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IMPULSIVITY AND TIME PERCEPTION AS PREDICTORS OF PATHOLOGICAL GAMBLING

Master´s Thesis

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Running Head: Impulsivity, Time and Gambling

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Contents

Abstract

Current study examined multivariate relationships between impulsivity, time perception, gambling behavior and co-variates as age, gender, education and nationality. Impulsivity, time perception and risk for pathological gambling (PG) was assessed in 3500 participants aged between 15 and 74 years (1506 men and 2024 woman, 2455 Estonians and 1075 non-Estonian residents of Estonia) with different educational and socio-economical background. Participants completed the South Oaks Gambling Screen (SOGS) and the modified Impulsive Behavior Scale (mUPPS). Time Production Task (TPT) was presented to all participants. As the result, impulsive subjects tend to perceive time intervals as shorter and they under produce time intervals more than self-controlled subjects. Impulsivity was associated with PG to the extent that this association can be interpreted as causal but it is not mediated by time perception as was hypothesized.

Keywords: impulsivity, time perception, problem and pathological gambling, SEM

IMPULSIIVSUS JA AJATAJU PATOLOOGILISE HASARTMÄNGIMISE ENNUSTAJATENA

Kokkuvõte

Käesolev uurimistöö keskendus impulsiivsuse, ajataju ja hasartmängimise vaheliste seoste uurimisele ning soo, vanuse, rahvuse ja hariduse mõju hindamisele nendes seostes. Kokku osales uuringus 3500 Eesti elanikku vanuses 15 – 74 aastat. Valim oli esinduslik Eesti elanikkonna suhtes hõlmates erineva sotsiaal-majandusliku tausta ning haridustasemega inimesi. Valimi moodustasid 1506 meest ja 2024 naist, kellest 2455 olid eestlased ning 1075 mitte-eestlased. Uuringus osalejad vastasid personaalintervjuude käigus hasartmängimisega seotud käitumist hindavale sõeltestile (*South Oaks Gambling Screen*, SOGS) ja modifitseeritud impulsiivse käitumise küsimustikule (mUPPS). Lisaks viidi kõigi uuringus osalejatega läbi ajataju hindamise eksperiment. Uuringu tulemustest selgus, et impulsiivsemad inimesed kalduvad aja produtseerimise ülesandes produtseerima etteantud ajast lühemaid ajaintervalle, mis viitab subjektiivse aja kiiremale kulgemisele. Samuti leidis kinnitust, et probleemse ja patoloogilise hasartmängimise riski ennustab kõrgem impulsiivsuse tase. Hüpotees, et impulsiivsuse mõju mängurluse väljakujunemises on vahendatud ajataju poolt, ei leidnud kinnitust.

Introduction

Impulsivity plays an important role in understanding and diagnosis of healthy/adaptive as well as disturbed/non-adaptive personality and various forms of psychopathology (Moeller, Barratt, Dougherty, Schmitz, & Swann, 2001). One of the mechanism by which high impulsivity may relate to other traits and forms of psychopathology is altered time perception. Research has shown equivocal associations between impulsivity and time perception. Likewise, time perception has been shown to have inconsistent associations with different cognitive and affective factors and psychopathology, especially in clinical samples. The main objective of this study was to attain clearer understanding on how impulsivity and time perception might be related to one another and to one form of psychopathology: pathological gambling. There appear robust associations between impulsivity and pathological gambling. Here we tested the hypothesis that the impulsivity-gambling association might be mediated by individual differences in time perception.

Impulsivity

A plethora of conceptualizations of impulsivity exist, varying in the research paradigm of origin (e.g. theories and models of personality and temperament, the information processing perspective, the neuropsychological, physiological and also psychopathological perspective of impulsivity) and research methods that have been used to uncover the essence of that construct (e.g. self-report measures, laboratory behavioral measures). As a result there is a lack of common understanding on how to define and measure impulsivity: there appear inconsistencies in labeling the differences and similarities in construct content by different researchers within and/or across different theories (Block, 1995; Whitside & Lynam, 2001). The notion that the umbrella term of impulsivity has complicated the research (Whiteside & Lynam, 2001) and that the construct of impulsivity thus needs to be revised and clarified has been confirmed by many researchers. Impulsivity appears to be multidimensional, multi-faceted and/or –factorial construct (Dickman, 1990; McDonald, Schleifer, Richards, & de Wit, 2003; Patton, Stanford, & Barratt, 1995; Stanford et al., 2009) having different underlying cognitive, physiological and neurobiological correlates (Dickman, 1990; Dickman, 2000; Evenden, 1999; Garavan, Ross, Murphy, Roche, & Stein, 2002; Humphreys & Revelle, 1984; McDonald, Schleifer, Richards, & de Wit, 2003;

Newman & Wallace, 1993; Wittmann & Paulus, 2008). But the problem is even more complex. It has been demonstrated that self-report and behavioral measures of impulsivity are not directly related, and even among the behavioral measures different tasks measure slightly different and unrelated aspects of impulsivity (Dougherty, Mathias, Marsh, & Jagar, 2005; Gorlyn, Keilp, Tryon, & Mann, 2005; Havik et al., 2012; Reynolds, Ortengren, Richards, & de Wit, 2006).

Whitside and Lynam (2001) have made an effort to clarify the multi-faceted construct of trait impulsivity by analyzing a variety of commonly used self-reported impulsivity measures within the framework of the Five Factor Model of Personality (FFM; McCrae & Costa, 1990) as embodied in the NEO-PI-R personality questionnaire (Costa & McCrae, 1992). They identified four distinct personality facets that lead to impulsive-like behaviors stating that these four facets should not be considered variations of impulsivity but "rather discrete psychological processes that lead to impulsive-like behaviors" (p.685) as each of the four components is related to distinct aspect of personality as described by FFM. Urgency (U) was found to be associated with the impulsiveness facet, (lack of) premeditation (P) with deliberation, (lack of) perseverance (P) with the self-discipline and sensation seeking (S) with the excitement seeking facet of the NEO-PI-R. As a result, the UPPS Impulsive Behavior Scale was created.

Impulsivity and gambling

Impulsivity serves as a predominant etiologic characteristic of different conceptual models of gambling that are based on impulse control (American Psychiatric Association, 2000), addiction (Blume, 1987; Jacobs, 1986; Leeman & Potenza, 2012) and obsessive-compulsive spectrum disorders (Skitch & Hodgins, 2004). From such a clinical point of view, impulsivity plays important role in understanding and diagnosis of pathological gambling (PG).

Pathological gamblers have impaired control over their urge to gamble, they engage in repetitive uncontrolled gambling that leads to serious destructive consequences in their life. Currently, thus, pathological gambling is formally categorized as an impulse control disorder by American Psychiatric Association (2000), a progressive and chronic disorder that encompasses an unrelenting failure to resist impulses to gamble and where this ''maladaptive behavior disrupts, or damages personal, family, or vocational pursuits''.

Even though PG is classified as a disorder of impulse control, the evidence is mixed regarding whether pathological gamblers are more impulsive than controls (Petry, 2001) and there are controversial findings as to how trait impulsivity is related to PG. This might be related to the conceptual mess that is impulsivity as well as to high co-morbidity rate of different psychiatric disorders among PGs demonstrated by several researchers (Hodgins, Peden, & Cassidy, 2005; Kaare, Mõttus, & Konstabel, 2009; Petry, Stinson, & Grant, 2005). In their comprehensive review, Raylu and Oei (2002) pointed to several studies that have demonstrated impulsivity being a major characteristic in PG. Indeed, abundant data confirm heightened impulsiveness being related to severe disturbances in pathological gamblers (Alessi & Petry, 2003; MacCallum, Blaszczynski, Ladouceur, & Nower, 2007; Steel & Blaszczynski, 1998; Vitaro, Arsenault, & Tremblay, 1997). Two Estonian gambling studies found that heightened impulsiveness was associated with the degree of severe disturbances in pathological gamblers (Kaare, Mõttus, & Konstabel, 2009; Laansoo, 2005). Likewise Steel and Blaszczynski (1998) demonstrated on gamblers in treatment that impulsivity is related to the severity of gambling behavior. Rodriguez-Jimenez et al. (2006) have demonstrated how co-morbidity of two impulsivity prone psychiatric disorders, pathological gambling and attention deficit/hyperactivity disorder (ADHD), may contribute to impulsivity depending on disorder specific impairments. They found that PGs with a history of childhood ADHD have lower capacity to delay gratification and less inhibitory control than PGs without such childhood history.

However, Langewisch and Frisch (1998) investigated the relationship between sensation seeking, impulsivity, risky behaviors and gambling and found that pathological gamblers' sensation seeking and impulsivity scores did not correlate with their degree of gambling pathology. Somewhat consistently, Bagby et al. (2007) reported that, relative to the population norms, pathological and non-pathological gamblers had equally high scores on excitement-seeking, a personality trait akin to sensation-seeking. This suggested that excitement-seeking characterizes gambling behavior generally rather than pathological gambling in particular. Based on a very small sample, Allcock and Grace (1988) reported that pathological gamblers were neither sensation-seekers nor impulsive. On a sample of Estonian gamblers in treatment, it was found that PGs tended to score higher on excitement-seeking than controls but the effect was not significant (Kaare, Mõttus, & Konstabel, 2009).

Impulsive behavior and time perception

One of the potential components to be considered as underlying mechanism for impulsive behavior could be time perception; more precisely, cognitive tempo as the subjective experience of time (Havik et al., 2012; Wittmann & Paulus, 2008). According to Burns and Lennings (1998), the notion that impulsivity is somehow associated with time estimation goes back to Siegman´s (1961) studies with young offenders. Since then ambiguous results have been reported and the evidence for impulsivity being associated with how people perceive time is not unanimous.

For instance, Gerbing, Ahadi, and Patton (1987) found moderate to low correlations between various self-reported impulsivity scales and time estimation measures. Burns and Lennings (1998) did not find consistent effects between time estimation and impulsivity measures in young and healthy college students. In contrast, Barratt (1983) found that high-impulsive subjects under produced time, i.e., produced shorter time intervals in time-production tasks, thus suggesting that they have faster cognitive tempo than low-impulsive subjects. Likewise several findings from clinical populations demonstrate that impulsive subjects tend to overestimate and/or under produce time intervals suggesting their subjective experience of time is accelerated compared to subjects with lower levels of both self-reported and behaviorally tested impulsivity (Berlin & Rolls, 2004; Berlin, Rolls, & Kischka, 2004; Dougherty et al., 2003; Reynolds & Schiffbauer, 2004; Wittmann, Leland, Churan, & Paulus, 2007). Most recently, similar findings with healthy (not evaluated for having psychological and/or psychiatric disorders) participants have been reported by Correa, Triviño, Pérez-Dueñas, Acosta, and Lupiàñez (2010) and Havik et al. (2012).

Wittmann and Paulus (2008) have proposed a theoretical model stating that impulsive individuals perceive time differently than self-controlled individuals because of an increased rate of accumulated pulses coming from their 'internal clocks' (see Fig.2, Wittmann & Paulus, 2008), which results in overestimation and/or under production of interval duration. The cognitive model proposed by these authors is linked to the attentional-gate model by Zakay and Block (1997) but differs in stating that ´mood states´ can influence the subjective experience of interval duration in two ways. First, arousal can increase the rate of pulses emitted by a hypothetical pacemaker. Second, increased attention to time is supposed to open the gate to a central counting mechanism which leads to accumulation of more pulses.

Above-mentioned ´mood states´ as referred to by Wittmann and Paulus (2008), affective and cognitive factors altering time perception are assumed to be dependent on altered internal and/or external stimuli. For instance altered physiological conditions (e.g. sleep deprivation, increase in body temperature, administration of stimulants), clinical state (e.g. acute stress, personality and/or psychiatric disorder) and/or environmental changes (e.g. emotional faces as an external stimulus evoking emotions) can lead to increased arousal resulting in impulsive like behavior (see p.10, Wittmann & Paulus, 2008 for prevalently clinical data). These authors also suggest that attention-related and activation-induced mechanisms proposed to alter the sense of time according to their cognitive model of time perception and impulsivity are not necessarily mutually exclusive but could contribute to the phenomenon of altered time perception in additive ways. Wittmann and Paulus (2008) also speculate that the documented failures to find relations between impulsivity and time estimation might have originated from the relatively normal variation of impulsivity in healthy subjects that "might not be strong enough to alter the subjective experience of time" (p.11, Wittmann & Paulus, 2008). Experimental results referred by Wittmann and Paulus (2008) with children and adults with ADHD give good reason to hypothesize that disorder-specific features as distractibility and other impaired attention related processes for ADHD make the contribution and might be the reason behind equivocal results describing the relationship between impulsiveness and time estimation (see p.10-11, Wittmann & Paulus, 2008).

Time perception and gambling

Given the implication of timing for impulsivity and the possible contribution of the latter to gambling, it is reasonable to ask how differences in timing performance relate to gambling risk. However, this question has not been systematically addressed before. Evidence in gambling research suggests a range of contextual and individual differences as risk factors for gambling behavior but the relationship between gambling behavior and time perception in association with impulsivity as viewed by Wittmann and Paulus (2008) has been ulterior for gambling research. Gambling behavior has only been considered in relation to the time perspective construct, an individual´s orientation toward the past, present and future, by some researchers (MacKillop, Anderson, Castelda, Mattson, & Donovick, 2006; Petry, 2001).

The current study: impulsivity, time perception and gambling

With this study we attempt to shed some light on association between an altered sense of time, impulsivity and PG. First it is hypothesized that impulsive subjects tend to perceive time intervals as shorter compared to self-controlled subjects, i.e. their averaged perceived interval duration is lower than that of more self-controlled subjects. Secondly, given the above-described literature, we hypothesize that the role of impulsivity in the etiology of pathological gambling is mediated by altered time perception (see Fig.1). We will also test the effect and differentiate impact of co-variates as age, gender, education and nationality on gambling behavior, time perception and impulsivity.

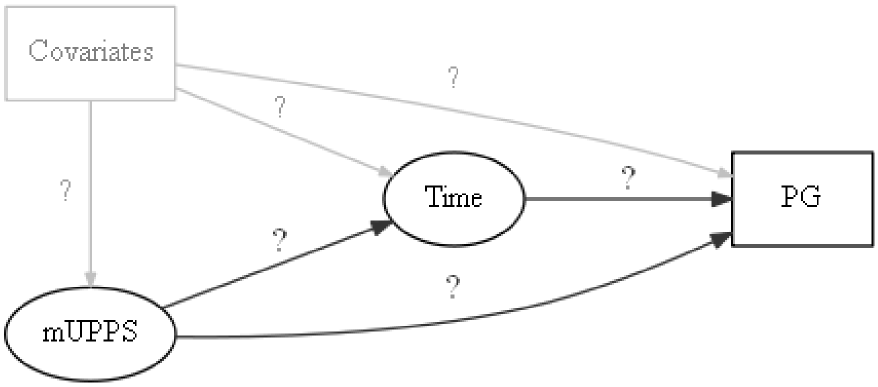

Figure 1 Working hypothesis about the mediated impact of impulsivity in etiology of pathological gambling.

Method

Design and participants

The data were collected in the course of prevalence study of problem gambling "Contacts of the Estonian residents with gambling" in 2010 (Emor, 2010). The survey sample, representative to population, consisted in total 3530 residents of Estonia, in age range 15-74 years (*M* = 45.4, *SD* = 17.04), men (46.8%) and woman (53.2%), Estonians (67.9%) and non-Estonian residents of Estonia (32.1%) with different educational and socio-economical background. The subjects with a TPT *(Time Production Task)* result outside of the +/- 3 standard deviations (from the mean) range were excluded based on the assumption that the subject did not understand the task or was not motivated to follow instructions. Descriptive information regarding the relevant measures is in Table 2.

The interviews were held by 78 trained interviewers in face to face manner using CAPI method (Computer Assisted Personal Interviewing). The questions were displayed on a laptop screen and the answers were typed directly to the computer by the interviewee. Participants completed the South Oaks Gambling Screen (SOGS) and the modified Impulsive Behavior Scale (mUPPS). In addition a time-production experiment was presented to all participants.

The fact of including psychological construct measures to prevalence study made some restraints to the choice of estimation tools and amount of tasks we could use in order to fit in the available budget.

Measures

Self-reported impulsivity measures

The modified UPPS Impulsive Behavior Scale (mUPPS) was constructed to assess trait impulsivity with eight comprehensive single items. Short measures have been considered especially useful in large scale surveys and in studies with primary interest other than personality as is the current study (see Konstabel, Lönnqvist, Walkowitz, Konstabel, & Verkasalo, 2012 for more theoretical assumptions in using and development of short scales).

In constructing the mUPPS two measures, the UPPS Impulsive Behavior Scale (UPPS; urgency, (lack of) premeditation, (lack of) perseverance and sensation seeking) created by Whiteside and Lynam (2001) and Short Five (S5) questionnaire constructed by Konstabel, Lönnqvist, Walkowitz, Konstabel, & Verkasalo (2012) were used. The original UPPS was used with one modification: UPPS (lack of) perseverance self-discipline (C5) items in S5 were replaced with S5 Dutifulness (C3) items. Then each facet was represented by two items from the Short Five (S5) questionnaire. More specifically, item pairs corresponding to the N5, C6, C3, and E5 facets of the Five Factor Model (FFM) of personality were selected (see Table 1 for clarification in acronym usage).

The UPPS (lack of) perseverance C5 items were replaced with C3 items as C3 has been demonstrated by Kaare, Mõttus, and Konstabel (2009) to be more sensitive in distinguishing PG-s from non PG-s than C5 (Table 1). Using items with higher predictive validity is in line with the rationale of Whiteside and Lynam (2001) stating that different facets of UPPS may have different criterion validity for different psychological disorders and that disorder-specific item selection might be an issue to consider for research in different target groups (p.685-687, Whiteside & Lynam, 2001). Also, the (lack of) perseverance factor comprises NEO-PI-R five facets of conscientiousness (including C5 and C3) suggesting that these facets describe almost the same aspects of impulsive behavior. Deliberation (C6) loads to separate factor and is conceptualized in mUPPS likewise in UPPS as (lack of) premeditation (P) facet (see Table 3, Whiteside & Lynam, 2001, p. 679).

The scale used to measure these four facets of impulsivity was conceptualized as continuous ranging from 1 to 7, “totally disagree” to “totally agree” respectively. As each facet was estimated by two items, one keyed positively and the other negatively (described in Table 1), the item values were summed after negatively keyed item values were reversed such that participants´ impulsivity scores could range from 2 to 14 with higher values indicating higher impulsivity.

Table 1 Item correction and content for mUPPS

UPPS Impulsive Behavior Scale	Associated NEO-PI-R personality facet	Cohen d [1]	Positively keyed item in S5[2] subscale	Negatively keyed item in S5 subscale
Urgency (U)	Impulsiveness (N5)	2.08[c]	It is very difficult for me to resist temptation and to keep my desires and feelings in check; I do things that I regret later	It is easy for me to resist temptation; I can always control my feelings and desires
(Lack of) premeditation (P)	Deliberation (C6)	-0.91[c]	I consider things carefully before acting or deciding; I take the possible consequences of my actions into account	I often rush into action without considering the consequences of my actions and decisions
(Lack of) perseverance (P)	Self-Discipline (C5)	-0.29	When I have started something, I finish it despite fatigue or other distractions. I always finish my tasks on time	I often postpone difficult or unpleasant activities and leave things unfinished. It is difficult for me to pull myself together and do the things that I have to
	Dutifulness (C3)	-1.12[c]	I am a reliable person, who values ethical principles; I keep my promises and work carefully and thoroughly	I sometimes break my promises. I do not take my responsibilities and ethical principles seriously
Sensation seeking (S)	Excitement-seeking (E5)	0.28	I crave new experiences and excitement. I like to test myself in unknown situations	I am not looking for excitement or adventures. I do not like to take risks

NOTE: [1] effect size of differences between tests scores of pathological gamblers and controls (Kaare, Mõttus, & Konstabel, 2009); [2] comprehensive single item from Short Five (S5) Personality Measure (Konstabel et al., 2012); [a] $p < 0.05$, [b] $p < 0.01$, [c] $p < 0.001$

Time perception measures

There are four different methods for measuring accuracy of time perception (Wittmann & Paulus, 2008; Zakay & Block, 1997): (1) duration may be estimated verbally, (2) by reproduction, (3) by production or (4) by comparison. An estimate may be made either prospectively or retrospectively (i.e., participants are informed about the estimation task before the target duration or participants are asked to estimate duration after the target duration respectively). Above-mentioned methods basically fall into two categories (Dougherty, Mathias, Marsh, & Jagar, 2005): time estimation or time production methods. These different ways of estimating duration involve somewhat different cognitive processes and therefore impact interpretation of the results. Zakay and Block (1997) argue that “prospective judgments depend both on arousal level and on the amount of attention allocated to time” (p.14, 15) whereas under retrospective conditions “participants primarily construct a duration judgment from information stored in memory representing the number of contextual changes that occurred during an interval” (p.13). Task demands determine the amount of attention divided between “temporal and non temporal information processors” and “if less non temporal (stimulus) information processing is required, the person allocates more attention to temporal information and vice versa” (p.13).

It can be argued that the attentional demands of a concurrent task can be possible confounders and these can be taken under control by an empty-time condition (i.e., no concurrent task is performed) whereas the allocation of more or less attention to time-estimation can be controlled by the same kind of task instruction for all subjects. Thus we have good reasons to hypothesize that, under prospective and empty-time conditions, main differences in cognitive tempo derive from cognitive and affective processes connected to differences in arousal level. But the question of potential contextual influences and memory processes involved in decision making process in interpretation of reported relations remains open.

As for current study, time perception was evaluated using prospective empty-time computerized Time Production Task (TPT) similar to that used in previous research to measure cognitive tempo (Barratt, Patton, Nils, & Zuker, 1981; Barratt, 1983; Gorlyn, Keilp, Tryon, & Mann, 2005). The participants were asked to indicate when they thought a certain time interval (respectively 2, 3 and 4 seconds) had elapsed by holding down the computer space key. Subjects were prospectively instructed as follows:

"*Now we are going to do something different. I will estimate how you experience the flow of time – do you perceive time as going quicker or slower comparing to actual time duration.*"

Four rehearsal trials with immediate feedback about how much time had elapsed while holding the key preceded the experimental trials. Six experimental trials were administered in total, so that each of three time intervals (2, 3 and 4s) was repeated two times in random order. For each time interval, the time produced was compared with the actual time interval participant was asked to produce and performance was measured as the deviation of participants' estimates from the actual length of the intervals.

Gambling prevalence and diagnostic measures

Prior to the gambling prevalence survey at 2010 there had been two gambling prevalence surveys among the Estonian population between ages 15 and 74 in 2004 and 2006 (Faktum Uuringukeskus, 2004; Turu-uuringud, 2006). In all three surveys, Estonian version of the South Oaks Gambling Screen (SOGS; Laansoo 2005; Lesieur & Blume, 1987, 1993) was used as the screening instrument for assessing the risk for pathological gambling. The16-item SOGS asks participants to report the frequency of various symptoms related to gambling behavior.

The SOGS was originally developed by Lesieur and Blume (1987) based on DSM-III and DSM-III-R (American Psychiatric Association, 1987) diagnostic criteria. It has become internationally most widely used self-report screening instrument to detect pathological gambling (Battersby, Thomas, Tolchard, & Esterman, 2002). The SOGS has been found to have satisfactory reliability with Cronbach alphas of 0.69 and 0.86 in the general population and gambling treatment samples, respectively (Stinchfield, 2002). It demonstrated well to excellent classification accuracy in the gambling treatment sample, but had poorer accuracy in the general population sample with a 50% false positive rate thus overestimating the number of pathological gamblers in the general population, as compared to DSM-IV diagnostic criteria (Stinchfield, 2002), the notion that has been mostly exploited in criticizing the use of SOGS for prevalence studies (Battersby, Thomas, Tolchard, & Esterman, 2002; Young & Stevens, 2008). However, the SOGS is a lifetime-based measure and was originally designed to detect or uncover also individuals in remission (Lesieur & Blume 1987, 1993) or “potential” cases in need for further clinical assessment (Battersby, Thomas, Tolchard, & Esterman, 2002). According to Battersby, Thomas, Tolchard, and Esterman (2002) this notion has been ignored in the reporting of prevalence studies where there is no clinical assessment, yet claims are made as to the prevalence rate of ´pathological gamblers´ in the population studied (p. 267). Thus in order to be clear in this distinction, in Estonian latest prevalence study at 2010 the scores were identified and described in the context of probable remission (i.e., in the context of risk for pathological gambling) as also suggested by Stinchfield (2002).

There are controversial findings in relation to criterion thresholds, or cutoff points, used to differentiate the severity of problems related to gambling. The original SOGS uses a cutoff point of 5 or more to identify “probable pathological” gamblers (Lesieur & Blume, 1987). Some researchers argue that problem gamblers have lower scores and have used a score of 3 or 4 in order to distinguish and classify individuals as „problem gamblers“ (Ladouceur, 1991; Lesieur et al., 1991; Volberg & Steadman, 1988). Battersby, Thomas, Tolchard, and Esterman (2002) suggest that „important differences in etiology, treatment response, motivation to seek treatment and cost benefit of community screening may exist between groups scoring 1 to 4, 5 to 9 and above (p.265). Stinchfield (2002) posits that even though scores in range 5 to 6 have about a 50/50 chance of having the disorder, a score of 5 remains „the best cut score in terms of maximizing the hit rate and balancing false positive and false negative errors” both for clinical and non-clinical sample (Figure 1, p.12 in Stinchfield, 2002). Some recent studies have distinguished between non-problematic gamblers (scoring ≥ 2), problem gamblers (scoring in range from 3 to 4) and probable pathological gamblers (scoring ≥ 5) (Strong, Lesieur, Breen, Stinchfield, & Lejuez, 2004). In the Estonian prevalence study in 2010, lifetime gambling behavior was assessed and those who scored 0 to 1 on the SOGS were not considered gamblers. Those who scored 2 to 4 were considered gamblers with some problems, thus (currently) at low risk for pathological gambling or according to Battersby, Thomas, Tolchard, and Esterman (2002) as possible pathological gamblers. The score of 5 or more was used as a cutoff point for probable pathological gambling (Battersby, Thomas, Tolchard, & Esterman, 2002; Lesieur & Blume 1987, 1993). However, a further distinction was also made: scores 5-8 were considered as gamblers with a number of characteristics for pathological gambling or with significant risk for pathological gambling whereas those scoring 9 or more were considered as „probable pathological gamblers“ or gamblers at high risk for pathological gambling. Thus in the 2010 survey the cutoff points remained the same as in two previous prevalence studies in order to gather valid and comparable data.

The cutoff points for current study were conceptualized and defined as follows: those who scored from 0 to 1 (i.e., cutoff < 2) on the SOGS were considered non-gamblers (NoPG). Those scoring in range 2 to 4 were considered gamblers with some problems (ProblG), thus (currently) at low risk for pathological gambling and those with cutoff scores ≥ 5 were considered as gamblers with significant risk for pathological gambling (PG).

Covariates

Gender and age differences in impulsivity and PG have been explored and reported by several researchers (González-Ortega, Echeburúa, Corral, Polo-López, & Alberich, 2013; Martins, Tavares, Sabbatini da Silva Lobo, Galetti, & Gentil, 2004). Therefore, gender (1 – men, 2 – women) was used as a co-variate in the present study. Additionally, nationality (1 – Estonians, 2 – Non-Estonians) was used as a categorical co-variate, as was education (1 - below high school, 2 – high school, 3 – vocational school, 4 - university).

Analytical procedures

First, participants with TPT *(Time Production Task)* values outside the range of +/- 3 standard deviations from the mean were excluded. Then the descriptive statistics of the variables are reported in Table 2. Bivariate relationships between the variables are given in Table 3.

To describe the roles of the selected co-variates, key measures were regressed on covariates using linear (for mUPPS and Time) and multinomial logistic (for PG) regressions. The covariate effects are presented in Table 4 and Table 5 and discussed further. In order to test the first hypothesis about the tendency of impulsive subjects to perceive time intervals as shorter compared to self-controlled subjects Time was regressed on mUPPS while controlling for co-variates (Table 6).

Next, structural equation modeling (SEM) was used to test all hypothesized associations (Figure 1) simultaneously. Two latent variables were defined: mUPPS was defined by urgency (U), (lack of) premeditation (P), dutifulness (P), sensation seeking (S) and Time was defined by six experimental TPT tasks in three sets (Time2, Time3, Time4) respectively. In the model, Time was predicted from mUPPS. PG, defined as ordered-categorical variable, was also predicted by mUPPS and Time. Essentially, then, mUPPS was defined as the causal variable predicting PG, whereas Time was seen as a possible mediator in the association. Time, mUPPS and PG were regressed on all covariates. The model was fitted using the 'lavaan' (Rosseel, 2012) package of R (R Core Team, 2013); diagonally weighted least squares estimator was used (DWLS). This initial model was then trimmed by omitting non-significant paths: the non-significant paths were detected using the Wald statistic. Modification indices were used to identify possible sources of model misspecification. The resulting SEM model, showing the unique associations among the variables, is given on Figure 2.

Results

Significant bivariate associations were detected between impulsivity and time perception, impulsivity and PG: higher impulsivity was significantly associated with lower time estimates and higher level, i.e. severity of PG. All observed variables of mUPPS (N5, C6, C3, and E5) were significantly associated with PG: higher scores in these variables were linked to more PG. N5, C6, C3, but not E5 were significantly associated with Time. In addition, higher impulsivity was significantly associated with lower educational level, younger age and significant group differences were estimated for gender and nationality. PG was related to younger age and relatively higher educational level. Importantly, PG was not related to time perception. Significant group difference in time perception was estimated for nationality (Table 3).

Table 2 Descriptive statistics of sample data and used measures

			Gamblers and non-gamblers		
		Total	NoPG[1]	ProblG[2]	PG[3]
N		3530	3267	184	79
Age	Range	15 – 74	15 – 74	15 – 74	16 – 68
	M (SD)	45.44 (17.04)	46.21 (17.04)	35.23 (14.45)	37.68 (12.49)
Gender	Male	1506	1320	123	63
	Female	2024	1947	61	16

Table 2 continued

		Total	Gamblers and non-gamblers: NoPG[1]	ProblG[2]	PG[3]
Nationality	Estonian	2455	2268	136	51
	Non-Estonian	1075	999	48	28
Education	Below high school	639	576	45	18
	High school	920	855	44	21
	Vocational school	1194	1097	70	27
	University	777	739	25	13
mUPPS	N	3530	3267	184	79
	Range	2 – 13.5	2 – 13.5	2.25 – 13.25	4 – 12.5
	M (SD)	5.71 (2.05)	5.58 (1.99)	6.99 (2.01)	8.05 (2.04)
U(N5)	Range	2 – 14	2 – 14	2 – 14	4 – 14
	M (SD)	5.95 (2.70)	5.82 (2.66)	7.16 (2.71)	8.47 (2.49)
P(C6)	Range	2 – 14	2 – 14	2 – 14	2 – 14
	M (SD)	5.29 (2.65)	5.18 (2.59)	6.23 (2.83)	7.84 (3.05)
P(C3)	Range	2 – 14	2 – 14	2 – 13	2 – 13
	M (SD)	4.94 (2.38)	4.83 (2.34)	5.97 (2.43)	7.1 (2.42)
S(E5)	Range	2 – 14	2 – 14	2 – 14	2 – 14
	M (SD)	6.67 (3.34)	6.51 (3.28)	8.63 (3.59)	8.79 (2.85)
Time	N	2941	2696	170	75
	Range	0.02 – 6.97	0.02 – 6.97	0.25 – 5.3	1.33 – 4.61
	M (SD)	2.44 (0.96)	2.41 (0.97)	2.62 (0.79)	2.96 (0.47)
Time2	N	2924	2679	170	75
	Range	0.00 – 4.8	0.00 – 4.79	0.24 – 4.29	0.88 – 3.57
	M (SD)	1.75 (0.73)	1.73 (0.74)	1.90 (0.70)	2.07 (0.41)
Time3	N	2935	2691	169	75
	Range	0.00 – 6.97	0.00 – 6.97	0.29 – 5.67	1.46 – 4.55
	M (SD)	2.46 (1.02)	2.43 (1.03)	2.64 (0.85)	2.97 (0.53)
Time4	N	2918	2673	170	75
	Range	0.06 – 7.51	0.06 – 7.51	0.23 – 6.87	1.64 – 6.05
	M (SD)	3.07 (1.22)	3.04 (1.23)	3.32 (0.99)	3.82 (0.63)

NOTE: *M* = Mean; SD = Standard Deviation; [1]subjects not in risk for PG (i.e, SOGS scores 0 to 1; [2]gamblers with some problems (i.e., SOGS scores 2 to 4); [3]gamblers with high risk for PG (i.e., cutoff ≥ 5 on the SOGS).

Table 3 The bivariate relationships between co-variates and study variables

		Cohen *d*		Correlations between variables											
		Gender	Nationality	Age	Education	1	2	3	4	5	6	7	8	9	10
1	mUPPS	0.39[c]	0.12[c]	-0.39[c]	-0.14[c]	-									
2	N5	0.21[c]	0.18[c]	-0.19[c]	-0.12[c]	0.76[c]	-								
3	C6	0.20[c]	0.01	-0.22[c]	-0.16[c]	0.80[c]	0.56[c]	-							
4	C3	0.44[c]	0.04	-0.22[c]	-0.16[c]	0.74[c]	0.48[c]	0.56[c]	-						
5	E5	0.31[c]	0.17[c]	-0.46[c]	0.00	0.68[c]	0.28[c]	0.32[c]	0.27[c]	-					
6	Time	0.01	0.30[c]	0.03	-0.02	-0.05[c]	-0.05[b]	-0.04[a]	-0.06[c]	-0.02	-				
7	Time2	0.03	0.21[c]	0.07[c]	-0.03	-0.05[b]	-0.03	-0.02	-0.05[b]	-0.05[b]	0.91[c]	-			
8	Time3	0.02	0.32[c]	0.03	-0.02	-0.05[b]	-0.04[a]	-0.03	-0.05[b]	-0.02	0.96[c]	0.84[c]	-		
9	Time4	0.06	0.29[c]	-0.03	0.01	-0.05[b]	-0.05[b]	-0.05[b]	-0.07[c]	0.01	0.96[c]	0.80[c]	0.88[c]	-	
10	PG[1]	-	-	-0.14[c]	-0.05[b]	0.21[c]	0.17[c]	0.14[c]	0.16[c]	0.16[c]	-0.01	-0.03	-0.01	-0.01	-

NOTE: For *M*, *SD* and *N* look in Table 2; [1] Spearman´s correlation coefficient; [a] $p < 0.05$, [b] $p < 0.01$, [c] $p < 0.001$

Table 4 Covariate effects on impulsivity, time perception and gambling behavior

	Standardized Estimate[1] (95% CIs)		Gambling level Odds ratio (95% CIs)		
	mUPPS	Time	No Gambling	Problem Gambling	Pathological Gambling
Gender	-0.28[c] (-0.33; -0.22)	-0.01 (-0.08; 0.06)	1.00 (1.00; 1.00)	0.38 (0.27; 0.52)	0.18 (0.11; 0.32)
Age	-0.02[c] (-0.02; -0.02)	0.00 (0.00; 0.00)	1.00 (1.00; 1.00)	0.96 (0.95; 0.97)	0.97 (0.96; 0.99)
Nationality	-0.06[a] (-0.13; -0.00)	-0.30[c] (-0.38; -0.23)	1.00 (1.00; 1.00)	0.90 (0.64; 1.27)	1.39 (0.86; 2.24)
Education	-0.09[c] (-0.12; -0.06)	-0.01 (-0.05; 0.02)	1.00 (1.00; 1.00)	0.97 (0.83; 1.13)	0.98 (0.78; 1.23)

NOTE: [1]effect sizes are per SD; [a] $p < 0.05$, [b] $p < 0.01$, [c] $p < 0.001$

Table 5 Covariate effects on gambling behavior when adjusted for impulsivity and time perception

	Standardized Estimate[1] (95% CIs)		Gambling level Odds ratio (95% CIs)		
	mUPPS	Time	No Gambling	Problem Gambling	Pathological Gambling
Gender	-0.28[c] (-0.33; -0.22)	-0.02 (-0.09; 0.05)	1.00 (1.00; 1.00)	0.41 (0.29; 0.58)	0.23 (0.12; 0.43)
Age	-0.02[c] (-0.02; -0.02)	0.02 (-0.06; 0.12)	1.00 (1.00; 1.00)	0.27 (0.17; 0.44)	0.79 (0.39; 1.59)
Nationality	-0.06[a] (-0.13; -0.00)	-0.30[c] (-0.37; -0.22)	1.00 (1.00; 1.00)	1.03 (0.70; 1.49)	1.84 (1.06; 3.20)[2]
Education	-0.09[c] (-0.12; -0.06)	-0.02 (-0.05; 0.02)	1.00 (1.00; 1.00)	1.03 (0.87; 1.22)	1.13 (0.86; 1.48)

NOTE: [1]effect sizes are per SD; [2] becomes significant as predictor when adjusted for impulsivity and time perception; [a] $p < 0.05$, [b] $p < 0.01$, [c] $p < 0.001$

Table 6 Regression coefficients for study variables while controlling for covariates

	Standardized Estimate[1] (95% CIs)	Gambling level Odds ratio (95% CIs)		
	Time	No Gambling	Problem Gambling	Pathological Gambling
mUPPS	-0.06[b] (-0.09; -0.02)	1.00 (1.00; 1.00)	1.55 (1.29; 1.85)	3.04 (2.31; 4.01)
Time		1.00 (1.00; 1.00)	0.99 (0.83; 1.19)	0.83 (0.63; 1.09)

NOTE: [1]effect size per SD; [b] $p < 0.01$, [c] $p < 0.001$;

In addition, to describe the roles of the selected co-variates, key measures were regressed on covariates. While simultaneously controlling for all the other variables, higher impulsivity was significantly associated with lower education (i.e., any relatively higher educational level predicts, on average, 0.9 standard deviation lower scores in mUPPS), younger age (i.e., ageing for one standard deviation predicts 0.2 standard deviations lower scores in mUPPS), nationality (i.e., non-Estonians scored lower than Estonians on mUPPS by an average of 0.06 standard deviations) and gender (i.e., woman score lower for impulsivity an average of 0.28 standard deviations than men) (Table 4).

Time perception was significantly associated and time intervals were under produced depending on nationality and the level of impulsivity: non-Estonians tended to under produce time intervals on average 0.30 standard deviations more than Estonians with the same impulsivity score and all the covariates controlled (Table 5). Everything else equal, those scoring higher for impulsivity tend to under produce time intervals on average 0.06 standard deviations more (Table 6). Time perception was not related and cannot be predicted by gender, age and education.

PG severity was significantly associated with gender and age: men have on average 2.63 times higher odds to have gambling related problems and 5.26 times higher odds for PG than women (Table 4). When adjusted for impulsivity and time perception the impact of gender was slightly changed to the benefit of men: 2.44 times higher odds for problem gambling and to 4.33 times higher odds for PG thus indicating that a fraction of the gender-differences in gambling severity was due to gender-differences in impulsivity and time perception. Likewise age was significant predictor for PG: when adjusting for impulsivity and time perception and everything else equal there are 3.7 times higher odds in younger age for problems related gambling behavior comparing to non-gamblers (Table 5). PG is also predicted by impulsivity: one standard deviation higher mUPPS score raises odds for problem gambling by 1.55 times and for gambling pathology by 3.04 times. With respect to nationality, the estimate becomes significant for non-Estonians when controlling for impulsivity and time perception so that non-Estonians have 1.84 times higher odds for pathology comparing to Estonians. PG was not associated with time perception.

After an initial SEM model was fitted on data, all parameters were estimated using Wald statistic and the parameters with $p > 0.05$ were dismissed from equations. Nationality and education were dismissed as predictors of PG. Gender, age and education were dismissed as predictor of Time and nationality no longer predicted mUPPS. Modification indices were also used to detect any sources of model misspecification: based on modification indices the residual variances of N5 and C6 were allowed to co-vary. The resulting SEM model, showing the unique associations among the variables, is given on Figure 2. The model fit indices were as follows: Comparative Fit Index (CFI) = 0.95 and Root Mean Square Error of Approximation (RMSEA) = 0.06 (90% CI: 0.05; 0.07) thus indicating relatively good model fit (Hu & Bentler, 1999). The effect sizes between all variables have minor changes comparing to associations described in Table 5 and Table 6. All the paths shown on the Figure 2 are significant at $p < 0.001$ with one exception: the direct and no significant association between Time and PG that was left on the figure for illustrative purposes since it pertained to the main hypothesis of the study.

As the result, gender, younger age and lower education predict higher impulsivity scores. Gender (i.e., being a man), younger age and higher impulsivity level are predictive of future problems and pathology related to gambling: one standard deviation higher scores in mUPPS raise the risk for problems and pathology related to gambling on average by 0.36 standard deviations. Impulsive subjects tend to perceive time intervals as shorter and they under produce time intervals by 0.08 standard deviations compared to more self-controlled subjects. Impulsivity is associated with PG but this association is not mediated by time perception as was hypothesized.

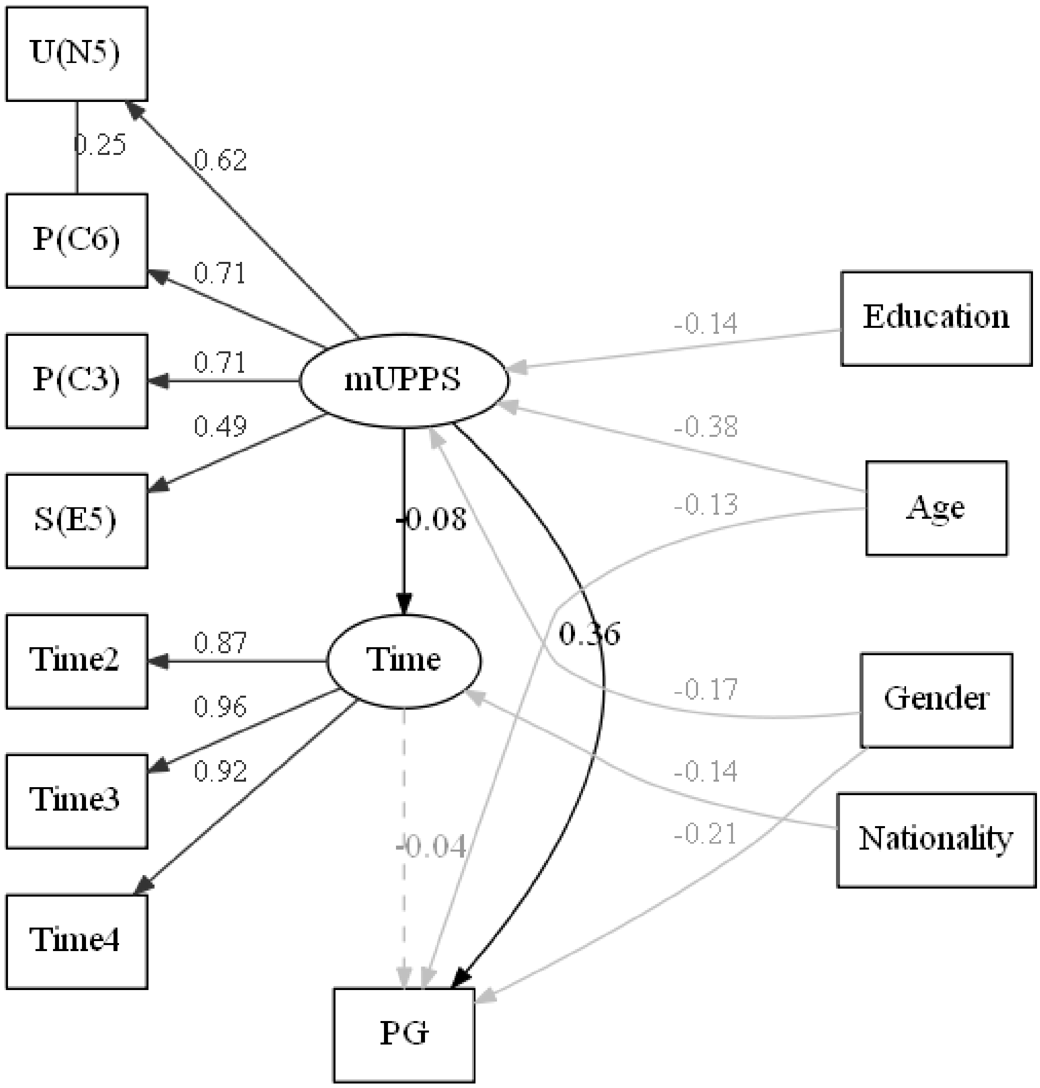

Figure 2 A path model specifying associations between impulsivity, time perception and gambling. Numbers represent standardized path coefficients. All significant paths are shown (p < 0.001) with solid lines.

Discussion

This study showed that time perception was associated with self-reported impulsivity such that time interval under production could be predicted by the level of impulsivity. To the extent that these associations can be interpreted as causal, the possible impact of impulsivity in the etiology of pathological gambling was confirmed but the hypothesized mediator role of time perception in the association was not detected.

An association between impulsivity and time perception has been demonstrated by previous research as referred earlier. Several findings have demonstrated that impulsive subjects tend to overestimate and/or under produce time intervals suggesting their subjective experience of time is accelerated compared to subjects with lower levels of both self-reported and behaviorally tested impulsivity (Dougherty et al., 2003; Havik et al., 2012; Reynolds & Schiffbauer, 2004; Wittmann, Leland, Churan, & Paulus, 2007). Our results confirm significant associations between these two constructs. They also constitute a demonstration of an expected relationship between self-reported and behavioral measures of impulsivity that have been reported missing in several studies. More specifically, the self-reported questionnaire (mUPPS) and time production task (TPT) measured here on a large sample small but significant correlation. It has been demonstrated by Wittmann et al. (2011) that brain activation during the interval reproduction task in motor execution areas (left pre and post central cortexes, right cerebellum) and the ‘core control network’ (i.e., inferior frontal, parietal, medial frontal cortex, anterior insula) correlated with both self-reported impulsivity and with behavioral performance in the duration reproduction task. Thus, neural substrates for trait impulsivity measured by mUPPS in our study and time production associated with impulsivity overlap at least to some degree and it may explain significant associations between higher trait impulsivity and time under productions identified with this study.

The results of this study that PG is not associated with timing performance and thus the impact of impulsivity on PG is not mediated by time perception is somewhat surprising. Given that impulsivity was related to both timing performance as well as gambling risk, it would be reasonable to assume that the subjects in risk for pathological gambling will also demonstrate time under-productions in TPT task. One possible reason we could not detect associations between time perception and risk for PG may be connected to the notion exploited in criticizing the use of SOGS for prevalence studies and PG screening. As described earlier, the SOGS has demonstrated good to excellent classification accuracy in the gambling treatment sample, but poorer accuracy in the general population sample with a 50% false positive rate thus overestimating the number of pathological gamblers in the general population, as compared to DSM-IV diagnostic criteria (Battersby, Thomas, Tolchard, & Esterman, 2002; Stinchfield, 2002; Young & Stevens, 2008). Thus it is possible that because of potentially high rate of false positive results, i.e., because of the low specificity of the measurement tool used, we could not differentiate impairments in time perception as a possible mediator for impulsivity related disorder. However, as the sample used in this study was representative to population, there is a solid base to argue that gambling behavior and PG specific impairments related to impulsivity might be mediated by some other aspect of impulsivity than was assessed with time production task (i.e., cognitive tempo). While several findings from clinical populations demonstrate that impulsive subjects tend to overestimate and/or under produce time intervals as described hereinbefore, but not confirmed with this study, the question of time perception in relation to PG requires further research.

The study demonstrated that there appear simultaneous multivariate associations between study variables and covariate effect sizes vary significantly across gender, age and nationality and affect the results depending on whether PG severity was regressed only on co-variates or additionally adjusted for impulsivity and time perception. This supported the choice for SEM as the analytical method. As for conclusion: gender, younger age and lower education predict higher impulsivity scores. Gender (i.e., being a man), younger age and higher impulsivity level are predictive of future problems and pathology related to gambling. These results are in sum consistent with previous research (González-Ortega, Echeburúa, Corral, Polo-López, & Alberich, 2013; Hermano et al., 2010; Kaare, Mõttus, & Konstabel, 2009). The result that relatively higher educational level was related to lower self-reported impulsivity and *vice versa* is somewhat consistent with what was reported by Kaare, Mõttus, & Konstabel (2009) that the likelihood of being a pathological gambler was best predicted by high immoderation score and low cognitive ability. With respect to nationality being associated with timing such that non-Estonians tended to under produce time intervals more than Estonians with the same impulsivity score is in line with the common stereotype that non-Estonians, especially Russians are more outgoing and expressive and therefore possibly more impulsive than Estonians. As these differences were not subject for systematic research for this study, any substantial inferences could be misleading and arbitrary.

The strength of this study was in large sample representative to population of Estonia thus adding statistical power for the results and conclusions of this study. However, this study was limited in that the available budget did set the limit to the amount of items to use in additional questionnaires and experimental tasks as the psychological construct measures were added to prevalence study. Participants took the tests at their homes thus the context was not controlled by all means. From another point of view it can be also interpreted as adding ecological validity to current study. It should be also noted that in this study we used only relatively short interval prospective estimations and the results should be interpreted accordingly as longer and/or shorter interval (re)productions and retrospective estimates are influenced by different cognitive, affective and contextual factors as it has been argued by Zakay and Block (1997).

The interest of further study might be to explore more specifically how the four facets associated with impulsive-like behavior identified by Whiteside and Lynam (2001) relate to PG and time perception. It has been stated by several researchers that given the possibly multi-faceted structure of impulsivity, understanding the relative contribution of each of its facets is critical for accurately characterizing an individual´s general level of impulsivity as well as for exploring more subtle relationships between impulsivity and different clinical syndromes (Patton, Stanford, & Barratt, 1995; Stanford et al., 2009). In the context of gambling research it has been hypothesized that different facets of impulsivity make different contributions to PG variability. For instance, Bagby et al. (2007) demonstrated that excitement-seeking characterizes gambling behavior generally rather than pathological gambling in particular. In our study we used the modified Impulsive Behavior Scale (mUPPS) with eight comprehensive single items such that two items measured each of the four impulsivity related personality facets proposed by Whitside and Lynam (2001). However, these four facets had fairly similar associations with PG. N5, C6, C3, but not E5 were significantly associated with timing. It might well be that E5 has protective function in etiology of gambling pathology and independent additive effect on time perception. This may also suggest little discriminant validity for the four impulsivity facets, at least in relation to gambling behavior. On the flip side, this demonstrates the robustness of the latent impulsivity trait that presumably defined the common variance of the four facets. Also an alternative model development could be the interest of further research as there may be alternative causal interpretation regarding the relationships between impulsivity, time perception and gambling.

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