differences between the different conditions.

	Value	*F*	*P*
Pillai's Trace	.505	3.572	.033
Wilks' Lambda	.495	3.572	.033
Hotelling's Trace	1.021	3.572	.033
Roy's Largest Root	1.021	3.572	.033

Table 72. Multivariate tests more defensive – DCM

Repeated measures ANOVA – More offensive

Mauchly's test indicated that the assumption of sphericity was violated, $X^2(9)$, = 82.118, $p < .001$. Therefore, degrees of freedom were corrected by using the Greenhouse-Geisser estimates of sphericity ($\varepsilon = .313$). The multivariate tests were all significant, $p = .004$. The univariate result also shows a significant effect, $F\ (1.250, 20.002) = 6.048$, $p = .018$. Post-hoc Bonferroni-corrected pairwise comparisons showed three significant differences: the 1 shield condition differs significantly in speed with the 3 shields condition ($p = .02$), 4 shields condition ($p = .017$) and 5 shields condition ($p = .008$).

	Value	*F*	*P*
Pillai's Trace	.667	6.513	.004
Wilks' Lambda	.333	6.513	.004
Hotelling's Trace	2.004	6.513	.004
Roy's Largest Root	2.004	6.513	.004

Table 73. Multivariate tests more offensive – DCM

4. Discussion

4.1 Hypothesis 1

Between conditions

The repeated measures ANOVA's for speed, TTC and DCM all showed significant differences between the different conditions (0, 1, 3, 4 and 5 shields). An increase in shields was related to an increase in speed, which is in accordance with the hypothesis. An increase in shields was also related to a decrease in TTC and DCM, which is also in accordance with the hypothesis. Participants show more risk-taking behavior when they have more protection: they increase their speed and decrease their distance to meteors. This clearly supports the risk homeostasis theory.

Within conditions

To see whether there also is a short(er)-term homeostatic effect, additional repeated measures ANOVA's were conducted. These ANOVA's measured whether the speed, TTC and DCM differed within a certain condition. Within each condition there were significant differences found for speed. However, these significant differences indicated an increase in speed when shields were decreasing. This result is contradictory to the hypothesis and the risk homeostasis theory. For TTC only a few significant results were found within the 5 shield condition. These results show that TTC decreased when the amount of shields decreased; this result is also contradictory to the hypothesis and the theory; participants take more risk when having fewer shields. For DCM no significant differences were found within the conditions.

Risk homeostasis

It can be concluded from these results that evidence is found for the risk homeostasis theory. As Wilde (1982) suggests, risk compensation is subject to lagged feedback and therefore the effect is rather long-term than short-term. This long(er)-term effect is supported by this study and the short(er)-term homeostatic effect is indeed not found. Participants compensate a low perceived risk level by showing more risk-taking behavior, while a high perceived risk level is accompanied by less risk-taking behavior. This effect is present at the beginning of each condition (level), but does not appear within a condition.

4.2 Hypothesis 2a and 2b: Intensity of sports

Hypothesis 2A (More participation in sports leads to more risk-taking behavior) was tested by doing multiple one-way ANOVA's. The results show no evidence for this hypothesis. For speed and TTC the variance is high. For DCM the variance is very low. There is no clear linear relationship for these variables with the hours of sport. This is in accordance with the mixed findings on this topic that were discussed in the introduction.

Hypothesis 2b (Depending on the participation in sports, a different risk-compensation strategy can be expected within different groups of sportspeople) was tested by doing repeated measures ANOVA's. Non-sports participants showed no significant differences in their means between the different conditions, while the sports participants did show significant differences in their means. The speed of the sports participants significantly increased when the amount of shields increased and the TTC and the DCM significantly decreased when the amount of shields increased. It can be concluded that sports participants show (more) risk compensation, while non-sports participants do not or do less. This finding can explain the mixed findings found in literature until now. As discussed in the introduction, some studies have found that sports participants show more risk-taking behavior than non-sports participants, while others have found opposing evidence. An explanation for these findings might be that the overall risk-taking behavior of sports participants depends on the perceived risk level. If the perceived risk level is low they are more likely to show more risk-taking behavior and if the perceived risk level is high they are more likely to show less risk-taking behavior. The risk-taking behavior of non-sports participants is less influenced by the perceived level of risk and will be relatively stable compared to sports participants. Therefore, in some situations sports participants may show more risk-taking behavior than non-sports participants, while in other situations this is the other way around.

4.3 Hypothesis 3a and 3b: Risk level of sports

Hypothesis 3A (Sportspeople that participate in high risk sports will show more risk-taking behavior, compared to sportspeople who participate in medium risk and low risk sports) was tested by doing one-way ANOVA's. Results show that there are no significant differences in speed, TTC and DCM for the different risk levels. However, for speed and TTC there is an linear relationship, only not significant: The speed increases when the risk level becomes higher and the TTC decreases when the risk level becomes higher.

Hypothesis 3B (Depending on the risk level of the sport, a different risk-compensation strategy can be expected within different groups of sportspeople) was tested by doing repeated measures ANOVA's. Results show that all three groups (low, medium and high risk level) show significant differences in their means for speed and TTC. The speed increases and the TTC decreases (both linearly) when having more shields: all three groups use risk compensation. However, they differ in their style. The low risk level group has an increase in speed of 92.57, the medium risk level group has an increase in speed of 103.57 and the high risk level group has an increase in speed of 145.9. The increase of speed is more stronger in the high(er) risk level group(s). It can be concluded that high(er) risk level sportspeople show a stronger risk compensation strategy. The determination coefficients show that all risk levels have a strong linear relationship with speed. The high risk level accounts for 91.52% of the variation in speed, the medium risk level accounts for 89.52% of the variation in speed and the low risk level accounts for 79.56% of the variation in speed.

For TTC the low risk level group has a decrease in TTC of .19, the medium risk level group has an decrease in TTC of .21 and the high risk level group has an decrease in TTC of .31. The decrease of speed is stronger in the high(er) risk level group(s). The high(er) risk level sportspeople show a stronger risk compensation strategy. The determination coefficients again show a strong linear relationship with speed. The high risk level accounts for 88.81% of the variation in TTC, the medium risk level accounts for 89.66% of the variation in TTC and the low risk level accounts for 75.05% of the variation in TTC.

For DCM the differences were are small. Results do show that the decrease in DCM when having more shields is biggest in the high risk level group. However, there is no significant effect found for risk compensation.

4.4 Hypothesis 4a and 4b: Position within sports

One-way ANOVA's were used to test hypothesis 4a (Sportspeople with an offensive position, show more risk-taking behavior than sportspeople with a defensive position). The means of speed, TTC and DCM do not significantly differ between the two groups. Although no significant effects, the expected linear relationship is found: the mean speed for offenders is higher than the mean speed for defenders. Also the mean TTC and DCM are lower for offenders than defenders. A bigger sample size might would have resulted in significant differences between the two groups.

Repeated measures ANOVA's were conducted to test hypothesis 4b (Depending on the position played within a sport, a different risk-compensation strategy can be expected within different groups of sportspeople). For speed and TTC no significant differences were found, but clear differences can be identified between the groups based on the means, F and R^2. The defensive group shows an increasing line in speed when shields are increasing ($R^{2\,=}$ .7346) and the univariate result is almost significant, F = .051. The offensive group shows a relatively stable line in speed when shields are increasing ($R^{2\,=}$ .2955) and the univariate result is not significant, F = .859. The increase in mean speed between 0 shields and 5 shields is 120.85 for the defensive group, while the offensive group only has an increase of 24.2. The defensive group shows a risk compensation strategy, although not significant, while the offensive group does not.

For TTC the defensive groups shows a decreasing line when shields are increasing ($R^2 =$ .788). The univariate result is almost significant, F = .063. The offensive group is again relatively stable; there is no linear relationship with TTC ($R^2 =$ .0155). The univariate result is not significant, F = .824. The decrease in mean TTC between 0 shields and 5 shields is .31 for the defensive group and .04 for the offensive group. The defensive group shows a risk compensation strategy, although not significant, while the offensive group does not. Both with speed and TTC a bigger sample size could have given a better picture of the effects.

Again, for DCM the offensive group was relatively stable while the defensive group fluctuated more depending on the amount of shields. This fluctuation was medium linear ($R^2 =$ .5133). The offensive group showed a strong linear line, but the differences between the values in the different conditions were very small ($R^2 =$ .8768).

Overall, defenders show a strong, but not significant, risk compensation strategy while offenders stay relatively stable and do not adjust their speed, TTC or DCM to the amount of shields given. The small sample size needs to be taken into account and might distort the results.

4.5 Hypothesis 5a and 5b: Sporting style

Hypothesis 5a (Sportspeople who perceive their sporting style as more offensive show more risk-taking behavior than sportspeople who perceive their sporting style as more defensive) was tested using one-way ANOVA's. The results show no significant differences in the means between the groups, however the expected linear relationship is found: sportspeople with a more offensive sporting style show a higher mean speed and a lower mean TTC and DCM than sportspeople with a more defensive sporting style.

Hypothesis 5b (Depending on the perceived sporting style, a different risk-compensation strategy can be expected within different groups of sportspeople) was tested using repeated measures ANOVA's. The mean speed for sportspeople with a more defensive sporting style shows significant differences depending on the amount of shields given, while the sportspeople with a more offensive sporting style do not have significant differences in their mean speed. The coefficients of determination also show a stronger linear relationship for the more defensive sporting style (R^2 = .8178) than the more offensive sporting style (R^2 = .6619). The offensive sporting style is again relatively stable while the defensive sporting style is using a risk compensation strategy.

For TTC the differences between the two groups were smaller. Both groups show a significant effect and the determination coefficients are quite similar (more defensive, R^2 = .7222 and more offensive, R^2 = .6818). The defensive group shows a decrease in TTC of .24, while the offensive group shows a decrease in TTC of .16. Both groups use a risk compensation strategy, but the defensive sporting style has a stronger risk compensation than the offensive sporting style.

For DCM both groups also had significant differences in means; DCM decreased when the amount of shields increased. Both groups use risk compensation. The coefficient of determination for the more defensive sporting style is R^2 = .5513 and for more offensive sporting style R^2 = .8571. The defensive groups shows a decrease in DCM of 56.43, while the offensive group shows a decrease in TTC of 35.96. Both groups use a risk compensation strategy, but the defensive sporting style has a stronger risk compensation than the offensive sporting style.

4.6 Conclusion

Overall, this study has found clear evidence for the risk homeostasis theory (Wilde, 1972). The moderating effect of sports shows interesting results. Sports participants show risk compensation, while non-sports participants do not. When taking a closer look at the group of sportspeople, differences based on risk level, position and sporting style can be found. Stronger risk compensation is reported in high(er) risk level sportspeople. Also sportspeople with a defensive position show more risk compensation than sportspeople with an offensive position. Idem ditto for sportspeople with a defensive sporting style versus sportspeople with an offensive sporting style. However, this difference is smaller. For the hypotheses of risk-taking the results were more inconclusive. Although the expected linear relationship was found within three out of four variables, differences were not significant.

The results of this study can contribute to less controversy on this theory. The new perspective of sports on risk compensation has given new insights on sportspeople; there are differences between sportspeople and their risk compensation strategy. These insights can be applied in the protection measures for sportspeople. Defenders change their behavior based on protection measures. They show very low, but sometimes also very high risk-taking behavior. As discussed in the introduction, this high risk-taking behavior often causes many injuries even when having protection. Theoretically speaking, if one would want to lower the chances on injuries, the high risk-taking behavior of defenders needs to be stopped by giving them less protection. Offenders are relatively stable and show medium risk-taking behavior independent from the amount of protection given. Therefore, their protection measures need to be proportional for the risk they are exposed to in their sports.

4.7 Limitations

Although the results are promising, there are some limitations of this study that need to be taken into account. As already mentioned in the introduction, one of the limitations of the risk homeostasis theory is that it does not explain how each individual determines his or her target level of risk and how this target level of risk can be measured best. Therefore, falsification of the theory is difficult. This study has included one aspect (sports) that has influence on the target level of risk of individuals, but there are many more that have not been included.

Another limitation is the setting of the experiment. Although the study used a standard protocol and controlled as many factors as possible, there were some factors that could not be controlled. A general concern when testing the risk homeostasis effect, also raised by Hoyes & Glendon (1993), is that the possibility of actual, real harm in controlled settings is absent. Therefore, participants may act in a different way than in real-life. Another concern is socially desirable behavior, which can distort the results.

Furthermore, the duration of the experiment might also cause some distortions in the data. The experiment existed out of 1 round of practice and 5 rounds of experimental conditions. Each round could take up to four minutes, which is quite long as the task complexity is low. It can be expected that participants increased their speed because they were bored or tired after a while. This could be true within each condition (showing more risk-taking behavior as time passes within a condition or even within a shield) but also between conditions (showing more risk-taking behavior as time passes in the entire experiment). The last one has been relatively covered by addressing the different conditions randomly to participant, but the effect within conditions cannot be accounted for. Therefore, results might not be less reliable.

Data showed that most participant show a 'habituation'-curve. In their first life (shield) they tend to stay relatively stable in speed, thereby the first shield of each condition significantly differs from the other shields. This difference is relatively large, compared to the differences between other shields within the same condition. As discussed earlier the first shields of TTC and DCM were not included as the meteors are not present at the beginning of each condition. To give more reliable results it would have been better to also exclude the first shield of each condition of speed. Thereby the effect of habituation would be accounted for.

There are also some limitations with regard to the moderating variable; sports. The sample size existed out of a group of diverse sportspeople. Most sportspeople participated in more than one sport and had no big differences in intensity or years of experience. Assigning participants to certain risk levels was sometimes hard and ambiguous. Also the sample sizes for position and sporting style were relatively small, thereby the results cannot be generalized. The sample size in general was quite small, which undermines the reliability and generalizability of the study. Also the sample size existed mainly out of young females, which could also have influence on the results.

4.8 Future directions

Future research on risk homeostasis is valuable as the controversy on this theory can be minimized. It is advised to account for as many individual factors as possible in future researches. Additionally, the falsification limitation of this theory could be overcome by establishing a baseline desired risk level for each individual separately. Consequently, results of risk homeostasis should also be analyzed for each individual separately.

Testing in a controlled environment makes it hard to generalize the results to other situations. The risk homeostasis could be best researched in a controlled, but realistic environment such as a simulator. (Future) technologies can make it possible to make this testing even more realistic, such as virtual reality.

Another important direction is to find out the duration of habituation. This can provide more reliable results as people in real life do not have to get used to driving their car, sporting or other activities. Additionally, the experiment should not take too long for participants to get bored. Although this also happens in real life, people are not confronted with real risks in an experiment. Therefore, boredom could easily lead to risk-taking behavior in an experimental setting, while this would not happen (so easily) in real life. Calculating both the duration of habituation and the 'boredom' should also, ideally, be done individually. Implementing these improvements would lead to more reliable results and better validation or falsification of the risk homeostasis theory.

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Appendices

Appendix A. The questionnaire (1)

Universiteit Leiden

What is your participant number? If you are unsure, check your post-it, or ask one of the supervisors.

What is your gender?

- ○ Male
- ◉ Female

What is your age in years?

What is your highest completed level of education?

- ◉ VMBO
- ○ HAVO
- ○ VWO
- ○ MBO
- ○ HBO
- ○ WO Bachelor
- ○ WO Master

Appendix A. The questionnaire (2)

How many hours do you currently participate in sports in a week? (Excluding your daily walks and cycling)

- ○ 0 hours in a week
- ○ 0-1 hours in a week
- ○ 1-2 hours in a week
- ○ 2-3 hours in a week
- ○ 3-4 hours in a week
- ○ 4-6 hours in a week
- ○ More than 6 hours in a week

What sport(s) do you participate in? *If you play more than 1 sport please indicate which sport is your 'main sport', 'second' sport et cetera. If you only play one sport, this is your 'main' sport.*

Main sport	
Sport 2	
Sport 3	
Sport 4	

Please indicate how many hours you spend per week on your 'main' sport and other sport(s).

0 1 2 3 4 5 6 7 8 9 10

Main sport

Second sport

Third sport

Fourth sport

How many years are you already participating in this sport/these sports?

Main sport	
Second sport	
Third sport	
Fourth sport	

Appendix A. The questionnaire (3)

Please indicate your position within your (main) sport:

- Goalkeeper
- Defender
- Defensive midfielder
- Offensive midfielder
- Forward
- Not applicable

Would you perceive your own sporting style as more defensive or more offensive? *Please fill in even if you do not have a specific position within your sport that is defensive or offensive. Only tick the third box if you really have no idea.*

- More defensive
- More offensive
- Both of the answers are not applicable

Appendix B. Calculating the risk parameters

The following formula was used to compute the risk parameter 'speed':

$$speed_p = \left(2.7 + (difficulty * 0.5)\right) * 100$$

This outcome equals the pixels per second, which has a minimum of 320 and a maximum of 920 pixels per second, depended on the selected difficulty level.

To compute the risk parameter 'time to collision' (TTC), the following formula was used:

$$TTC = \frac{meteor\ in\ path\ location\ x - 109}{speed_p}$$

To calculate TTC the variable '*meteor in path location x*' is needed, which can be found in the steplog file. Subsequently, the value 109 has to be subtracted from meteor in path location x as the ship is not displayed at the left side of the screen but in the middle (109 pixels to the right). This calculation is then divided by the speed. The formula yields the time, in seconds, until a collision between the ship and the meteor in its path would happen.

To calculate the risk parameter 'distance to the closest meteor', the following formula was used:

$$distance = \sqrt{(closest\ meteor\ location\ x)^2 + (closest\ meteor\ location\ y - ship\ location\ y)^2}$$

The Pythagorean Theorem was used to create this formula. The formula yields the distance, in pixels, between the spaceship and the closest meteor on its path.

Appendix C. The information letter

Information letter - Risk homeostasis in gaming

Welcome and thank you for coming! You are going to play a computer game and fill in a questionnaire. Before you start, please read this information letter and sign the informed consent. Your participation is completely anonymous and voluntarily. Your records are coded by means of a participant number (see the post-it). You will need to enter this number when starting the game and the questionnaire. Please double check when entering your number, this is important. If you would like to stop the experiment you may do so at any moment. The results of this study will be used in SPSS to conduct statistical analyses for our master thesis about the risk homeostasis theory.

The game

The game is about a little spaceship in a galaxy not so far away on its way to deliver very valuable cargo. The spaceship is in a hurry and has to reach its destination as soon as possible. Unfortunately, the ship runs into a thick cloud of meteors. You are the ship's captain and you have to stay on your toes to dodge the danger and get through. The goal is to go as fast as you can (a faster speed will result in more points) but also try to avoid the meteors (a collision with a meteor will cost you a life).
You will receive specific instructions about the game (e.g. which buttons to use etcetera) when starting the game.

Instructions

Please pay attention only to your own computer screen. Also, please do not make noise. When you have a question raise your hand and one of us will come to you.

After you have read and completed the informed consent, please login with your UL account (Some of the computers are already logged in, if so, do not log in with your own UL account). When your desktop is completely loaded raise your hand. We will start the game for you. After you have finished the game please raise your hand and we will start the questionnaire for you. *Please do not forget to enter your (correct) post-it number both in the game and questionnaire*! When you completed the questionnaire you can collect your money or credits for participating.

Any questions?

Remarks or complaints afterwards can be directed towards the senior researcher:

Jop Groeneweg
Groeneweg@fsw.leidenuniv.nl

Appendix D. The informed consent

Informed Consent - Risk homeostasis in gaming

In this experiment we will test the risk homeostasis theory by means of a computer game. The experiment will take about 45 minutes. You will be compensated for your time by receiving 2 credits or €6,50. By signing the form you agree with the following statements.

- I have read the information letter. I could ask additional questions. Questions that I had have been answered adequately. I have had sufficient time to decide whether or not I participate.

- I am aware that participation is completely voluntary. I know that I can decide at any moment not to participate or to stop. I do not need to provide a reason for that.

- My responses are processed anonymously or in a coded way.

- I give consent to use my data for the purposes that are mentioned in the information letter.

I consent to participating in this study.

Name of participant: ____

Signature: ____

Date: _____/_____/______

Appendix E. Instructions of the Spaceship game

Instruction at the start

Dear participant,

You are now going to play a video game in which you control a spaceship that is flying through a field of meteors. You need to make sure the ship has a safe flight. At the start of each round (5 in total) you will receive a certain number of shields. You see these shields at the left upper corner. These shields serve as ‘lives’. Each time you collide with a meteor a shield will disappear. When you run out of shields, the round is over.

The up and down arrow keys control the movement of the ship. You also have the option to control the speed of the ship: pressing the right arrow key makes the ship fly faster, while pressing the left arrow key slows the ship down.

During the game you will gain points per second. The amount of points you gain depends on (1) your total flying time (so don’t run out of shields!) and (2) your speed: the faster you fly, the more points per second you gain.

Good luck and have fun!
We will start with a test round first.

Instruction at the end

Thank you for playing the game! You can now collect your credits or money. Please bring along the informed consent and information letter. You will get a debriefing letter by one of the researchers.

Next week we will e-mail you a list of all the achieved scores. This list will be coded by means of participants numbers, so please do not forget your participant number! The three participants with the highest scores will receive a prize (€50, €30 and €10). You will receive further information via e-mail.

Appendix F. The debriefing

Debriefing – Risk Homeostasis in Gaming

The aim of this study was to test the risk homeostasis theory and the moderating role of substance use, music preference, participation in sports and masculinity. Risk homeostasis means that you show more risk behavior when you feel safer, for example cycling faster and more dangerously when wearing a helmet. In the computer game we measured risk behavior by measuring your speed and proximity to meteorites in interaction with the amount of shields present.

We expect to find that:
(1) People take more risk when they perceive the situation to be safer (so when you have more shields left, you will show more risky behavior);
(2) Masculine men or women show more risk behavior;
(3) Participation in sports (depending on the kind of sport and the position within this sport) influences risk behavior;
(4) More recent and frequent use of substance, and higher quantity per substance use will be related to higher risk-taking.
(5) Music preference and its resulting emotional arousal influence risk behavior.

Your contribution is important to understanding how these factors influence risk-taking behavior, as safety implementations and interventions can be applied more effectively.

Questions, remarks or complaints afterwards can be directed towards the senior researcher:

Jop Groeneweg

Groeneweg@fsw.leidenuniv.nl

Appendix F. Descriptive statistics for the variable 'Hours of sport'

Speed

	Total			0 hours			0-1 hours		
	N	*M*	*SD*	*N*	*M*	*SD*	*N*	*M*	*SD*
0 shields	69	432.49	112.42	11	436.19	150.38	10	405.41	92.46
1 shield	69	467.36	121.77	11	441.03	92.11	10	463.45	102.88
3 shields	69	503.39	139.60	11	490.79	172.63	10	456.20	109.09
4 shields	69	521.22	160.73	11	479.89	139.25	10	489.84	168.82
5 shields	69	528.61	142.35	11	486.35	83.99	10	507.18	125.84

	1-2 hours			2-3 hours			3-4 hours		
	N	*M*	*SD*	*N*	*M*	*SD*	*N*	*M*	*SD*
0 shields	7	451.94	114.05	15	474.04	121.48	7	370.66	94.53
1 shield	7	503.60	127.92	15	509.58	126.17	7	390.96	93.52
3 shields	7	502.53	121.86	15	540.17	155.55	7	435.30	76.69
4 shields	7	535.34	137.61	15	573.90	164.71	7	378.73	117.38
5 shields	7	551.22	147.53	15	590.36	168.53	7	440.68	89.78

	4-6 hours			> 6 hours		
	N	*M*	*SD*	*N*	*M*	*SD*
0 shields	9	354.18	41.90	10	493.33	73.86
1 shield	9	399.81	73.55	10	525.81	167.19
3 shields	9	515.52	128.11	10	546.60	159.46
4 shields	9	506.70	161.63	10	621.98	150.53
5 shields	9	495.03	152.55	10	579.83	158.64

TTC

	Total			0 hours			0-1 hours		
	N	*M*	*SD*	*N*	*M*	*SD*	*N*	*M*	*SD*
0 shields	69	1.06	.27	11	1.04	.28	10	1.11	.27
1 shield	69	.98	.23	11	1.02	.18	10	.96	.23
3 shields	69	.91	.25	11	.96	.30	10	.98	.27
4 shields	69	.88	.27	11	.94	.20	10	.92	.28
5 shields	69	.86	.24	11	.90	.16	10	.88	.24

	1-2 hours			2-3 hours			3-4 hours		
	N	*M*	*SD*	*N*	*M*	*SD*	*N*	*M*	*SD*
0 shields	7	1.03	.28	15	.97	.27	7	1.16	.22
1 shield	7	.91	.25	15	.92	.21	7	1.12	.24
3 shields	7	.91	.24	15	.85	.27	7	1.01	.19
4 shields	7	.85	.26	15	.77	.25	7	1.21	.25
5 shields	7	.81	.19	15	.76	.26	7	1.01	.24

	4-6 hours			> 6 hours		
	N	*M*	*SD*	*N*	*M*	*SD*
0 shields	9	1.28	.27	10	.92	.16
1 shield	9	1.13	.20	10	.86	.22
3 shields	9	.87	.21	10	.85	.25
4 shields	9	.92	.29	10	.71	.18
5 shields	9	.92	.28	10	.79	.23

DCM

	Total			0 hours			0-1 hours		
	N	*M*	*SD*	*N*	*M*	*SD*	*N*	*M*	*SD*
0 shields	69	261.89	71.55	11	237.20	28.36	10	258.73	47.49
1 shield	69	231.33	27.65	11	236.02	48.65	10	224.85	11.12
3 shields	69	223.97	15.95	11	222.64	15.52	10	222.64	11.52
4 shields	69	221.08	12.56	11	218.73	9.95	10	221.48	8.24
5 shields	69	218.80	11.48	11	214.67	4.90	10	219.82	9.03

	1-2 hours			2-3 hours			3-4 hours		
	N	*M*	*SD*	*N*	*M*	*SD*	*N*	*M*	*SD*
0 shields	7	234.98	22.07	15	283.23	110.95	7	250.35	31.48
1 shield	7	228.79	20.52	15	240.54	32.83	7	227.95	23.04
3 shields	7	215.01	8.95	15	230.33	24.01	7	219.99	12.36
4 shields	7	216.59	6.23	15	222.83	19.71	7	217.31	6.40
5 shields	7	216.81	6.70	15	222.02	19.06	7	221.70	10.42

	4-6 hours			> 6 hours		
	N	*M*	*SD*	*N*	*M*	*SD*
0 shields	9	307.21	94.72	10	246.34	53.98
1 shield	9	221.54	11.14	10	231.83	16.69
3 shields	9	227.52	13.00	10	223.08	12.60
4 shields	9	221.35	11.15	10	226.16	13.37
5 shields	9	220.45	11.37	10	215.38	6.37