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APPROBATION OF A GAME OF SKILL (MINIMUM-TB) AS A MODEL OF RISKY BEHAVIOUR

Master`s thesis

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CONTENTS

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ABSTRACT

The present study examined whether the score and playing style in the game of skill (Minimum-TB) is related to personality traits and biological marker´s platelet monoamine oxidase (MAO) activity. As a model, the game of skill Minimum-TB was used, which can be used to determine whether an individual is inclined to take risks in his actions or not. Introducing Minimum-TB in order to measure risky behaviour was a novel solution and there are no records of analogous previous research material. Platelet MAO activity was used as the biological marker of the personality traits known to be associated with risk proneness. Blood samples were taken from the participants and the activity of enzyme monoamine oxidase-B was ascertained. The sample consisted of 49 participants (38 male and 11 female).

Points gained in the Minimum-TB game correlated with both the Zuckerman subscales such as sensation seeking and the platelet MAO activity. A significant correlation was found between the results of the two versions of the game and platelet MAO activity (correlate of behavioural preferences) and Zuckerman SSS VI.

The mean scores gained in the game of skill were related to gender. Men threw the ball higher than women, i.e. men took more risks. MAO activity had a significant negative correlation with the sum of the ordinary version. The number of “critical” scores in the ordinary version of the game had a statistically significant correlation with the Zuckerman Sensation Seeking Scale. E-DIS correlated with the scores in the low-risk game and I-TAS with the scores in the high-risk game. E-DIS, I-TAS and I-DIS correlated with the number of “critical” throws followed by new “critical” throws.

Although a statistically significant relation appears to exist between the *whole group* results of a game of skill that involves elements of risk and some well established correlates of personal risk proneness such as sensation seeking and platelet MAO activity, it would be premature to use a game of skill as a predictor of risk proneness of an *individual subject*. For this, further research taking into account all principal variables involved and building up some instruments of game validation should be necessary.

Osavusmängu (Minimum-TB) aprobeerimine riskeeriva käitumise mudelina

KOKKUVÕTE

Käesolev uurimus vaatles, kas osavusmänguga Minimum-TB saadud punktid ja mängimise stiil on seotud mängijate isiksuseomaduste ja bioloogilise markeri (monoamiinide oksüdaasi, MAO) aktiivsusega. Mudeliks kasutati osavusmängu Minimum-TB, mille abil saab eeldatavalt kindlaks määrata, kas isik oma tegevuses kaldub riskeerima või mitte. Minimum-TB–kasutuselevõtt riskeeriva käitumise mõõtmiseks on uudne ja varasematest analoogsetest uurimustöödest andmed puuduvad. Riskile kalduvusega seotud isiksuseomaduste bioloogilise markerina kasutatati vereliistakute monoamiinoksüdaasi (MAO) aktiivsust vereliistakutel. Katseisikutelt võeti veeniverd ja määrati vereliistakute MAO aktiivsus. Valim koosnes 49 isikust (38 meest ja 11 naist).

Minimum-TB mängu tulemusega saadud punktid korreleerusid nii Zuckermani alaskaaladega kui ka vereliistakute MAO aktiivsusega. Leiti oluline korrelatsioon mängu tulemuste ja käitumiseelistuse korrelaadi vereliistakute MAO aktiivsuse ja Zuckermani SSS VI vahel.

Osavusmängus saadud keskmised skoorid olid seotud sooga. Mehed viskasid palli naistega võrreldes kõrgemale ehk riskeerisid rohkem. Osavusmängu tavalise versiooni punktide summa oli statistiliselt oluliselt negatiivselt seotud MAO aktiivsusega. Kriitiliste skooride arv tavalises mängus oli oluliselt seotud Zuckermani elamusjanu skaalaga. E-DIS oli seotud madalama riskitasemega mängu skooridega ja I-TAS riskeerivama mängu skooridega. E-DIS, I-TAS ja I-DIS olid seotud riskeerivale viskele järgnenud riskeerivate visetega.

Kuigi riskielemente sisaldava osavusmängu *kogu grupi* tulemuste ja mõningate isiku riskikalduvuslike korrelaatide nagu elamusjanu ja MAO aktiivsus vahel leiti statistiliselt oluline korrelatsioon, oleks ennatlik kasutada osavusmängu *üksikisiku* riskikalduvuse ennustamiseks. Selleks oleks vajalikud edasised uuringud, mis võtaksid arvesse kõik peamised muutujad ja vahendid, et tagada mängu valiidsus riskikalduvuse mõõdikuna.

INTRODUCTION

The mainstream agenda of risky behaviour research

Risk is a common daily phenomenon, and every person experiences it to some degree. Whereas some people avoid it as much as they can, others seem to be attracted to it. Risk taking behaviour is voluntary participation in behaviours that contain, or at least seem to contain, a significant degree of risk. The notion of significant risk is a slippery one to define, however, a case can be made that certain behaviours are assessed to involve a high degree of risk in comparison with other equivalent behaviours, and also involve a high degree of actual risk as measured by the possibility of death, injury, financial loss and so on.

Different people have different level of preference for risks. When some people prefer to read a book, others go rock-climbing, bungee jumping or skydiving. Whether or not a person is willing to take risks will depend on much more than his or her personality. Demographic variables also have a large effect on risk propensity. It has long been established that risk taking depends on sex (males have a higher risk propensity than females), age (older people have a lower risk propensity than younger people and age effects are more pronounced for men than for women), culture (e.g. Scandinavians take less risk than Russian) and family and number of dependents (a person with more dependents will tend to take fewer risks). No less important are illusions of control: people dislike uncertainty and are likely to make unwarranted rationalizations in uncertain situations or feel that they are in control of the situation. Outcome history influences how often people switch their risk-taking strategies. Another factor is framing (Gonzalez *et al.*, 2005). Last but not least, willingness to take risk can be influenced by such factors as mood and feelings. Risk taking also depends on a person's emotional state. Dysfunctional styles of regulating emotions and emotionally driven behaviors are core features of risky or problem behaviours during adolescence (Cooper, Wood, Orcutt, Albino, 2003).

The risk and personality research has two important implications. First, risk behaviour can be understood in terms of dispositional motivations. For example, people will take or avoid risks to achieve goals that are consistent with their character, e.g., extraverts take risks because of a generalized need for sensation (Zuckerman,

1994), and sensation is the goal for their risk taking. Second, since personality is relatively stable across adulthood, tendencies to take or avoid risk might also be robust (Soane & Chimel, 2005).

The prediction of risk taking has been the goal of a number of studies. One theoretical approach is to study the consistency through understanding the consistency of risky decision-making (e.g. Weber, Blais, & Betz, 2002; Weber & Milliman, 1997; Soane & Chimiel, 2005). The relationship between sensation seeking and risky behavior has been observed since the 1970s. The most commonly used measure of sensation seeking is the Sensation Seeking Scale (SSS) that measures risk taking and adventure seeking preference and variety of experience (Zuckerman, 1994). SS scores also tend to increase with the level of education and status of individuals and that of their parents although the relationship is not linear. In terms of construct validity, SSS scores positively correlate with a variety of risky behaviors, including injury proneness, sexual activity, gambling, financial risk taking and smoking (Zuckerman, 1994). High-sensation seekers tend to engage in behaviour that most persons appraise as moderately risky (e.g. volunteering for experiments involving hypnosis, sensory deprivation and drug taking), whereas low-sensation seekers tend to avoid such situations. Sensation seekers also engage in activities or sports that are generally regarded as risky, such as parachuting and scuba diving. Furthermore, the lack of fear of physical harm in the sensation seeker was apparent in the correlations with scales that measure such specific fears (Zuckerman, 1979).

Why do high sensation seekers do not avoid activities which are risky? One reason may be that they value the rewards of the activities more than low sensation seekers. The intense reward effects of such activities may outweigh the risks for high sensation seekers. An alternative, but not necessarily contradictory, hypothesis is that high sensation seekers have an “optimistic bias” (Weinstein, 1980), that is, they see themselves less at risk and having less possibility of a negative outcome of the risky activity.

Sensation seeking and related personality characteristics

Sensation seeking (SS) is an interesting personality trait that affects several spheres of our lives. Among healthy young adults, sensation seeking has been associated with a number of risky behaviours. It is also a trait with a strong biological basis, as indicated by its heritability and its biological correlates (Zuckerman, 1994).

Sensation seeking is a trait defined by the seeking of varied, novel, complex, and intense sensations and experiences, and the willingness to take physical, social, legal, and financial risks for the sake of such experience (Zuckerman, 1991). The explanation for sensation seeking is based on a model influenced by genetic, biological, psychophysiological, and social factors (Zuckerman, 1983, 1984, 1990, 1996; Zuckerman, Buchsbaum, & Murphy, 1980), which influence certain behaviours, attitudes, and preferences. It affects what music we prefer (Weisskirch & Murphy, 2004), what activities we prefer and what sports or occupations we choose.

The concept of risk addiction, or high sensation-seeking trait, as experts know it, helps to explain why people jump out of a plane at 10,000ft or belt down the motorway at 100mph. Professor Marvin Zuckerman, who began to work on the first sensation-seeking scale in the early 1960s, found in his research that a tendency to live on the edge was more common in men than women, and more likely among divorcees than married or single people. The characteristic tends to peak in late teens and early 20s and manifests itself in various ways, from extreme sports and dangerous challenges to less energetic past-times such as exotic travel. Sensation seeking is associated with lifestyle factors such as smoking, alcohol consumption, and using drugs (Zuckerman, 1994).

Sensation seeking has been found to be higher in males than females and for both males and females SS increases with age until about age 16 and then declines with age. As was mentioned above, SSS scores positively correlate with a variety of risky behaviours, including injury proneness, sexual activity, gambling, financial risk taking and smoking (Zuckerman, 1994), as well risky driving (Jonah, 1997). Sensation seeking, defined as a personality trait involving the degree to which one desires novel and intense stimuli (Zuckerman, 1990), is a factor that has received considerable attention for its role in driving behavior.

People with high combined risk-taking and sensation seeking scores differ significantly in their travel behavior, mode of destination choice, preferred tourist activities and demographics, from those who have low risk-taking and sensation seeking scores (Pizam at al, 2004).

Sensation seekers have been defined as persons who are willing to take risks for the sake of increases in stimulation and arousal (Zuckerman, 1994), but even sensation seekers can apprise risk and weigh it against the rewards provided by the risky activities in which they engage. There is some tendency for high sensation seekers to judge risk as less than do low sensation seekers for many kinds of activities (Zuckerman, 1994), but even when risk is estimated equally by high and low sensation seekers the first are more likely to anticipate positive outcomes while the latter anticipate negative effects if they engage in these activities. This tendency could account for the greater incidence of cigarette smoking among high as compared to low sensation seekers (Goldring, Harper, & Brent-Smith, 1983; Kohn & Coulas, 1985; Thieme & Feij, 1986; von Knorring & Oreland, 1985; Zuckerman, Bone, Neary, Mangelsdorff, & Brustman, 1972; Zuckerman & Neeb, 1980).

Risk taking is a correlate of sensation seeking but it is not a primary motive in behaviour (Zuckerman, 1994). Sensation seekers accept risk as a possible outcome of obtaining this arousal, yet do not seek out risk for its own sake (Zuckerman, 1994). Sensation seeking is associated with various biological correlates, including neurotransmitters, enzymes, and hormones (Roberty, 2004). Sensation seeking and impulsiveness have been combined in a supertrait called impulsive sensation seeking (Zuckerman, 1994).

Impulsiveness

Impulsiveness is another component of risk-taking that has received attention, especially in the accident prevention literature. Impulsiveness is conceptually similar to sensation seeking, however, impulsiveness deals with one´s control over one´s thoughts and behaviours (Barratt, 1972), while sensation seeking refers to one´s preference for novel experiences and a willingness to take risks (Zuckerman, 1994). Thus high sensation seeking might lead to risk taking because of the thrill it provides

(Arnett, 1994); impulsiveness might lead to risk taking because the individual simply lacks the self-control to refrain from engaging in it (Barratt, 1994). The actual behaviour of risk taking may be conceptualised as a weighed outcome of relative strengths of SS and impulsiveness.

Platelet monoamine oxidase activity as a biological marker of risk-taking and impulsiveness

Zuckerman (1994) notes that the level of monoamine oxidase activity, which has a strong genetic determination, has consistently been lower in high SSs than in low SSs. In a study of 1,000 Swedish army recruits by von Knorring and Oreland (1984), subjects with high levels of MAO had significantly lower levels of SS and SS was the only personality measure that contributed to the discrimination between high and low MAO groups.

Monoamine oxidase (MAO) is an enzyme that regulates the three monoamine systems in the brain. MAO is classified as A or B on the basis of differential substrate specificities and differential sensitivity to inhibitors. In human platelets only MAO-B (platelet MAO) is present. Brain and platelet MAO-B have been shown to be highly correlated (Oreland & Shaskan, 1983; Chen *et al*., 1993). MAO-B is a very reliable biological trait changing only slowly as a function of age. Inversely mirroring the relation of sensation seeking to age, MAO is lowest in adolescence and rises with age in brain and platelets. MAO activity correlate highly with increasing age for all three human tissues (hindbrain, plasma, and platelets). Women were found to have a significantly higher mean platelet and plasma MAO activity than men (Robinson *et al.*, 1971).

Platelet MAO has a high degree of heritability (Oreland *et al*., 2002). MAO-B has been found to have a high degree of genetic regulation, together with an association between low enzyme activity and personality traits related to serotonergic activity, constitute the cornerstones for the hypothesis that platelet MAO is a genetic marker for some property of the central serotonin system.

Numerous studies have shown that MAO-B activity in platelets correlates with specific personality characteristics such as sensation seeking, impulsiveness,

monotony avoidance, creativity with excessive risk-taking behaviours such as gambling (e.g. Schalling *et al*., 1987; Stålenheim, von Knorring & Oreland, 1997; Oreland 1999; Zuckerman & Kuhlman, 2000; Longato-Stadler *et al*., 2002). Investigations on the correlation between platelet MAO activity and neuropsychological measures supported the hypothesis (af Klinteberg *et al*., 1990). Las but not least, low MAO probands tend to prefer speed before accuracy.

Platelet MAO activity is highly genetically regulated and stable in the individual, and personality trait, had its gratest impact on the understanding of the nature of constitutional factors making individuals vulnerable for e.g. substance abuse and other forms of sociopathic behaviour (Oreland *et al*., 2004). Low levels of MAO have been found among chronic alcoholics and marijuana users, and low MAO males in normal populations reportedly use more drugs and smoke more cigarettes than high MAO types (Coursey *et al*., 1979; von Knorring *et al*., 1987; Irving *et al*., 1989; Kiive, 2001). Lowered MAO activity is specific to Type 2 alcoholics (in contrast to type 1 with a smaller genetic component) and the sensation seeking-related personality traits associated with this biochemical marker (Cloninger *et al*., 1996; von Knorring *et al*., 1987). It has been also shown that low MAO activity is associated with driving while impaired (Paaver, 2003; Eensoo *et al*., 2004; Paaver *et al*, 2006).

Platelet MAO activity has been found to have behavioural (psychiatric and personality) correlates (Oreland, 1990). High sensation seeking and impulsivity tend to be connected with low platelet MAO activity. Another interesting area in relation to platelet MAO activity is psychopathy, criminality (e.g. Alm *et al.* 1996; Skondras, 2003) and aggressive behaviour. Individuals with platelet MAO activity deviating from the average are more likely to start smoking during adolescence (Harro *et al*., 2004).

In conclusion, personality, psychopathology, and comparative behavioural studies are consistent in linking low MAO-B levels with sensation seeking, sociability, disinhibition, and impulsivity. Human risk-taking behavior in several areas is also related to low MAO levels. MAO is not active itself, however, but influences behaviour through its enzymatic actions on the monoamine neurotransmitters (Zuckerman, 2000).

Motor control

Risk takers express their proneness to risk in several activities by choosing their goals and danger limits. There is reason to believe that persons that are prone to take risks are also more likely to teeter on the edge of risk in actions that require fine motor skills. So far, studies of risky behaviour have paid little attention to the aspect of motor control. Although different simple manual dexterity tasks, measuring motor speed and coordination between MAO activity and personality and behavior, has been used also in earlier studies (e.g. af Klinteberg, 1990).

It can be postulated that in persons that are prone to risk, risky behaviour is evident in all activities, including games. This should be especially evident in games that involve a clear element of risk. For empirical studies, the result of risky behaviour must be quantifiable. In games of skill, it is possible to measure it exactly and thourougly. Not obeying the rules of the game will usually result in subpar result. However, for the best result, one must often play at the edge of risk (e.g. in casino, in football etc).

A game of skill called Minimum-TB contains all the above-mentioned elements. In this game, to achieve a maximum amount of points, one must play on the edge of risk. However, exaggerated throws are rendered null. In such games, containing elements of risk, choosing a right strategy is crucial, but no less important are skills and (sensorimotor) talent. Because of the influence of the factor of talent and/or skill which is independent of risk proneness, the results of the game should be normalised with regard to the typical score level of a person. Only then it would be necessary to manipulate with the level of risk (low and high risk). In other words, two different types of games should be modelled involving different levels of risk and the comparative dynamics of high-risk and low-risk performance could be used as a hypothetically valid indice of risk proneness. In persons whose psychobiological characteristics predict a higher level of risk, the difference between the two games – risky games and ordinary games should be relatively small compared to persons who belong to the low risk proneness group. Also, the relative number of performances involving extreme (risky) actions should be higher in the high-risk group.

The above-mentioned game of skill requires sophisticated motor and sensorimotor action. In acquiring the accuracy of movements, the score of the player (i.e. feedback) plays an important role. On the basis of this, the player develops an understanding of what kind of throws are more successful. In an online-type feedback regulation, the movement itself takes less than a second. During the next throws, information retained in memory is used for achieving a finer coordination of one's movements. During the play, several muscles are activated, from feet to fingertips. In a ball game, a successful throw depends on the work of biceps and fingers. In consecutive ball throws of a similar kind, wrist and finger extensor muscles are deemed to be very important from the point of view of accuracy (Hughes *et al.*, 2004; Hore *et al*, 1996, 1999, 2001).

In throwing a ball, finger extensors have a very large effect on ball directions as any other joint rotation (Hore *et al.*, 1996). Throwing a heavy ball and throwing a light ball presumably require different neural commands, because the weight of the ball affects the mechanism of the arm, and particularly, the mechanics of the finger (Hore *et al.*, 1999). Because in the present model game the ball is light-weight (a tennisball), the factor of pure physical strength should have a relatively insubstantial effect on the results and thus the game will not be too much restrictive for different population subgroups.

No matter how hard you practise a movement, you can never be entirely sure how it will turn out. The same action (e.g. throwing a tennisball) executed under the same conditions does not produce the same result. Even professional darts players throwing from the same distance from the board can miss the bull´s-eye. Many theories of muscle control have assumed that such errors arise from variation generated during the movement – particularly "noise" in the way that neurons pass instructions to the muscles at the neuromuscular junction (Churchland, Afshar, Shenoy, 2006). Well practiced task is limited by the brain´s ability to plan the same movement over and over again (Churchland, Afshar, Shenoy, 2006).

Movements are universally, sometimes frustratingly, variable. At the simplest level, motor skill can be thought of as a series of decisions and movements and related correlations of these while the outcome of movement is being monitored. Perceptual analysis indicates a discrepancy between a current state of the environment and a goal. In response, a movement is chosen that alters the environment or its cues, setting the stage for yet another decision and movement, and so on, until the goal is achieved.

This applies in the case of simple movements target. The initial movement choice depends on the discrepancy of hand location and target. Typically an initial impulse ends in error, and a correcting movement ensues. With accumulating practice and skill, sensorimotor memory component in movement pre-planning, execution and regulation obtains more and more a leading role compared to the low-level on-line movement execution mechanisms.

In the present study it is postulated that independently of his/her initial level of skill and practice, players of a game of skill adapt a game strategy and/or choose single actions that are more risky in terms of the possibility to fail in performance because of execution of a movement that leads to an outcome within a high risk zone. Playning in this zone means a strategy that could be termed, “win it all or loose it all”. The movement pattern and intensity jointly leading to a game trial outcome within this zone can be termed “risky movement”. The corresponding movement based actions (e.g., throws of a ball termed “risky throws”) can lead to a failure of action possibly exemplified in penalised outcomes. This kind of action outcome can be termed “critical”.

Aims of the study

In this study, the effects of psychological characteristics of risk-taking and sensation seeking on playing a game of skill, involving elements of risk, were assessed.

Hypotheses

In this study, the following hypotheses were examined:

1) In persons with lower MAO activity and/or higher scores in the SS scale – markers that are both associated with high risk proneness – the number of “critical” throws in a high-risk game decreases less as compared to the same type of throws in a low-risk game than in persons having higher MAO activity and/or lower SS scale result, the markers associated with low risk proneness.

2) Persons with lower platelet MAO activity and higher scores in personality scales predicting high risk proneness display relatively more throws with a "critical" score in a high-risk game.

3) As the individuals with low platelet MAO activity will engage in and/or prefer to take more risk in the game of skill Minimum-TB, and the scores of a high-risk game do not differ very much from the scores of a low-risk game, then after an unsuccessful throw the "criticality" of the next throw is still high in this group of subjects.

METHOD

Subjects

Fifty voluntary subjects, healthy and with corrected-to-normal vision gave their informed consent and participated in the present experiment. One person with abnormal platelet MAO activity was eliminated from the study. The analyses were thus conducted on 49 subjects. Data were obtained for 39 males and for 11 females. The average age of participants was 31.5 years (SD, 7.1; range 21-53). The average age of male and female participants was 31.9 and 30.0, respectively. Forty-five subjects were right-handed and 4 left-handed. All measures were collected anonymously (except the game of skill, conducted by myself, where personal identity of subjects was disclosed). Subjects did not receive any financial reward for participating in the study. This study was approved by the Ethics Committee on Human Research at Tartu University.

Of the subjects, 45% were nonsmokers and 55% smokers. As for marital status, 59% were unmarried, 16% married and 25% cohabitants. 37% of the subjects had secondary education, 20% had vocational secondary education and 43% had higher education. 38% of the subjects were chief executives (16% in a big private company and 23% in a small private company) 43% were employees (29% worked in a big company, 12% in a small company and 2% in a big government enterprise), 6% were professional sportsmen, 4% students, 4% unemployed and 4% odd-job workers. 23% of the participants did no sports, but 47% claimed to do sports every day, 20% three of four times a week and 10% almost every day. (The demographic

characteristics just listed, except for gender, did not have a significant effect on or correlation with performance measures collected in this study.)

Procedure

After receiving a detailed description of the procedural aspects of the study, all the participants were informed of the voluntary nature of their involvement in the study. The participants were not explicitly informed that the aim of the study was to study risk-related behaviour as this might have induced socially desirable behaviour in the ball game or other artefactual effects. They were told that the study was designed to explore the relationships between a ball game and different personality scales and enzyme MAO activity. Also, it was announced that they may terminate participation at any moment when they feel unwell or displeased. The order of participation in different measurements was as follows: first the subjects gave a blood sample, then they played the game of skill, and finally they filled in the questionaire.

MEASURES

Main independent variables

In this study, the principal independent variables were (1) personality trait expression level tested by the sensation seeking scale, (2) platelet MAO activity level, (3) type of game. For (3), different risk level of the game was used as an independent variable with two levels: high-risk and low-risk. High-risk game version meant that each nullified throw nullified also the sum of the previously acquired scores and thus the penalty for each unsuccessful throw was high (and risk of touching the ceiling – see part Game of Skill later on -- also high). Low-risk game version meant that the previously acquired sum of scores was maintained even if a throw yielded zero because of hitting the ceiling (and thus low risk of touching the ceiling in terms of the impact for the whole score). Several additional characteristics were taken into account or just registered as well (see later on in the part Measures).

Main dependent variables

The score obtained playing the game was the main dependent variable, hypothetically related to the risk proneness of subjects.

Game of skill

All participants played a game of skill called Minimum-TB. Introducing Minimum-TB in order to measure risky behaviour is a novel solution and there are no records of analogous previous research material. The game of skill consists in throwing a ball towards ceiling, with the aim to reach as close as possible to it, but without touching it by the ball. The closer the ball arrives to the ceiling without touching it, i.e., the smaller the distance between ball and ceiling, the higher the score awarded for this throw. Maximum score for a single throw is 100 points. One game comprises 20 throws. The game has 2 levels or risk: regular and risky. Respondents were playing the two versions corresponding to the two risk levels in counterbalanced order. The score gained is easily computable because it is calculated automatically, based on the measurements aided by optic sensors that feed computer with digital data about the duration of the excursion of the ball within the measurement zone after which, based on a special algorithm, software helps to calculate the score after each throw and also indicate if the ceiling was hit.

Minimum-TB is a new game and none of the subjects had any previous experience with it. Minimum-TB was novel and difficult for all subjects. Throws were asked to be made with the dominant arm. For practising, each participant had 20 throws. Then the real experiment followed in which each subject played 4 games, each consisting of 20 throws: 2 times the regular and 2 times the risky version. In the regular game, the scores were summed accumulatively; in the risky version the score was rendered null after a throw that was too strong (i.e., the ball touching the ceiling). The scores were weighed against the individual scores obtained in the regular version of the game, i.e. in low-risk control conditions; the order of playing the regular and risky version of the game was counterbalanced.

The average scores and the total number of hits of ceiling ("critical" trials) were assessed. The schematic for the game of skill Minimum-TB is depicted in Figure 1. The task of the subject was to throw a ball as close to the ceiling as possible; he/she was informed and practiced that the smaller the distance, the higher the score awarded for this throw. If the ball touched the ceiling, the subject was scored 0 and an unpleasant sound followed. A device measuring the distance, involving a computer, allowed to announce the score awarded to the subject immediately after the throw.To eliminate the effect of the first game, the participants played the games with a different level of risk in random order.

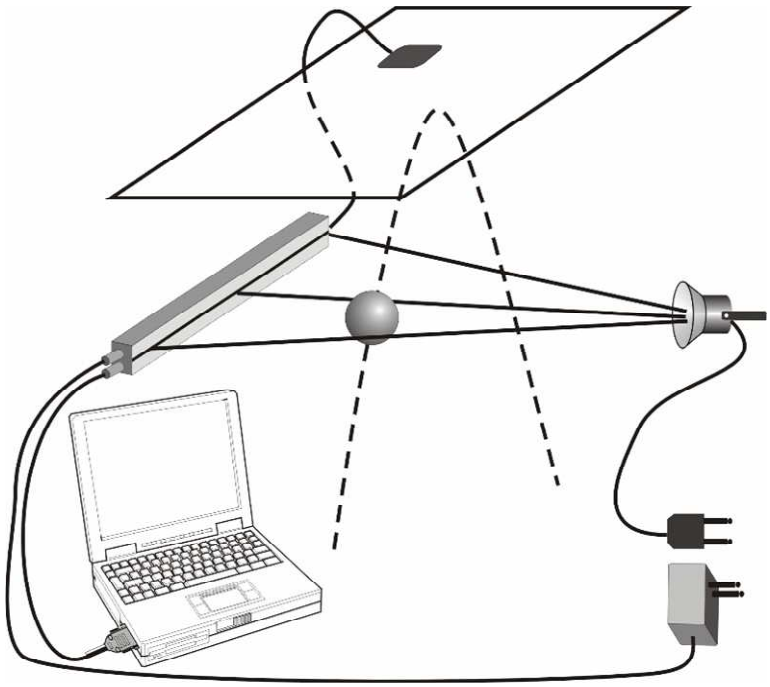

Figure 1. Schematic of the equipment and arrangement of the game of skill -- Minimum-TB. The task of the subject was to throw a ball as close to the ceiling as possible; the smaller the distance, the higher the score awarded for this throw. The gain in poits was uneven as dependent on the distance. Large increments of distance paid little when ball was far from ceiling, but each little increment paid off considerably at near distances from ceiling. This feature of the game motivated more risk strategies as the only means to acquire really high scores. If the ball touched the ceiling, the subject was scored 0 and an unpleasant sound followed. Immediately after a throw, a subject was informed of his or her score.

Personality measures

Zuckerman's Sensation Seeking Scale

Estonian translation of the Zuckerman's (1984) Sensation Seeking Activities schedule (SSS VI) was used to measuring Sensation Seeking. Zuckerman has gone through six different revisions to improve the measurement of these sensation seeking behaviours. This measure was chosen because it is a valid, reliable measure with good test-retest stability in a range of leisure exploration activities (Zuckerman, 1994). Although the test is not validated and adapted in Estonian for Estonian population as yet, I use it as a means of measurement in a quasi-experimental type of investigation, with the assumption that translation into Estonian and possible differences between Estonian and original subject samples do not jeopardise construct validity related capacity of a meaningful measurement of sensation seeking trait in an Estonian group of subjects. Participants indicated on a 3-point frequency scale experience and intention in a list of 64 activities. VI version separates past experiences from desired future experiences for the Disinhibition (Dis) and Thrill and Adventure Seeking (TAS) sub-scales. The Thrill and Adventure Seeking (TAS) subscale is made up of items that assess desires of the subject to be involved in physically risky/dangerous behaviours such as sky diving, climbing mountains, speeding, bungee jumping, etc. The Disinhibition (Dis) subscale assesses the desire to be socially uninhibited through partying, drinking, and seeking variety in sexual partners.

Demographic characteristics

In addition to the above, participants filled in a self-report questionnaire about the person´s age, gender, education, sporting habits, previous injuries etc.

Questionnaire about alcohol, tobacco consumption and traffic behaviour

A specially constructed inventory (based on Paaver, 2003) was used in the end of other personality measures. Questions were asked about alcohol and tobacco consumption. Subjects provided information on their use of tobacco, and were categorized into those who reported smoking tobacco and those who did not smoke. Questions were asked about alcohol consumption and driving behavior.

Estimation of Platetet MAO activity

Platelet MAO activity was used as the biological marker of the relevant (psycho)biological attribute of personality. Blood samples were taken from the participants and the activity of the enzyme monoamine oxidase-B was ascertained.

Venous blood samples were collected into 4,5 ml test-tubes containing K_3EDTA as an anticoagulant. MAO activity was analysed in platelet-rich plasma by a radioenzymatic method with β-phenylethylamine as the substrate according to the procedure described by Hallman, Oreland, Edman, & Schalling (1987) and Harro *et al*. (2001). All samples were analysed blindly and in duplicates. MAO activity was expressed as nanomoles of substrate oxidized per 10^{1o} platelets per minute.

Blood samples were taken and prepared for laboratory analysis by a nurse at the National Institute for Health Development. To separate the thrombocyte-rich plasma, the tubes were centrifuged. After centrifugation, the samples were transported to the HTI laboratory in Tallinn the same day. Before measuring the platelet MAO activity, the plasma was frozen at -70ºC. Platelet MAO activity was ascertained in the laboratory of Biomedicum of the University of Tartu.

Statistical analyses

All statistical calculations were performed using the statistical program SPSS for Windows version 11.5. For the analysis of correlations, Pearson`s and Spearman`s correlations were used. For the analysis of means, analysis of variance (ANOVA) and t-test were applied. P-values below 0.05 were considered significant. Tukey *post hoc* test was used. The Zuckerman scale was analysed with principal component analysis. For comparing the the game scores of with high and low MAO activity, participants were divided into low, medium and high MAO activity subgroups (according to 30^{th} and 70^{th} percentile ranks of frequencies. In In all tests, two-tailed levels of significance were used. The data are presented as means and standard deviations. The distribution of the nominal characteristics in groups are expressed in per cents.

RESULTS

Minimum TB

As the aim of the study was the approbation of a game of skill as a model of risky behaviour, the playing style and results of Minimum-TB were compared with platelet MAO activity – a well-known model of risk proneness – and Zuckerman SSS VI scales. As the game of skill was the focus of the study, the scoring system of Minimum-TB shall be described first.

In the game, it was possible to gather 2,000 points with 20 throws (100 points each). Naturally, achieving such a result was sufficiently difficult or even impossible for people who had no previous experience with the game. (The score of the known world best result is 1629 points.) The average scores for a throw in all games ranged from 18.65 to 37.71 (M=29.25, SD=4.82). The range of scores obtained by the participants (n=49) in different games are presented in Table 1. Throws resulting in a zero score because of a too much high level intensity of a throw define what are the "critical" trials. The number of "critical" throws (zeros) are shown in Table 3.

T-test revealed a significant effect of risk level in a comparison between low-risk versus high-risk total scores (Table 2) and also between the number of "critical" throws (Table 4). Paired sample correlations were significant between all games in Total Scores (p<.001), but in "critical" throws only correlations between the second low-risk game and second high risk-game were significant (p<.05).

Table 1. Total scores for different types of game.

	N	Minimum	Maximum	Mean	Std. Deviation
Low risk game 1	49	246	1112	712,90	193,543
Low risk game 2	49	241	1079	706,92	189,767
High risk game 1	49	228	1197	631,51	206,609
High risk game 2	49	190	1083	658,14	242,783

Table 2. Comparison of mean scores in different games

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	LR1-HR1	81,39	168,648	24,093	32,95	129,83	3,378	48	,001
Pair 2	LR1-HR2	75,41	183,238	26,177	22,78	128,04	2,881	48	,006
Pair 3	LR2-HR1	48,78	232,135	33,162	-17,90	115,45	1,471	48	,148
Pair 4	LR2-HR2	54,76	232,587	33,227	-12,05	121,56	1,648	48	,106

NOTE: LR1-Low risk game 1; LR2- Low risk game 2; HR1-High risk game 1; HR2. High risk game 2.

Table 3. Total number of "critical" throws (i.e. throws that gave 0 points) in different games

	N	Minimum	Maximum	Mean	Std. Deviation
Low risk game 1	49	0	9	3,61	2,206
Low risk game 2	49	1	9	3,71	2,031
High risk game 1	49	0	5	2,41	1,428
High risk game 2	49	0	9	2,55	1,872

Table 4. Comparison of "critical" throws in different games

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	0LR1-0HR1	1,20	2,558	,365	,47	1,94	3,296	48	,002
Pair 2	0LR1-0HR2	1,06	2,641	,377	,30	1,82	2,813	48	,007
Pair 3	0LR2-0HR1	1,31	2,172	,310	,68	1,93	4,210	48	,000
Pair 4	0LR2-0HR2	1,16	2,144	,306	,55	1,78	3,798	48	,000

NOTE: 0LR1-"critical" throws in Low risk game 1; 0LR2- "critical" throws in Low risk game 2; HR1-"critical" throws in High risk game 1; HR2; "critical" throws in High risk game 2.

The mean scores and number of "critical" throws in the game of skill for different factors were analysed by means of analysis of variance. The effect of game risk level was significant for mean scores ($F(3, 44) = 4.02$; $p<.01$) and also for number of "critical" throws ($F(3, 44) = 3.44$; $p<.001$). Post hoc additional ANOVA showed that there was no significant interaction between game risk level and level of MAO (F (6, 90) = 1.15; p=.34) for mean scores and also no signitifant interaction between game risk level and level of MAO (F (6, 90) = 1.15; p=.26) for number of critical throws. This result provides no support for the first hypothesis. Although the observation that low MAO level subjects on the average produced by about 1.0 critical throws less in the high risk game condition compared to low risk game

condition and that this difference for high MAO level subjects was about 1.5 on the average is consistent with Hypothesis 1, there is no statistical significance in this.

ANOVA established a significant gender effect ($F(1,45) = 15.68$; $p<.001$). In Figure 2, the average scores for a throw (with standard deviation) are shown for both men and women.

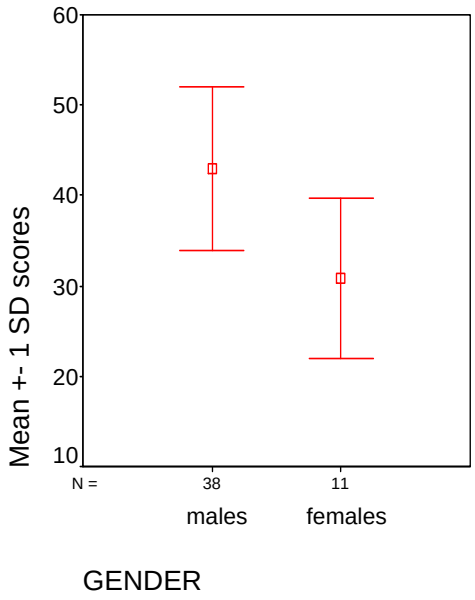

Figure 2. The average results of throws with standard deviation in men and women.

At the same time, smoking had no statistically significant effect on the mean scores, but the combined effect of smoking and gender had a statistically significant effect of the average score obtained in all games ($F(1,45)= 6.13$; $p<.05$). Male participants (n=38) threw the ball more boldly than women (n=11). The average score of all throws in male smokers (n=22) was lower than in non-smokers (n=16). However, in women the opposite trend could be observed: smokers (n=5) threw the ball much more boldly than non-smokers (n=6) (see Figure 3).

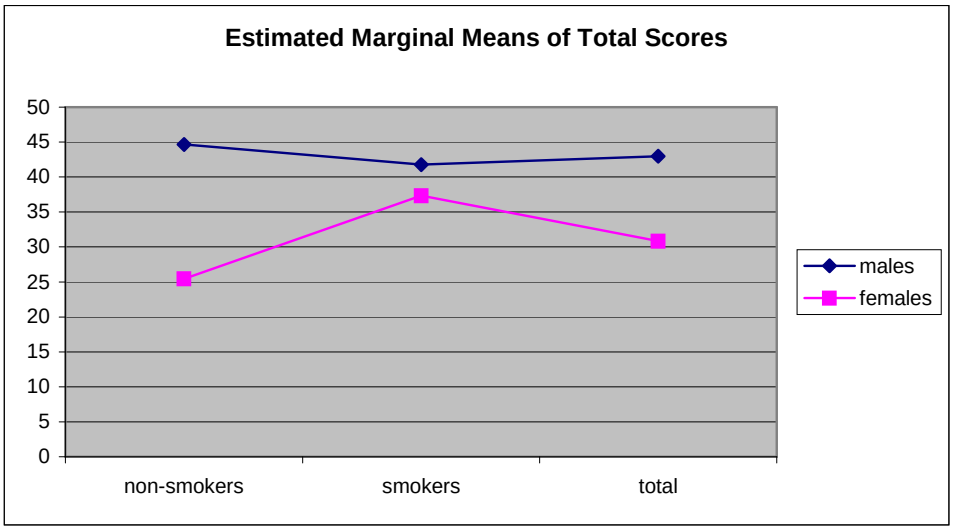

Figure 3. The average results of throws with standard deviation in men, women, smokers and non-smokers.

Smoking and platelet MAO

Monoamine oxidase (MAO) activity was determined in 49 participants. MAO activity ranged from 3.05 to 17.90, the average was 6.66±3.32. There was no significant difference in mean platelet MAO activity between males and females $F(1,46)=.30$, ($p<.59$). The percentage of male and female subjects who said they were past or current smokers was 55. There was a tendency towards a relationship between MAO activity and smoking, but it was not statistically significant ($p=.08$).

Relation between Minimum TB and MAO

The comparison of scores in Minimum-TB with platelet MAO revealed several significant main effects. The groups with different game scores and groups of low, medium and high MAO activity were compared by means of Tukey *post hoc* test. Although, there was no significant general effect between the game scores and MAO subgroups, there was a significant effect for game score in the first low-risk game $F(2,46)=3.15$, ($p<.05$). In high, medium and low MAO activity groups (n=15; 14; 20) the game scores were 628.0, 699.8 and 785.8, respectively. No difference was found between MAO activity groups and the number of "critical" throws in other low and high risk games.

The analysis of scores in Minimum-TB with platelet MAO revealed several significant correlations. Statistical correlations between MAO values and Minimum-TB scores were tested by means of Pearson`s correlation test. In both low-risk and high-risk version of the game, a stronger correlation between a score and platelet MAO activity appeared in the first series. MAO activity had a significant negative correlation with the sum of the first low-risk game $r(47)=-.32$ ($p<.01$) and the total sum of the two low-risk games $r(47)=-.29$ ($p<.05$). The sum obtained in the first series had a stronger correlation with MAO activity, but the correlation for the results of two series combined also remained significant. Correlations between platelet MAO and Minimum-TB scores for subjects ($n=49$) are given in Table 5.

Table 5. Correlation coefficients (Pearson r) between platelet MAO and Minimum TB Total Scores

	Low-risk game 1	Low-risk game 2	High-risk game 1	High-risk game 2	Sum of two low-risk games	Sum of two high-risk games
Platelet MAO	-.32**	-.18	-.23	-.05	-.29*	-.15

*$p<.05$, ** $p<.01$

The correlation between the average throw scores and platelet MAO activity was weaker than the correlation between MAO activity and the score achieved in the game. MAO activity and the mean score of all games combined and MAO activity and the score of the first low-risk game were correlated at a significance level of $r(47) =-.23$, $p<0.1$. The scatterplot of mean scores in the fist low risk game and the average score in all four games are given respectively on Fig 4 and 5.

In the first and second high-risk game, the number of throws that followed "critical" throws were not correlated with MAO activity (r (47)=-0.06, $p<.67$; $r(47)= -.13$, p<.38, respectively). “Critical” throws followed by new “critical” throws were not associated with the MAO activity.

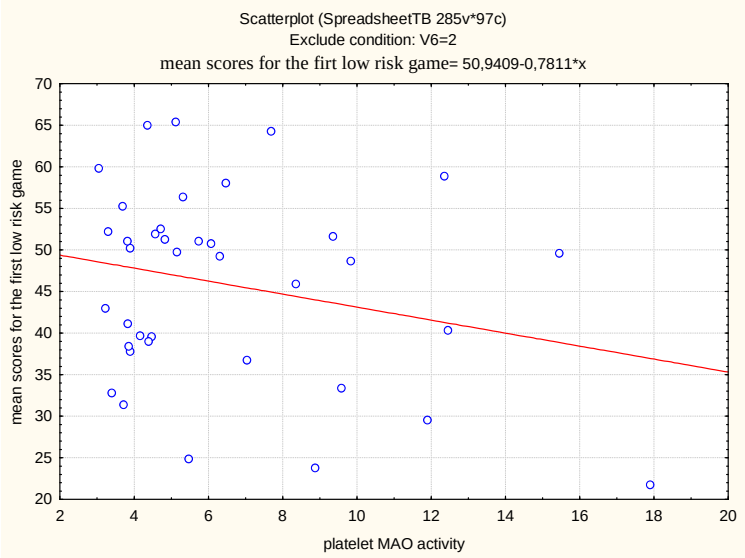

Figure 4. Scatterplot for the mean scores in first low-risk game

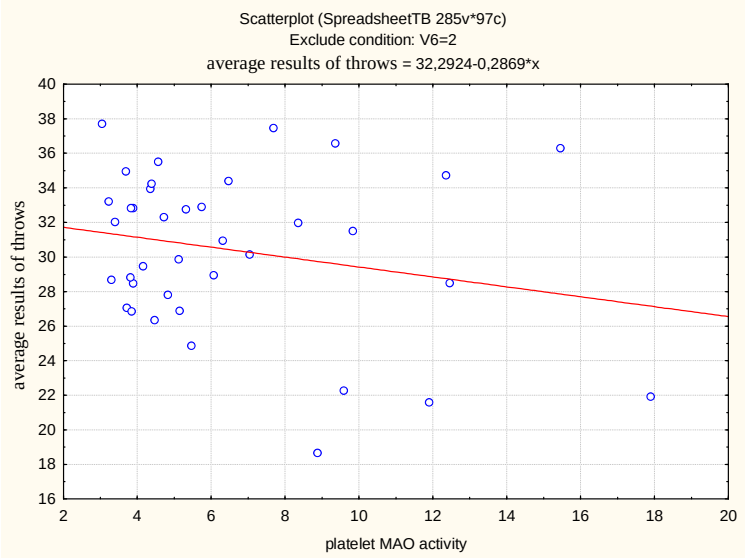

Figure 5. Scatterplot for the average results of throws in Minimum-TB

Coeffects of high-risk games and MAO activity

Next the results of high-scoring and low-scoring participants were compared. The means of games with different risk levels were different. The analysis of mean MAO activity in groups with different scores in the game gave the following results. The average MAO activity of participants that scored less than average in both game 1 and game 2, was 7.7 (n=16). The means and coeffects are not statistically significant.

Participants scoring less than average both in the first and second high-risk game had a mean MAO activity of 6.4 (n=19). Here the coeffect is tending towards significant at a 10% confidence level: $F(1,45)=3.02$, $p<0.1$. The coeffect here means that the participants who scored lower than average in the first high-risk game, but higher than average in the second high-risk had higher MAO activity than those participants who did not take any risks in the second high-risk game (i.e. whose result in the second high-risk game was also below average). The participants who scored above average both in the first and second high-risk game had lower MAO activity than those who scored below average in the second high-risk game.

The ranking of groups according to mean MAO activity (from the lowest): both scores above average (5.97), both scores below average (6.37), first high-risk game below average and second high-risk game above average (7.29), first high-risk game above average and second high-risk game below average (8.77)

Zuckerman SSS VI

As it was the beginning stage of using the not yet adopted and validated Estonian version of Marvin Zuckerman's SSS VI, it is first necessary to make sure that the Disinhibition (Dis) and Thrill and adventure seeking (TAS) scales of the test really describe sensation seeking. To gather the questions of one subscale under one factor or principal component, principal component analysis was used. The internal reliability of the scales was as follows: E-TAS (15 items) Cronbach α=.78, E-DIS (42 items) α=.90, I-TAS (22 items) α=.87 ja I-DIS (42 items) α=.92. The intercorrelations of the four factors were between .42 and .77. See Table 6.

Table 6. The intercorrelations of the four factors.

	E-DIS	E-TAS	I-DIS
E-TAS	.55**		
I-DIS	.77**	.47**	
I-TAS	.42**	.77**	.56**

**p<.01

One-way ANOVA showed that males scored significantly higher than females on every sensation seeking scale. There was a strong covariatite effect between SS scales and gender E-TAS F (1,47)=5.69, p <.05; E-DIS F(1,47)=4.45, p < .05; I-DIS F (1,47)=6.26, p <.05 and I-TAS F (1,47)=6.93, p <.05. No correlation between Zuckerman SSS VI and platelet MAO activity was found.

Interrelations between scores of game of skill and Zuckerman SSS VI

The correlations between the principal components of the Zuckerman's scales and the mean scores of Minimum-TB were analysed. No correlation was found between SS scales and Minimum-TB Total Scores and none of the factors had any significant correlation with the activity of MAO and with the mean scores.

Correlations of Minimum-TB and the number of "critical" scores are presented in Table 7. E-TAS had no correlation with the number of "critical" throws in the games. A statistically significant correlation was found between the number of "critical" throws in the first low-risk game and Zuckerman E-DIS scale (p<.01). It appeared that the higher the score for factor E-DIS was, the more "critical" throws the participant made in the first low-risk series of the game and in two low-risk series combined. The number of "critical" throws in the high-risk game had a statistically significant negative correlation with the I-TAS scale (p<.01). The higher was the value of factor I-TAS, the smaller was the number of zeros ("critical" throws) in the first high-risk game. The number of "critical" throws in the two low-risk games combined were correlated with the score in the E-DIS scale. At a 10% level, factor I-DIS correlated with the number of "critical" throws in all games (p<.1).

Table 7. Correlation coefficients (Pearson r) between SSS VI and Minimum-TB for the number of "critical" throws.

Sensation Seeking Scales	Low-risk game 1	High-risk game 1	Sum of two low-risk games
E-TAS	.21	-.16	.19
E-DIS	.40**	-.00	.31*
I-TAS	.18	-.38**	.12
I-DIS	.26	-.22	.26

*p<.05, ** p<.01

"Critical" throws followed by new "critical" throws were associated with the SS scales. Table 8 shows that the first high-risk game has a statistically significant correlation with the SS scales. The higher were the number of scores in the sensation seeking scales, the smaller was the number of "critical" throws followed by new "critical" throws; however, high scores in the E-DIS scale had a statistically significant positive impact on the followed "critical" throws in the low-risk game ($p<.05$). Thus, the second hypothesis received partial support: there were more "critical" throws by subjects scoring high in SSS VI, but only in the low risk game.

Table 8. Correlation coefficients (Pearson *r*) between SSS VI and Minimum-TB for the number of "critical" throws followed by new "critical" throws.

Sensation Seeking Scales	Low-risk game 1	Low-risk game 2	High-risk game 1	High-risk game 2
E-TAS	.19	.10	-.21	-.02
E-DIS	.29*	.13	-.45**	.16
I-TAS	.02	-.01	-.34*	.07
I-DIS	.05	.13	-.33*	.32*

*$p<.05$, **$p<.01$

Smoking, alcohol consumption and other risks behavioural ratings (driving behaviour and gambling)

Alcohol use and traffic behaviour had also some interesting significant relationships with the results of the game of skill (Table 9). Spearman coefficients showed that the consumption of vodka and other strong alcohol had a statistically significant negative correlation with the mean score of Minimum-TB. It appeared that the more frequently strong alcohol was consumed the lower was the mean score in the game. Competing with other drivers had a positive correlation with the mean score.

A significant negative correlation was revealed between strong alcohol consumption and the results of the second low-risk game ($p<.05$) and the two high-risk games combined ($p<.01$). In the first games, a similar trend could be observed at a 94% confidence level. The sums of two low-risk games combined ($p<.05$), two

high-risk games combined (p<.01) and all four games combined (p<.01) showed also a strong negative correlation.

The mean scores of the two high-risk games combined and all four games combined were also negatively correlated with the frequency of strong alcohol consumption (r=-.30, -.35, and -.42, respectively, p<.05). From these data it can be concluded that the more strong alcohol was reportedly used, the smaller were the total scores in the game and the mean scores of the high-risk games.

Table 9. Correlation coefficients (Spearman r) between Minimum-TB Scores and alcohol habits and driving behaviour

	Low-risk game 1	Low-risk game 2	High-risk game 1	High-risk game 2	Sum of two low-risk games	Sum of two high-risk games	Total sum
Vodka and other strong alcohol	-.27	-.31*	-.28	-.42**	-.33*	-.41**	-.40**
Ignoring of speed limit traffic signs	.22	.33**	.35*	.03	.31*	.15	.30*
Competing with other drivers	.29*	.40**	.43**	.23	.36*	.30*	.44**

*p<.05, ** p<.01

The score of the first high-risk game had a significant correlation with the frequency of playing lottery (r=.78, p<.05). The mean scores of both the first and second high-risk game and the mean score of the first high-risk game were correlated with the importance for a person of winning on a lottery (r=-.76, -.76, and -.87, respectively, p<.05).

Table 10 shows that the habit of playing lottery frequently had a strong correlation with the number of "critical" throws in the first low-risk game (r=.42, p<.01) and a weaker, but still statistically significant correlation with the same number obtained in the low-risk games combined (r=.34, p<.05). The number of "critical" throws (zeros) in all games combined correlated statistically significantly with the frequency of playing a lottery (r=.31, p<.05).

Table 10. The number of "critical" scores and the frequency of playing lottery

	Low-risk game 1	Low-risk game 2	High-risk game 1	High-risk game 2	Sum of two low-risk games	Sum of two high-risk games	Total sum
Playing lottery	.42**	.05	.03	.228	.34*	.21	.31*

*p<.05, ** p<.01

NOTE: Possible answers in the scale were as follows: 1 – never ; 2 – some times per year, 3 – 1-3 times per month, 4 – 3-4 times per week, 5 – always

The number of zeros was also correlated with driving while being tired. Namely, the more frequently the participants had been driving while being tired, the lower was the number of "critical" throws in the first high-risk game (r=-.30; p<.05). The points obtained and the number of "critical" throws in the game of skill had no correlation with the consumption of wine and other weak alcohol, creating of dangerous situations in traffic and the frequency of casino visits.

DISCUSSION

Game of skill

The focus of this study was the approbation of the game of skill Minimum-TB as a model of risky behaviour. The aim of the study was to study the relationships between game behaviour and the Zuckerman SSS VI scales and platelet MAO activity. A significant correlation was revealed between the results of the game and platelet MAO activity (correlate of behavioural preferences) and Zuckerman SSS VI. As the focus of the study was mainly explorative, i.e. looking for relationships, the hypotheses are based on the results of previous studies on MAO activity and Zuckerman scales. The study was primarily based on the game of skill Minimum-TB, therefore first I would like to discuss about the results of the game.

The game was a novel experience for all the participants. However, some participants might have had some experience in games involving similarly light-weight balls, like tennis. There were no professional tennis players among the

participants. Therefore, it can be assumed that the success in the game depended primarily on each individual's natural abilities and talent in transferring other sensorimotor skills over to a new game. Good motor and sensorimotor abilities, and good vision, but also skills and the easiness with which the skills develop were probably important in the game. However, the main focus was on personality factors: risk proneness, self-regulation and motivation to achieve. Half a hundred people quasi-randomly selected should be enough to assess risk proneness as a character trait in the context of game scoresk, with skills related factors postulated to be a random factor or nuisance variables.

There were three hypotheses. First, it was assumed that in participants with low MAO activity – a marker associated with greater risk proneness – the number of "critical" throws in a high-risk game decreases less as compared to the same type of throws in a low-risk game than in persons having higher MAO activity, a marker associated with low risk. The results of the study did not support the first hypothesis. First of all, there was no statistical proof to the expectation that low MAO group subjects show smaller difference between the number of critical throws in high risk and low risk game conditions. Also, one-way ANOVA revealed that platelet MAO activity was not correlated with neither the number of "critical" throws nor the total sums gained in different games. It was also assumed that high scores on the sensation seeking scale are related to a greater number of "critical" throws. There were more "critical" throws by subjects scoring high in SSS VI, but only in the low-risk game. However, partly the results showed the reverse: the figure depicting mean scores and MAO activity shows that in the high-risk game, people with low MAO activity preferred to throw the ball significantly lower than participants with high MAO activity. This may result from the reason that high MAO activity participants played more carefully in the low-risk game, too and they had no reason to change their behaviour. However, low MAO activity individuals played too much on the edge of risk in the low-risk game and therefore they were forced to correct their strategy in the high-risk game. It was difficult to foresee that high MAO activity participants will play so modestly. For future studies, a new method should be developed that would also make people with low risk proneness more willing to take risks.

Second, it was reasonable to assume that persons with lower platelet MAO activity and higher scores in personality scales predicting high risk proneness display relatively more "critical" throws in a high-risk game. The second hypothesis was

partly supported by the results. Namely, high scores in the E-DIS scale had a statistically significant positive impact on the scores in the low-risk game ($p<.05$). Indeed, there were more "critical" throws by subjects scoring high in SSS VI, but only in the low risk game. Thus the hypothesis received a partial support.

The third hypothesis was that because individuals who have low platelet MAO activity should engage and/or prefer to take more risk in the game of skill Minimum-TB, the number of "critical" throws produced in the trials immediately after a previous "critical" throw should be relatively higher. This hypothesis was not supported by the results. Number of "critical" throws followed by new "critical" throws was statistically significantly correlated to Zuckerman subscales, but also also reverse to the hypothesis. The higher was the value of factor E-DIS, I-TAS and I-DIS scales, the smaller was the number of zeros ("critical" throws) in the first high-risk game.

In what follows let me comment on the results in a more detail.

Platelet MAO activity and the level of play

A significant correlation was found in certain conditions between the game results and platelet MAO activity: subjects hypothesised to belong to the high risk proneness group as indicated by low MAO level scored generally higher in the game of skill. It appeared that in both low-risk and high-risk versions on the game the relationship with platelet MAO activity was stronger in the very first games. These findings are consistent with earlier results that platelet MAO activity is lower in subjects with higher risk proneness when it was assumed that this type of person is willing to "play high" even in a new, unexperienced activity.

Platelet MAO activity did not correlate with age in our study (age range 21 to 53 years). For platelet MAO activity, several groups have found no correlations with age (e.g., Skondras, 2004).

MAO activity and other factors

Samples were collected from 27 active smokers and 22 non-smokers (ex-smokers or those who had never smoked). No correlation was observed between platelet MAO-B activity and the age of the subjects. The small size of the sample may be the reason for this lack of correlation. On the other hand, this result makes treatment of the results of the present research simpler.

Several previous studies have established relationships between MAO-B activity and the Zuckerman scales. For example, Ward (1987) found that platelet MAO activity was negatively correlated with the Disinhibition and Total scales of the SSS. These correlations were not significantly different in smokers and non-smokers (Ward *et al*., 1987). The results of this study did not found any statistically significant relationship between lower platelet MAO activity and higher scores on the Sensation Seeking Scale. Signifficant negative correlations were mostly observed in male subjects and another form of the SSS used. Ward *et al.* (1987) found that differences in sensation seeking only account for 5-10% of the variance in platelet MAO activity. The small size of the correlation coefficients reported in previous studies are consistent with extensive evidence that an estimate of platelet MAO activity is influenced by many state and trait variables unrelated to a sensation-seeking personality trait (e.g. Fowler, Tipton, MacKay, Youdhim, 1982).

According to Zuckerman (1984) the interpretation of the results obtained in female students is difficult, given the small size of the sample, and the inconsistent findings in females in previous studies. It has been suggested that this inconsistency may relate to variability of platelet MAO activity during the menstrual cycle (Zuckerman, 1984). This study was based on 11 female and 38 male participants, thus the samples were not equal. However, based on the results, no gender differences were found.

Zuckerman SSS VI and Minimum-TB scores

It is still the beginning of use of the Estonian version of Marvin Zuckerman's SSS VI (1984), but the internal reliability of the scales was very good.

The central underlying theme is that people differ along the dimension of sensation seeking and that this explains in part vocations and hobbies. This difference is biologically based and rather stable, though it may fluctuate as a result of satiation, diurnal rhythms, and lowering with age of the need for sensation. Heritability of sensation seeking has been investigated on a very large sample and including non-twin siblings in the design. According to some investigations, in males the heritability is the highest for the Dis scale (Stoel *et al.*, 2006).

The results of this investigation revealed a statistically significant correlation between the game of skill and the Zuckerman scales. Games with different risk levels correlated with different scales of SSS VI. "Critical" throws of the first low-risk game, and also the total score of the two low-risk games combined, were related to the E-DIS scale. However, the scores of the first high-risk game showed a negative correlation with the I-TAS scale. It is known that the DIS scale describes sensation seeking through social variables like parties, sex and drinking by which common social norms and limitations are ignored (Zuckerman, 1994). The TAS scale reflects a need for physical excitement and risky behaviour, like skin-diving, mountaineering and water-skiing. In the first high-risk game, participants with a higher score on the I-TAS scale had more zeros and it had a negative correlation with the MAO activity. In means that people with higher scores on the TAS scale had lower MAO activity and the scores obtained in the high-risk version of the game were primarily associated with the sensation seeking scale, associated with the need for physical excitement. Dis scale is known to implicate an impulsive, unsocialized form of sensation seeking (Horvath & Zuckerman, 1993). In contrast, the prosocial risk taker would probably score predominantly high on thrill and adventure seeking (TAS) (Horvath & Zuckerman, 1993). Similarly to several previous studies, this work showed that in a low-risk game, those people who tend to seek sensation through social variables score more "critical" scores.

It was assumed that in persons that according to the MAO activity and the Zuckerman scales are more prone to take risks, the score in a high-risk game is not significantly different from the score in a low-risk game. However, the results were

inconsistent with this prediction. When measured by number of critical throws, some trend towards this can be noticed, but the effect was far from any significance. However, simple inspection of the mean scores showed that there was an opposite trend to what was suggested in this hypothesis. As explained earlier, it is likely that because subjects less prone to risk opted for "safe" game strategy, there was not any need to adjust game styles and risks to the different levels of riskiness of the two game versions. Our results show, that there was a strong negative interrelation between the number of "critical" throws in the high-risk game with the I-TAS scale and posivitve correlation with the number of "critical" throws in the low-risk game with the score in the E-DIS scale. This is a complex interaction that needs to be studied in further research.

High scores on the Sensation Seeking Scale indicate that these individuals are likely to be involved with certain risky activities and behaviours (Zuckerman, 1979; Zuckerman, 1983). Here, Low-risk game was associted with the E-DIS scale. The Disinhibition (DIS) sub-scale reflects the impulsive extroverted behaviours of an individual (Cronin, 1991). High-risk game had a negative correlation with I-TAS scales. The Adventure Seeking sub-scale reflects an individual's desire to act in risky, impulsive, and adventurous sports and activities, offering the individual unique sensations. In the low-risk game, the participants with a higher sensation seeking score on E-DIS, I-DIS and I-TAS scales were more successful in the game of skill, i.e. obtained a better total sum. In the high-risk game it appeared that the greater was the need to seek adventures in the future (i.e. high scores on the Adventure Seeking (I-TAS) scale) the less points the person achieved in the skill of game. The more points the participants scored on all SS scales combined, the more points they achieved in the Minimum-TB. In the low-risk game a high score on the E-DIS scale helped to achieve more points in the game of skill, but in the high-risk version of the game a higher score on the SS scale had the opposite effect. Again, higher engagement and risk do not always pay off because of the failed throws.

Some stydies have found, that high sensation seekers have better focused attention than low sensation seekers on tasks requiring selective attention (e.g. Ball et al., 1992). Additional studies along the lines taken in this thesis may be able to explore the possible role attention plays in a game of skill like the one adopted here. Most importantly, it should be made sure that the game effects attributed to risk proneness are not actually artefacts of different capacity for attentional concentration.

Minimum-TB and alcohol use, driving behaviour and other risks

Alcohol use and traffic behaviour had also some interesting significant relationships with the results of the game of skill. Spearman analysis showed that the consumption of vodka and other strong alcohol had a statistically significant negative correlation with the mean score of Minimum-TB. It appeared that the more frequently strong alcohol was consumed, the lower was the mean score in the game. Competing with other drivers had a positive correlation with the mean score. Thus two different known correlates of risky behaviour have opposite effects in this study. Whether stronger alcohol consumption habit has any impairing effect on the performance in games of skill or are there other more complex interactions involved cannot be concluded from the data of this study.

Alcohol consumption had a significant correlation with the high-risk games. Tendency to compete with other drivers was related to the sums obtained in the first high-risk game and in the two low-risk series of the game combined. It appeared that the more frequently the particopants had driven a car while being tired, the smaller was the number of "critical" throws (i.e. zeros). This interesting relation deserves special exploration in future.

A habit to play lottery frequently correlated significantly with the number of "critical" throws in the first low-risk game and to a lesser extent, but still statistically significantly, with the results of the two low-risk series combined.

Correlations were also revealed between competing with other drivers and ignoring of speed limit traffic signs and the results of the second low-risk series and the first high-risk series of the ball game.

Summing up, studying risky behaviour is relatively difficult. Actual behaviour of a person is one thing, filling in a questionnaire is quite another. A ball game might be a better indicator of a person’s proneness to risk than a scale. All in all, a real action and not its retrospective or imaginary commentaries is what is at stake. Measurement of risky behaviour is complicated by the fact that there is a difference between frequent and occasional risk-taking. Occasional risk-takers are rarely different from abstainers and do not seem to suffer from poor psychological and social adjustment, unlike frequent risk-takers. Occasional risk-taking is a stable tendency of an individual that will be manifested in varied domains of risk-taking, and

that the psychological profile associated with an occasional risk-taker is very different from that of a frequent risk-taker (Desrichard & Denarié, 2005). A game of skill, administered only once cannot of course differentiate between frequent and occasional risk-taking styles of behaviour.

General Conclusion

Main findings and conclusion from this study are as follows:

1. The sum obtained in the game of skill had a statistically significant negative correlation with MAO activity. Lower MAO meant bigger total score , i.e. bolder throws.
2. The number of "critical" scores in the ordinary version of the game had a statistically significant correlation with the Zuckerman Sensation Seeking Scale. Sensation seekers may play higher, but only in a . E-DIS correlated with the number of "critical" scores in the low-risk game and E-DIS, I-DIS and I-TAS with the scores in the high-risk game. Clear-cut interpretations for this result cannot be drawn from the data of this study.
3. The mean scores gained in the game of skill were related to gender. Men threw the ball higher than women, i.e. men took more risks.

Conclusively, satisfying a preference for stimulation can be accomplished through many behaviours, activities, and attitudes (Arnett, 1991; Irwing & Millstein, 1986; Zuckerman, 1985, 1994; Zuckerman & Neeb, 1980). Therefore, it would be natural to use a ball game as one possible method for the measurement of risk behaviour. The present study assessed Minimum-TB scores with biological marker MAO-B and Zuckerman SSS VI. Current results demonstrate that the dynamics of playing a game of skill is related to the Zuckerman's sensation seeking scales, and the number of "critical" throws is related to platelet MAO activity. Therefore, there is a basis and reason for continuation of the studies in order to fine-tune a game of skill based model of risky behaviour proneness.

Limitations

The future developments should take into account the pertinent limitations, constraints and the existing open ends. Limitations of the present study should be delineated. First, the sample size was relatively small (n = 49). There were too few participants and many variables like gender, education, smoking, sporting skills, etc. The numbers of men and women were not equal (n=38 and n=11, respectively). Thus, 78% of the participants were men and 22% women. Women's level of MAO-B activity has been relatively little studied and there is no consensus among researchers as to when and to what extent it changes. It can be assumed that volunteering in experiments can also be one way to express risk proneness. Although the present sample was not very representative and this sets limits to generalization, the results of the study still demonstrate that it is possible to ascertain persons that are more risk-prone on the basis of a game of skill. It would be interesting to conduct further studies to test the validity of this conclusion.

The participants of the study received no monetary compensation. The scores of the game would have had an even clearer relationship with risky behaviour if the players had been persuaded to take more risks by means of incentives.

The results of the first series in both low-risk and high-risk games were more reliable than the scores obtained in the second series. This game of skill is relatively tiring. Players have to stare at the ceiling for a long time and in the course of time hand may get tired and attention may dissipate.

This study explored risk proneness in a group of people and statistically significant results apply to the whole group; however, it is probably not so easy to determine the risk proneness of an individual by means of such a game unless individual validation and/or population norms which are adjusted to personal level of skill are worked out.

The fact that SSS VI has not been adapted into Estonian is also a shortcoming. For the purpose of this study, the scale was translated into Estonian.

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APPENDIX

SSS VI

Järgnevalt palume Teil täita paljude erinevate tegevuste nimekiri. Palun märkige, kas olete seda teinud. Nendele küsimustele pole õigeid ega valesid vastuseid. Olge otsekohene ja aus. Me oleme huvitatud Teie kogemustest, mitte sellest, mis teised arvaksid nendest tegevustest. Teie vastused on täiesti konfidentsiaalsed.

Vastuse variante on 3 ning lahtrisse kirjutage neist sobivaim:

A Ma pole seda kunagi teinud
B Olen teinud seda üks kord
C Olen teinud seda rohkem kui üks kord

1.	Roninud kõrgetes mägedes	
2.	Lugenud avameelseid raamatud seksist	
3.	Jooksnud maratoni	
4.	Käinud läbi tõeliste „peoloomadega”	
5.	Teinud striptiisi	
6.	Hüpanud tundmatus kohas pea ees vette	
7.	Veetnud aega inimeste seltsis, kes suhtuvad väga vabameelselt seksi ja kellel partnerid vahetuvad üsna tihti	
8.	Olnud lugupidamatu õpetaja või ülemuse suhtes	
9.	Manustanud tundmatut narkootikumi	
10.	Šokeerinud vanemaid inimesi ainult lõbu pärast	
11.	Teinud benji-hüpet	
12.	Seksinud avalikus kohas	
13.	Teinud langevarjuhüppeid	
14.	Abielueelseid seksuaalsuhteid omanud	
15.	Lennukiga lennanud	
16.	Teiste seltsis ennast “pilve tõmmanud”	
17.	Teinud midagi vahvat, hoolimata sellest, et see on seadusevastane	
18.	Tegelenud sukeldumisega	
19.	Hobuse seljas galoppi sõitnud	
20.	Purjetanud pikki vahemaid	
21.	Ujunud üksinda kaldast kaugel	
22.	Seksuaalses vahekorras olnud kellegagi, kellega saite just tuttavaks ja keda ei pruugi enam näha	
23.	Roninud mööda kaljuseina	
24.	Sõitnud suuskadega kõrgest mäenõlvast alla	
25.	Autoga sõites kihutanud, seades ohtu enda turvalisuse	
26.	Teinud midagi väga tavapäratut	
27.	Proovinud kokaiini	
28.	Uurinud koopaid	
29.	Arutanud oma seksuaalelu sõpradega	
30.	Jahil käinud	

31.	Vaadanud pornograafilist filmi	
32.	Joonud end ettekavatsetult purju	
33.	Elanud ajutisel kokkuleppel vastassoo esindajaga koos	
34.	Proovinud LSD-d	
35.	“Teinud seda, mis tundub hea”, tagajärgedele vaatamata	
36.	Teise autoga võidu sõitnud	
37.	Sõitnud mootorrattaga	
38.	Nautinud “metsikuid” või ebatavalisi seksuaalfantaasiaid	
39.	Rännanud seljakotiga Euroopas	
40.	Pöidlaküüdiga reisinud	
41.	Teinud pikema reisi mõnesse Aasia riiki	
42.	Käinud peol, kus toimub “raske joomine”	
43.	Käinud läbi inimestega, kellest ei või kunagi teada, mis neile parajasti pähe tuleb ja mida nad ette võtavad	
44.	Käinud suurel rock-kontserdil	
45.	Reisinud Aafrikasse	
46.	Läinud välja kellegagi vaid seepärast, et pead teda füüsiliselt erutavaks	
47.	Teinud midagi ohtlikku, kuna keegi esitas Teile väljakutse julgustüki tegemiseks	
48.	Teinud tavapäratuid asju, kuigi need on veidike hirmutavad	
49.	Keeldunud vanemate või ülemuse poolt antud käsu täitmisest	
50.	Kõrgest hüppetornist vette hüpanud	
51.	Seljakotiga looduses rännanud	
52.	Seksinud rohkem kui ühe inimesega samal päeval	
53.	Sõitnud lumelauaga	
54.	Varastanud midagi, kui võis kindel olla, et ei jää vahele	
55.	Teinud “hullumeelseid” asju, et näha teiste reaktsiooni	
56.	Tarvitanud illegaalseid narkootikume	
57.	Üksinda tsiviliseerimata saarel või laiul nädala vastu pidanud	
58.	Alasti ujunud mõlema soo esindajate seltsis	
59.	Võrgutanud kedagi	
60.	Teinud riskantseid kihlvedusid Teie jaoks suurte summade peale	
61.	Tarvitanud marihuaanat	
62.	Peol „lantinud” endale kaaslase	
63.	Kasiinos kõrgetele panustele mänginud	
64.	Käinud üksinda ööklubis	

II osa – kavatsused tulevikus

Alljärgnevalt leiate erinevate tegevuste loetelu. Palun märkige, kas tahaksite seda teha tulevikus hoolimata sellest, kas olete seda varem teinud. Ärge jätke ühtegi küsimust vahele ja olge siiras.

TULEVIKUS:
A Mul pole mingit tahtmist seda teha
B Ma olen mõelnud sellest, kuid arvatavasti ei tee seda
C Ma olen mõelnud selle tegemisest ja arvatavasti ka teen seda kui võimalik

1.	Ronida kõrgetes mägedes	
2.	Lugeda avameelseid raamatud seksist	
3.	Joosta maratoni	
4.	Käia läbi tõeliste „peoloomadega”	
5.	Teha striptiisi	
6.	Hüpata tundmatus kohas pea ees vette	
7.	Veeta aega inimeste seltsis, kes suhtuvad väga vabameelselt seksi ja kes vahepeal vahetavad partnereid	
8.	Olla lugupidamatu õpetaja või ülemuse suhtes	
9.	Manustada tundmatut narkootikumi	
10.	Šokeerida vanemaid inimesi ainult lõbu pärast	
11.	Teha benji hüpet	
12.	Seksida avalikus kohas	
13.	Langevarjuga hüppeid teha	
14.	Abielueelseid seksuaalsuhteid omada	
15.	Lennukiga lennata	
16.	Teiste seltsis ennast „pilve tõmmata”	
17.	Teha midagi vahvat hoolimata sellest, et see on seadusvastane	
18.	Sukelduda	
19.	Hobuse seljas galoppi ratsutada	
20.	Purjetada pikki vahemaid	
21.	Ujuda üksinda kaldast kaugel	
22.	Seksuaalses vahekorras olla kellegagi, kellega saite just tuttavaks ja keda ei pruugi enam näha	
23.	Ronida mööda kaljuseina	
24.	Suusatada alla kõrgest mäenõlvast	
25.	Autoga sõites kihutada, seades ohtu oma turvalisuse	
26.	Teha midagi väga tavapäratut	
27.	Proovida kokaiini	
28.	Uurida koopaid	
29.	Arutada oma seksuaalelu sõpradega	
30.	Jahile minna	
31.	Vaadata pornograafilist filmi	
32.	Juua end ettekavatsetult purju	
33.	Elada ajutise kokkuleppega vastassoo esindajaga koos	
34.	Proovida LSD-d	
35.	„Teha seda, mis tundub hea”, tagajärgedele vaatamata	
36.	Autoga võidu sõita	

37.	Sõita mootorrattaga	
38.	Nautida pööraseid või ebatavalisi seksuaalfantaasiaid	
39.	Rännata seljakotiga Euroopas	
40.	Pöidlaküüdiga reisida	
41.	Teha pikema reisi mõnesse Aasia riiki	
42.	Käia peol, kus toimub raske joomine	
43.	Käia läbi inimestega, kellest ei või kunagi teada, mis neil parajasti pähe tuleb ja mida nad ette võtavad	
44.	Käia suurel rokk-kontserdil	
45.	Reisida Aafrikasse	
46.	Minna välja kellegagi vaid seepärast, et peate neid füüsiliselt erutavaks	
47.	Teha midagi ohtlikku, kuna keegi esitas Teile väljakutse julgustüki tegemiseks	
48.	Teha tavapäratuid asju, kuigi nad on veidike hirmutavad	
49.	Keelduda vanemate või ülemuse poolt antud käsu täitmisest	
50.	Kõrgest hüppetornist vette hüpata	
51.	Seljakotiga looduses rännata	
52.	Seksida rohkem kui ühe inimesega samal päeval	
53.	Sõita lumelauaga	
54.	Varastada midagi, kui võib kindel olla, et ei jää vahele	
55.	Teha “hullumeelseid” asju, et näha teiste reaktsiooni	
56.	Tarvitada illegaalseid narkootikume (peale marihuaana)	
57.	Üksinda tsiviliseerimata saarel või laiul nädala vastu pidada	
58.	Alasti ujuda mõlema soo esindajate seltsis	
59.	Võrgutada kedagi	
60.	Teha riskantseid kihlvedusid Teie jaoks suurte summade peale	
61.	Tarvitada marihuaanat	
62.	Peol „lantida” endale kaaslast	
63.	Kasiinos kõrgetele panustele mängida	
64.	Käia üksi ööklubis	