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Multidimenzionální analýza impulzivity u respondentů s antisociální poruchou osobnosti a komorbidní ADHD poruchou ve vězeňském prostředí

The Multidimensional Analysis of Impulsivity in Incarcerated Offenders with the Antisocial Personality Disorder and the Attention Deficit Hyperactivity Disorder

Disertační práce

Vedoucí závěrečné práce/Školitel: prof. MUDr. Jan Vevera, Ph.D.

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Table of Contents

The assessment of impulsivity and overview of its measures

Introduction

Impulsivity is a complex phenomenon operationalized and conceptualized in various definitions. As a multidimensional construct that subsumes a number of behavioral features, impulsivity can be perceived in terms of frequent shopping, overindulging, and bingeing or described as the inability to abstain from alcohol. These behaviors can be maladaptive or socially desirable (Evenden, 1999). According to Evenden (1999) determining a universal definition of impulsivity is difficult, since what is useful for psychological studies has no impact on biological studies focusing on impulsivity and vice versa.

Mitchell and Potenza (2014), for example, described three types of impulsivity: self-reported impulsivity (general impulsivity measure or personality trait), response impulsivity or response inhibition (inability to withhold a proponent response; diminished control over action cancellation) and choice impulsivity (inability to delay gratification for a larger payout, also including risky behaviors and sensitivity to risk). Each of these behaviors appears to be associated with multiple brain regions, such as the temporal lobe (Fineberg et al., 2014; Mitchell & Potenza, 2014) and the frontal lobe (Bari & Robbins, 2013; Fineberg et al., 2014). These three facets of impulsivity tend to load independently on factor analyses in both human and animal studies (Broos et al., 2012). Interestingly, the measures of impulsive choice and impulsive action in both rats and healthy humans appear not to be correlated (Broos et al., 2012). This may be due to the fact that the mechanisms of impulsivity are independent constructs, but it may also point to the inconsistencies in the measurement of self-report vs. laboratory behavioral measures of impulsivity.

Impulsivity as a Trait of Personality

Inconsistencies in the results of self-report measures/questionnaires and laboratory measures of impulsive behaviors may be explained by several factors. One explanation is that self-

report tasks measure more general tendencies or traits, whereas behavioral tasks measure functioning or current states (Cyders & Coskunpinar, 2011; Cyders & Coskunpinar, 2012). Another explanation suggests that impulsivity is relatively stable across situations. For example, delay discounting can be considered a personality factor, because of its test-retest reliability and strong cross-commodity correlations (Odum, 2011). However, environmental factors, in addition to the emotional state of the participant (e.g. anxiety, anger, desire) (Barri & Robbins, 2013; Mischel & Shoda, 1995, Lawyer & Jenks, in press) and mood awareness (Wingrove & Bond, 1997; Moeller, Barratt, Dougherty, Schmitz, & Swann, 2001), can also alter discounting processes (Bickel, Yi, Landes, Hill, & Baxter, 2011; Hendrickson & Rasmussen, 2013, 2017; Haushofer & Fehr, 2014; Morrison, Madden, Odum, Friedel, & Twohig, 2014).

Therefore, impulsivity can be considered a personality characteristic that may fluctuate with specific conditions, including emotional states (Wingrove & Bond, 1997; Bari & Robbins, 2013). The use of both self-reported and behavioral measures may assess different markers of impulsivity known as "state impulsivity" (determined by environmental factors) and "trait impulsivity" (stable personality characteristics) (Wingrove & Bond, 1997; Bari & Robbins, 2013). Nevertheless, attempts to classify impulsivity in terms of one explanatory factor have failed, and authors acknowledged the interaction of the independent factors that explain impulsive phenomena. Further studies attempted to determine the underlying latent structures of impulsivity, in order to reveal a pattern, however, neither were successful (Mackillop et al., 2016). A three structure model of impulsivity (impulsive choice, impulsive action, and impulsive personality traits) was identified by Mackillop and colleagues (2016) based on an array of standardized tests and questionnaires, but the relations between the domains were only modest, which provided support for the multidimensionality of impulsivity, and which was in agreement with the previous findings (Evenden, 1999). Since the different factorial

dimensions of impulsivity could be well presented in a comprehensive article, this introduction has highlighted only several of them. In addition, we have decided to include the brief definitions of different aspects of impulsivity derived from Evenden (1999) and summarized in Table 1 to provide a more comprehensive overview.

Measures

Impulsivity in terms of the assessment of personality can be evaluated by the Temperament and Character Inventory (TCI, Cloninger, 1994). It contains 240 items, each item is evaluated on a 5-point Likert type scale, leading to four dimensions of temperament (harm avoidance, novelty seeking, reward dependence, persistence) and three dimensions of character (self-directedness, cooperativeness, self-transcendence). Impulsivity is characterized in terms of Novelty Seeking and Reward Dependence. Relationships between impulsivity and personality traits in this inventory were confirmed by Zuckerman and Cloninger (1996), who found correlations between impulsive sensation seeking and novelty seeking ($r = 0.68$) and harm avoidance and neuroticism scale in the Zuckerman-Kuhlman Personality Questionnaire. Furthermore, Nussbaum and colleagues (2002) examined the differences between three groups of violent offenders, nonviolent offenders, and sexual offenders using the TCI. Higher impulsivity and lower levels of empathy were found in violent offenders in comparison to nonviolent offenders. Likewise, higher levels of impulsivity were seen in violent and non-violent offenders when compared to the sexual offenders with the lowest levels of impulsivity. This instrument is particularly useful, when examining impulsivity as it relates to psychopathology, as evidenced by the relationships between novelty seeking, sensation seeking and antisocial behavior, antisocial personality or substance abuse. At the same time, there was none or very weak association with neurotic and anxious personality disorders (Zuckerman and Cloninger, 1996).

Another example of a personality-based measure that includes impulsivity as a trait of personality is the Eysenck Personality Inventory (EPI, Eysenck & Eysenck, 1978). It includes 63 items and measures three personality traits of impulsiveness, venturesomeness and empathy. The EPI defines impulsiveness in terms of risk preferences and contains two subscales related to the assessment of risk and risky situations (Impulsiveness and Venturesomeness), although the relation between these variables is not strong. Shortly after the publication of EPI and the Eysenck Personality Questionnaire (EPQ), there was a concern if these scales were in fact the same as originally intended and whether they built upon each other. Rocklin and Revelle (1981) showed that EPI was in fact not unidimensional in comparison to EPQ, which was deemed unidimensional. Based on the author´s further analyses the original impulsivity scale of EPI was replaced by sociability (Rocklin and Revelle, 1981). Therefore, researchers assessing personality traits related impulsivity in terms of normal rather than pathological personality and with reference to extraversion should use the EPI for their studies.

As for the specific self-report questionnaires assessing impulsive choice or impulsive action, the Barratt Impulsiveness Scale (BIS-11, Patton et al., 1995) is one of the most frequently cited measure of impulsivity (Stanford et al., 2009). The structure of impulsivity in the BIS-11, captured in 30 items, is divided into first order factors: attention, cognitive instability, motor impulsivity, perseverance, self-control, and cognitive complexity. The original structure of motor and attentional impulsiveness showed low internal consistency in forensic psychiatric patients, suggesting that the second-order factor structure (including attentional, motor and nonplanning factors) may not be the best measure of impulsiveness for this sample (Haden & Shiva, 2008). Therefore, other alternative factor models of impulsivity were proposed by different authors (Haden & Shiva, 2008; Ruiz, Skeem, Poythress, Douglas & Lilienfeld, 2010) with regard to the structure of the BIS-11 for certain populations, such as the

forensic population. As for the psychometric properties of this instrument, the results showed no gender differences for the second order subscales. The only gender difference in the first order subscales was found in perseverance, where men scored significantly higher. In terms of the internal consistency measured by Cronbach's α all subscales of both orders were above 0.7 with the exception of motor impulsivity from the second order and cognitive complexity, perseverance and cognitive instability from the first order subscales. The test-retest reliability showed varying strengths, however, all correlations were statistically significant at the level $p \leq 0.01$ (Stanford et al., 2009). BIS-11 is a suitable measure for research targeting personality or behavioral aspects of impulsivity, Stanford and colleagues (2009) also suggest its diverse use in clinical settings, focusing on substance use problems and former Axis I disorders.

Further self-report measures that examine impulsive choice or action include the UPPS-P Impulsive Behavior Scale (Whiteside & Lynam, 2001) and the Delay of Gratification Inventory (DGI, Hoerger, Quirk, & Weed, 2011). The UPPS-P was developed from the Five-Factor Model of personality introduced by McCrae and Costa in 1990. Whiteside and Lynam (2001) hypothesized four distinct traits leading to impulsive behavior. These traits were conceptualized as impulsiveness, excitement seeking, self-discipline and deliberation. After the factor analysis of 9 impulsivity measures on 437 students, four personality facets (Urgency, Lack of Perseverance, Lack of Premeditation and Sensation Seeking) related to overt impulsive behavior were identified. In a later study, the urgency trait has been divided into positive and negative aspect (Lynam, Smith & Whiteside, 2006). Thus, current UPPS-P examines five different aspects of impulsivity using 59 items with a 4-point Likert type scale. The factors on this measure include: negative urgency (negative emotions associated with impulsivity, such as depression, stress or boredom); positive urgency (positive emotions associated with impulsivity, such as happiness or excitement) (Lynam, Smith & Whiteside, 2006; Savvidou et al., 2017); sensation seeking (aspects of seeking sensations and excitement

associated with impulsivity); lack of perseverance (the patience or the ability to finish tasks and avoid boredom), and lack of premeditation (the typical conceptualization of impulsivity) (Whiteside & Lynam, 2001). This measure was shown to be useful in clinical settings for disorders containing impulsivity, such as eating disorders, substance use disorders or non-suicidal self-injury (Savvidou et al., 2017), and for risk-taking individuals. This measure was further shown to be consistent, while no differences were found between genders (Cyders, 2011). Based on Savvidou and colleagues (2017) UPPS-P has been supported as one of the most valid measure of impulsivity and more appropriate measure, when assessing patients with former Axis I disorders in comparison to for example BIS-11.

A self-report measure leading toward the behavioral measures is the Delay and Gratification Inventory (DGI). The DGI was the first measure to capture all five domains associated with risky behavior (food, physical pleasure, social interaction, money and achievement) introduced by Hoerger, Quirk and Weed (2011). DGI is a 35-item measure with a 5-point Likert-type scale. The DGI is frequently used by psychologists and clinicians when examining impulsive behaviors. This inventory defines impulsivity in terms of five domains of delayed behavior: food, physical pleasures or the avoidance of unpleasantness, social interactions, money, and achievement. The psychometric properties were supported in terms of internal consistency, ranging from 0.71 – 0.85, independent of gender or location and test-retest reliability, which was strong across all factors ranging from r = 0.74 – r = 0.90. Construct validity showed significant correlations with psychopathologic and adjustment impulsivity measures. This measure is suitable for professionals in public health area and researchers evaluating tendency towards delay gratification (Hoerger, Quirk & Weed, 2011).

Cognitive/Behavioral Perspective of Impulsivity

By reviewing some of the most influential research on impulsivity, one may see that it has been defined as the inability to inhibit one´s responses, the inability to delay gratification, or

the inability to plan ahead or act without any aforethought (Ainslie, 1975, Barratt & Patton, 1983, Eysenck, 1993). In behavioral studies, behavioral economists and social scientists believe that human behavior is largely influenced by the consequences following one´s behavior. The concept of operant conditioning and the importance of behavioral consequences were introduced by B.F. Skinner (Skinner, 1938). The influence of such behavioral consequences is often tested in laboratory settings using more current operant procedures that incorporate time elements into choices between outcomes or in task performance.

For example, the differential reinforcement of low (DRL) rate schedule is one, in which a reinforcer (usually a preferred outcome) is delivered only when a specific time period had elapsed between responses. This schedule is used to reduce high rates of behavior and enhance self-control by focusing on patience and the ability to wait (e.g., Ainslie, 1974; Vollmer, Iwata, Zarcone, Smith, & Mazaleski, 1993). This procedure is related to the behavioral inhibition aspect of impulsivity. Another important aspect is the role of immediacy of the reinforcement and its relationship to impulsivity. Humans have a tendency to be sensitive to the immediacy of outcomes such that delayed outcomes tend to have less impact on their behavior (Navarick, 1996). Therefore, another operant method incorporating time and behavioral performance is the delay discounting procedure, where preferences for smaller, more immediate rewards over larger, delayed rewards are assessed (see Critchfield & Kollins, 2001; Madden & Johnson 2010; other reviews). Self-control from the operant perspective then refers to a preference for delayed, larger outcomes over immediate, smaller outcomes, which is consistent with the delay to gratification facet of impulsivity.

Therefore, an alternative model of impulsivity that recently gained the attention of many researchers is founded on the behavioral expressions of this concept and divided impulsivity into the following domains: behavioral inhibition, risk taking, and delay discounting (Reynolds, Ortengen, Richards & de Wit, 2006).

Measures

Impulsivity in the area of behavioral measures is generally studied in terms of response inhibition, risk taking, or delay discounting. Response inhibition can be assessed using the Go/No-Go Task (the paradigm originated with Donders, 1868/1969), where stimuli are presented to the participant in a continuous stream, while the participant is forced to make binary choices to each stimulus. One stimulus (the Go signal) prompts participants to respond with a button press, while the other stimulus (the Stop signal) prompts participants to withhold their response. Accuracy (commission and omission errors) and response times are measured for each stimulus. "Go" signals are presented with a higher frequency in comparison to the "Stop" signals. Impulsivity, defined as a measure of inhibitory control, is assessed by the response accuracy for each No-Go trial. This task was used with various modifications in research for various clinical populations, including the diagnosis of Attention-Deficit/Hyperactivity Disorder (ADHD) or Schizophrenia (Verbruggen & Logan, 2008; Wright, Lipszyc, Dupuis, Thayapararajah & Schachar, 2014).

An extension of the original Go/No-Go Task is the Stop Signal Task (this paradigm originated with Lappin & Eriksen, 1966), which measures the ability to inhibit dominant motor reactions, consequently measuring impulsivity as a mean of response inhibition. After a short fixation period, participants are prompted to react to a "go signal" as fast as possible, unless an auditory or visual "stop signal" is presented to them. Generally, the "stop signal" is presented within milliseconds after the "go signal" but before the next fixation period, and occurs in approximately 25% of trials. The variables of interest include: errors with regard to direction determination, ratio of successful stops, reaction times during the "go signal," and the stop signal reactions time (SSRT). Individuals with longer SSRT are perceived as more impulsive (have poorer inhibition ability) (Lipszyc & Schachar, 2010). Based on the meta-analysis by Lipszyc and Schachar (2010), this task was shown to be a valid assessment of

impulsivity especially for ADHD with reading impairment. Furthermore, this instrument is applicable for Obsessive – Compulsive Disorder (OCD) and Schizophrenia, showing a medium deficit for the stop reaction. Since other clinical conditions, such as anxiety, depression or substance use did not show relevant distinctions, this measure is recommended for specific clinical use or specific clinical research.

The Wisconsin Card Sorting Task (WCST) was originally developed by Grant and Berg (1948) for the assessment of cognitive reasoning, but showed direct relevance to impulsivity. In this task, participants are asked to categorize cards according to different criteria; there are four possible alternatives of classification (according to the colors or shapes of the symbols and the number of shapes presented in each card). However, participants receive feedback only on the correctness of their classification. The rules for the categorization change after 10 cards, measuring the adaptability of the participants to the shifting rules of the task. The measures of interest include the total number of errors, the preservation errors (continuing to apply the old rule) and the non-preservation errors (Grant & Berg, 1948; Milner, 1963; Nyhus & Barcelo, 2009). This task is also beneficial in use with decision-making that is influenced by emotions and feelings, which were not assessed by previous research designs (Bechara, 2004). Nonetheless, this task is not directly related to impulsive choice per se, but instead is a better measure of general executive functioning. Therefore, it could be applied to populations with more sensitivity to attention and motivation or flexibility.

In terms of risk taking, The Balloon Analogue Risk Task (BART) (Lejuez et al., 2002; Lejuez, Aklin, Zvolensky & Pedulla, 2003; Hunt, Hopko, Bare, Lejuez & Robinson, 2005) was designed to help participants evaluate the sensitivity to reward versus sensitivity to loss. In this task, participants are presented with an image of a balloon on a computer screen, which can be “pumped” to earn hypothetical cash reward. The value of the reward that the participant can receive differs in each trial of the experiment (for example 20 balloons/0.50

cents per pump, 20 balloons/1 cent per pump, 20 balloons/5 cents per pump). The number of cents increases with each pump until the balloon breaks at unpredictable times, which means that the participant has lost all money associated with that attempt. The variable of interest includes the amount of "adjusted average pumps" (defined as the number of balloon pumps that did not end with an explosion). Based on the experimental psychometric study done by Lejuez and colleagues (2002) BART was supported to be used in assessing risk taking behaviors, while the variance was found not to be due to demographics, self-report measures or risk-related constructs.

The delay (DD) and probability discounting (PD) tasks were developed to assess the extent to which the value of a given commodity decreases as a function of time and/or probability (Rachlin, Ranieri & Cross, 1991; see also Green & Myerson, 2004). In DD tasks, participants are asked to make a series of choices between a smaller immediate reward (e.g. $1 now) vs. a larger delayed reward (e.g. $10 in 1 day) For PD, the choices are between a smaller certain reward ($5 with 100% certainty or for sure) vs. a larger uncertain reward ($10 with a 5% chance). The original discounting tasks offered monetary rewards as outcomes. Nevertheless, recent advances incorporated other commodities into these tasks, such as food (e.g., Rasmussen, Lawyer, & Reilly, 2010; Hendrickson & Rasmussen, 2013, 2017), sexual activity (e.g., Lawyer, Williams, Prihodova, Rollins & Lester, 2010; Johnson, & Bruner, 2012) or cigarettes (e.g., Lawyer, Schoepflin, Green & Jenks, 2011).

Biological Perspective of Impulsivity

Neuroanatomy

Clinical studies reported that aggressive and impulsive patients (often with low serotonin levels) show abnormalities in the inferior and orbital prefrontal cortex (Rubia et al., 2005). Further findings collected in behavioral studies and on patients with lesion focusing on traumatic brain injury (TBI) suggested that impulsivity is associated with frontal region of the

brain, in particular, the dorsolateral prefrontal cortex (DLPFC), orbitofrontal cortex (OFC), anterior cingulate cortex (ACC), and insula (for review see Wong & Lee, 2013). Newcombe and colleagues (2011) have also found that impulsive behaviors in TBI patients are associated with abnormalities in bilateral OFC, insula, and caudate.

Aside from TBI, substance use disorders or addictive behaviors are often associated with impulsivity. In particular, abstinent heroin users with weak inhibitory control exhibited lower activation in the ventral lateral frontal regions, left anterior cingulate cortex, and left parietal region (Lee et al., 2005). Pathological gambling habits were associated with ventral striatum and posterior orbitofrontal cortex (Balodis et al., 2012), dorsolateral prefrontal cortex, inferior frontal, and anterior cingulate cortex (Van Holst et al., 2012). Another condition often associated with impulsivity is Schizophrenia. Abnormalities in the frontostriatal system, in particular, in the anterior cingulate cortex and orbitofrontal cortex have been documented (Barch & Dowd, 2010). The structural and functional deviations in the dorsolateral prefrontal cortex and the anterior cingulate cortex are associated with impairments in inhibitory control, while the deviations in orbitofrontal cortex and insula are associated with impulsive risky decisions with respect to reward (Wong, Lee, 2013).

The majority of studies also combine impulsivity with aggressiveness and violence (Stein, Hollander, & Liebowitz, 1993; Barrat, Stanford, Kent & Felthous, 1997; Gvion & Apter, 2011). These studies enhanced the understanding of the mechanisms of human aggression as links between temporal lobe dysfunction and violence (Volavka, Martell & Convit, 1992). The frontal lobe has further been shown to play an important role in inhibition, executive control, and in regulation or suppression of violent impulses. Supporters of the Frontal-Dysexecutive Theory explain that behavioral disinhibition in violence is likely a result of malfunction in the frontal lobe, in particular the orbitofrontal cortex (Mar, Walker, Theobald, Eagle, & Robbins, 2011; Roszyk & Łukaszewska, 2011; Mitchell & Potenza, 2014; Fineberg et al., 2014);

indeed, this area is mainly involved in the action of self-control.

Roszyk and Łukaszewska (2011) described other crucial cognitive processes responsible for impulsive behaviors and associated criminal behaviors related to the frontal lobe regions and the deep structures of the temporal lobe. According to their review, the primary responsibility of the frontal lobe is behavioral correction, in which consequences related to behavior and the ability to learn and understand rules governing behavior are internalized. This ability includes contingencies involved in interpersonal relationships and the capability for reasoning in terms of moral values. Therefore, aggression, which was often associated with impulsivity in these studies, was linked to dysfunction of the temporal lobe and the limbic system, particularly the amygdala and hippocampus, which provided support for the Temporal-Limbic Theory (Volavka, 1999; Roszyk & Łukaszewska, 2011).

Researchers (Bickel et al., 2011; Bickel et al., 2014) also discussed the role of the orbitofrontal cortex in impulsivity; however, as a system that competes with the reward areas of the brain. Deemed as a reinforcer pathology, impulsive behavior, such as substance abuse, is defined as "the persistently high valuation of a reinforcer (tangible commodities and experiences) and/or the excessive preference for the immediate acquisition or consumption of a commodity despite long-term negative outcomes" (Bickel et al., 2011, p. 407). Choices between immediate vs. delayed reinforcers are related to the competition of two neural systems – the impulsive system, which consists of the limbic and paralimbic areas involved in immediate rewards, and the executive system, which consists of prefrontal cortices involved in delayed rewards (Bickel et al., 2011). Activation in the impulsive system is associated with the valuation of immediate rewards or outcomes and the values become reduced as reinforcers become more delayed (Bickel et al., 2011; Kable & Glimcher, 2010). Activation of the executive system is related to self-control or the valuation of delayed outcomes or rewards (Bickel et al., 2011; Wunderlich, Rangel & O'Doherty, 2009). The executive systems of

individuals suffering from reinforcer pathologies show lower cortical volume and gray matter density (Bickel et al., 2011).

Neuromodulation

Human and animal studies of the neurobiological bases of impulsivity focus primarily on the monoaminergic corticostriatal systems and brain imaging. Human studies identify structural and functional alterations in corticostriatal circuitry in impulsive individuals (Mitchell & Potenza, 2014). Dysfunctional monoaminergic signaling within the dopaminergic (DA) and serotonergic (5-HT) systems seems to underline impulsive responses and impulsive choices. Impulsivity and aggression is therefore explained in terms of a failure in the serotonergically-mediated behavioral inhibition and appears to respond to treatments involving the blocking of serotonin reuptake (Stein et al., 1993). Studies of serotonergic function show potential for future research in violent crimes (Volavka et al., 1992) with associated treatment advances (Stein et al., 1993).

While the 5-HT system seems to be an important factor in the modulation of different functions and behaviors including appetite, sleep, memory and learning, mood or sexuality (Marazziti et al., 2010), it is indeed one of the most widely implicated neurotransmitter systems with Impulse Control Disorders, pathological gambling (Williams & Potenza, 2008), and aggression (Volavka, 1999). Specifically, reduced 5-HT neurotransmission has been associated with increased impulsivity in human studies and in animal models (Williams & Potenza, 2008; Dougherty, Richard, James, & Mathias, 2010). Rodent studies have shown that similar to the dopaminergic system, global reductions in 5-HT increase impulsive, compulsive and aggressive behaviors (Mitchell & Potenza, 2014; Marazziti et al., 2010).

In human studies, impulsive aggression may be the result of the interaction between serotonin and dopamine systems. Decreased serotonergic activity, in the context of aggressive behavior, is closely associated with increased dopamine activity. Neuronal connections of serotonin and

dopamine systems promote the functional modulation of 5-HT over dopamine activities in the neural network. While the 5-HT2 receptors inhibit dopamine activity, the 5-HT2 antagonists support the dopamine activity (for review see Seo, Patrick & Kennealy, 2008). The dopamine system is also involved in reward-seeking (gambling, drugs) and is responsible for the production of subjectively pleasurable feelings in humans. Studies have further shown that mesolimbic dopamine is responsible for variations in impulsivity and inhibition and that CSF dopamine correlates with histrionic traits (Stein et al., 1993). SLC6A3 is a gene responsible for the transfer of dopamine back to presynaptic neurons (Wong & Lee, 2013). Allelic variations of SLC6A3 are related to inhibitory behaviors and may also predict pathological gambling (Comings et al., 2001). Likewise, studies show that levels of 5- hydroxyindoleacetic acid (5-HIAA), the major metabolite of 5-HT that is found in cerebrospinal fluid (CSF), are lower in individuals with impulsive characteristics, people attempting suicide (especially in violent suicide attempts), impulsive alcoholic criminals, arsonists, and in individuals suffering from alcohol use disorders (Marazziti et al., 2010; Williams & Potenza, 2008). Additionally, Volavka and colleagues (1992) suggested that impulsive offenders, recidivists and offenders with the history of suicide attempts displayed impaired serotonergic transmissions and indicated lower levels of CSF 5-HIAA. These offenders showed signs of impairment for specific types of violence in contrast to non-impulsive offenders (Volavka et al., 1992).

While Brown, Goodwin, Ballenger, Goyer, and Major (1979) reported that 5-HIAA levels in CSF negatively correlated with aggression and impulsive behaviors, they also discussed the critical role of the noradrenergic (or also called norepinephrine; NE) system in impulsivity. The norepinephrine metabolite 3- methoxy-4- hydroxyphenylglycol (MHPG) was positively associated with a history of aggression in participants diagnosed with personality disorders. This result, however, was not replicated in a second study (Stein et al., 1993). An examination of a sample of pathological gamblers confirmed greater levels of CSF MHPG compared to

control subjects. Nonetheless, similar levels of CSF 5- HIAA were observed. Other studies have shown increased beta-adrenergic receptor binding in the prefrontal/temporal cortex in suicidal participants (Stockmeier & Meltzer, 1991; Gross-Isseroff, Dillon & Fieldust, 1990). Suppression of violent behavior within neuropsychiatric patients has been clinically induced using beta-adrenergic blockers (Volavka, 1999).

The Tryptophan hydroxylase (TPH) is an enzyme involved in the rate-limiting synthesis of the neurotransmitter serotonin (5-HT) and influences impulsivity through its regulation of 5-HT (Wong & Lee, 2013). The Acute tryptophan depletion (ATD) has been shown to decrease 5-HT synthesis in the brain (Rubia et al., 2005) and was associated with more impulsive choices (Rogers et al., 2003) or more risky choices in gambling (Juhasz et al., 2010). The influence of different allelic combinations of TPH2 in response inhibition during the Stop-Signal Task (SST) differs between genders. C/C was associated with higher inhibitory control in females and T/T genotype was associated with less inhibitory control in males (Stoltenberg et al., 2006). The study examining the effect of acute tryptophan depletion (ATD) on functional brain activation during a Go/No-Go task has showed decreased activation in the right orbito-inferior prefrontal cortex and increased activation in the left and right middle temporal lobes (Rubia et al., 2005). Abnormalities of the 5-HT2a receptor gene have been also related to decreased impulse control in a continuous performance task (Bjork et al., 2002).

Monoamine oxidases (MAO; subtypes MAO- A and MAO- B) are the enzymes that metabolize NE, 5- HT and DA. They have been shown to decrease platelet MAO activity, which is inversely associated with impulsive aggression (Williams & Potenza, 2008). Thus, these enzymes may play a significant role in disorders characterized by impaired impulse control, such as eating disorders or pathological gambling, or high levels of sensation seeking. Low levels of MAO activity have also been found in the platelets of violent offenders

(Volavka, 1999). MAO- A genotypes increase the risk for later-life violence, the risk to commit violent crimes, and play a regulatory role in the control of socially inappropriate or acting out behaviors (Reif et al., 2007). Moreover, MAO levels have been shown to negatively correlate with the Cloninger´s Novelty Seeking Scale and Zuckerman´s Sensation Seeking Scale (Zuckerman & Cloninger, 1996).

Measures

With regard to the biological aspects of impulsivity, it is important to note that the biological evaluation of different models of impulsivity is primarily conducted with behavioral measures. These include the Go-Stop Impulsivity Paradigm (Dougherty, Mathias, Marsh, & Jagar, 2005), The Two Choice Impulsivity Paradigm (TCIP; Dougherty et al., 2005), the Immediate and Delayed Memory task (IMT/DMT; Dougherty, Marsh & Mathias, 2002) and the Single Key Impulsivity Paradigm (SKIP; Dougherty et al., 2005). These measures hold a number of advantages, such as objectivity, and lower cultural bias. According to Bari and Robbins (2013), the most important advantage of laboratory measures is the substantial agreement among the results of human and animal studies. This is especially true when examining performance that involves brain regions and interventional effects of pharmacological treatments or environmental interferences.

Conclusion

In this article, impulsivity was examined from the personality, cognitive/behavioral, and biological perspectives, while key points were outlined for each discipline. The main focus of this article was to emphasize the psychological aspects of impulsivity and the difference between personality and behavioral perception with corresponding measures. Both the self-report and behavioral measures have strengths and limitations; both seem to focus on different aspects of impulsivity, as to that they are designed to be domain specific. It is also important to acknowledge that impulsivity has a number of underlying facets that are independent,

however, related. Studies described above supported the combination of self-report and behavioral measures, in cases, where the same domains are targeted in each assessment. When applied together, they increase the incremental predictive power. At the same time, biological and behavioral studies find themselves in a crisis in terms of replication of the original findings. This could be due to several reason, however the most prominent seems to be the small sample size (e.g. N= 22 in Bickel, Odum and Madden, 1999 study; N=62 in Johnson & Bruner, 2012 study; N=5 in Lappin & Eriksen, 1966 study; N=30 in Bickel et al., 2009; N=17 in Miyapuram et al., 2012). Furthermore, participants for these studies are generally pre-selected, therefore results are less generalizable, and thus replicability of such studies is limited.

Therefore, future research should incorporate larger sample sizes, in order for the results to be generalizable to larger populations. Furthermore, based on the results of previous studies, it is important to recognize the domain specificity of different impulsivity assessments, and their utilization with various populations. There is value in studying impulsivity as it is relates to socially-relevant health risk behaviors including but not limited to smoking, alcohol consumption, obesity, drug use, gambling or risky sexual behaviors (Critchfield & Kollins, 2001; Bickel, Odum, & Madden, 1999; Petry, 2001; Rasmussen et al., 2010; Madden, Petry, Badger, & Bickel, 1997; Holt, Green, & Myerson, 2003; Lawyer et al., 2010). As an underlying set of processes in many health and health-risk behaviors, understanding these mechanisms in humans and in animals is valuable and beneficial.

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Table 1 Modified table of varieties of impulsivity from Evenden (1999)

Human-subject studies	Dickman (1990)	Dysfunctional impulsivity	The tendency to act with less forethought than most people of equal ability when this tendency is source of difficulty
		Functional impulsivity	The tendency to act with relatively little forethought when such a style is optimal
	Dickman (1993)	Attentional	Insufficient focusing of attention leads to impulsivity
		"Reflection-impulsivity"	As measured by the matching familiar figures task (Kagan, 1966)
		Disinhibition	Failure to withhold responses often leading to omission of reward (Newman et al. 1985)
	Buss and Plomin (1975)	Inhibitory control	E.g. I have trouble controlling my impulses, usually I can't stand waiting
		Decision time	E.g. I often say the first thing that comes into my head, or act on the spur of the moment
		Lack of persistence	E.g. I tend to give up easily, I tend to hop from interest to interest quickly
		Boredom/sensation seeking	E.g. I generally seek new and exciting experiences and sensations, I get bored easily
	Eysenck (1993)	Impulsiveness	Unconscious risk taking
		Venturesomeness	Conscious sensation seeking
	BIS – 10	Motor	Acting without thinking
	(Patton et al. 1995)	Cognitive	Making quick cognitive decisions
		Non-planning	Present orientation or lack of "futuring"
	BIS -11	Ideomotor	Acting without thinking
	(Barratt 1994)	Careful planning	Paying attention to details
		Coping stability	Orientation towards future
	Tridimensional	Novelty seeking	E.g. – acts immediately on monetary whims
	Personality Questionnaire	Harm avoidance	E.g. – carefree lack of inhibition even when the situation calls for attention
	(Cloninger 1987)	Reward dependence	E.g. – lack of persistent ambition for delayed rewards
	Karolinska Scales	Impulsiveness	E.g. – I have a tendency to act on the spur of the moment
	of Personality (Schalling 1987)	Irritability	Irritable, lacking in patience
	IRS	"Self-control"	In normals weighting irritability, aggressivity and control of responses
	(Lecrubier et al 1995)	Time needed for decision	In normals weighting time needed for decision and capacity for delay
	DSM IV (APA 1994) Substance		E.g. – persistent desire or unsuccessful efforts to cut down or control substance abuse
	abuse disorders		E.g. – great deal of time spent in activities necessary to obtain the substance
	DSM-5 (APA 2013) Substance use disorder	Impaired control	E.g. – persistent desire to cut down or regulate substance use and may report unsuccessful efforts to decrease or discontinue use
			E.g. – spend great deal of time obtaining the

			substance, or recovering from its effects
	DSM IV (APA 1994) Attention deficit/hyperactivity disorder	Inattention	E.g. – often has difficulty in sustaining attention in tasks of play activities
		Hyperactivity	E.g. – often leaves seat in classroom or situations in which remaining seated is expected
		Impulsivity	E.g. – often blurts answers before questions have been completed
	DSM-5 (APA 2013)	ADHD symptoms are the same as in the previous version DSM IV (APA 1994)	
	DSM IV (APA 1994) Mania	Criterion 7	Excessive involvement in pleasurable activities that have a high potential for painful consequences
	DSM-5 (APA 2013)	Criterion 7 for Manic episode is the same as in the previous version of DSM IV (APA 1994)	
Non-human subject studies	Soubrié (1986)	Response inhibition	Serotonergic neurons are brought into play whenever behavioral inhibition is required
	Logue (1988)	Resistance to delay of reinforcement	Impulsiveness cannot wait for delayed reward and have problems with delay of gratification
	Bradshaw and colleagues	Timing	Impulsiveness show poor temporal judgment. Intervals produced too short
	Ho et al. (1998)	Behavioral switching	Increased frequency of switching between response alternatives
	Brunner and Hen (1997)	Motor impulsivity	Failure to inhibit behavior, characterized by fast, inaccurate responding
		Cognitive impulsivity	Distorted judgment of alternative outcomes, resulting in a loss of reward in the long term
	Evenden (1998d)	Preparation	Not all relevant information is taken into account before making a decision
		Execution	The behavior chain is terminated before the goal is reached
		Outcome	A quick, but less valuable outcome is chosen rather than a later but more valuable
	Evenden – Possible additional factors	Premature responding	Responding when the opportunity is given before discriminating information available
		Lack of persistence	Qualitatively less behavior emitted than normally expected

The Attention Deficit Hyperactivity Disorder

According to the Diagnostic and Statistical Manual of Mental Disorders (American Psychiatric Association [APA], 2013), the Attention-Deficit Hyperactivity Disorder, which is categorized under the neurodevelopmental disorders, is mainly characterized by inattention, hyperactivity, and/or impulsiveness. Inattention within this context is described as "wandering off task, lacking persistence, having difficulty sustaining focus, and being disorganized," while impulsivity "refers to hasty actions that occur in the moment without forethought and that have high potential for harm to the individual" or "desire for immediate rewards or an inability to delay gratification" or "as social intrusiveness (e.g., interrupting others excessively) and/or making important decisions without consideration of long-term consequences (e.g., taking a job without adequate information)" (APA, 2013, p. 61).

In the International Classification of Diseases (ICD-10) (World Health Organization [WHO], 1992) ADHD is categorized under the Hyperkinetic Disorders in the Disturbance of Activity and Attention Section. The descriptions of impulsivity in the ICD-10 involve "a lack of persistence in activities that require cognitive involvement, and a tendency to move from one activity to another without completing any one, together with disorganized, ill-regulated, and excessive activity" (WHO, 1992). The ICD-11 adjusted the definition of impulsivity to "a tendency to act in response to immediate stimuli, without deliberation or consideration of the risks and consequences" (WHO, 2022).

According to the DSM-5, ADHD is seen in approximately 5% of children and about 2.5% of adults across different cultures and populations, while this diagnosis seems to be more frequent in males in comparison to females with the ratio of 2:1 in children and 1.6:1 in adults (APA, 2013). Furthermore, this disorder appears to persist into adulthood for approximately two-thirds of patients that have been diagnosed with ADHD during their childhood (Ramos-Quiroga, Montoya, Kutzelnigg, Debredt, & Sobanski, 2013). In terms of the development and

the course of the disorder, the DSM-5 (APA, 2013) states that hyperactivity tends to be dominant during preschool years, while inattention gains its dominance during elementary school. In contrast, inattention, restlessness, and impulsivity tend be prominent in adulthood. Importantly, a higher likelihood of comorbid diagnoses of Conduct Disorder in adolescence (seen in approximately one quarter of the cases) and/or Antisocial Personality Disorder in adulthood is seen for patients diagnosed with ADHD (DSM-5, APA, 2013), which may carry severe consequences for the future of these individuals. Some studies even suggested that impulsivity might be the core mechanism for many behavioral dysfunctions that are observed in the adult ADHD population (Babinski et al., 1999).

The Role of Impulsivity in relation to the Attention-Deficit Hyperactivity Disorder

Only in recent years have researchers started to conduct multidimensional analyses of impulsivity for specific diagnoses. For example, Lopez, Dauvilliers, Jaussent, Billieux, and Bayard (2015) studied various dimensions of impulsivity in adults diagnosed with ADHD and its different subtypes using the Conner's Adult ADHD Rating Scale-Self-Report: Short Version (CAARS-S:S) and the UPPS Impulsive Behavior Scale. The results showed that participants diagnosed with ADHD received higher scores on urgency, lack of premeditation, and lack of perseverance (Lopez et al., 2015). Specifically, lack of perseverance (defined as "the ability to remain focused on a task that may be boring or difficult") showed the strongest association to ADHD. Furthermore, the area under the ROC Curves for these facets of impulsivity were greater in comparison to the more traditional self-report measures, such as the ADHD Self-report Scale (Adult version) or the CAARS-S:S, suggesting that the UPPS Impulsive Behavior Scale may be more suitable for patients with ADHD diagnosis. With regard to the different subtypes of ADHD, this study showed that patients diagnosed with the combined type of ADHD obtained higher scores on the urgency and sensation-seeking scales in comparison to patients diagnosed with the predominantly inattentive type, suggesting that

patients with the combined type of ADHD may show poorer response inhibition as well as poorer decision making in emotional situations (Lopez et al., 2015).

Similarly, Malloy-Dinitz, Fuentes, Leite, Correa, and Bechara (2007) examined the presence of the three dimensions of impulsivity: attentional, non-planning, and motor impulsivity (according to the concepts of Barratt and Bechara) in adult patients with ADHD using self-report measures as well as behavioral measures of impulsivity. The results of this study showed that patients with ADHD differed on all three dimensions of impulsivity in comparison to a matched control group. Specifically, differences were observed on the total score of the Barratt Impulsiveness Scale as well as on its all three second order factors (attentional, motor, and nonplanning impulsivity). With regard to the behavioral measures, authors found more errors of omission and commission in comparison to the control sample on the Conner´s Continuous Performance Test (CPT-II), which measures sustained attention and impulsiveness (consistent with motor and attentional dimensions of impulsivity). In terms of the nonplanning or cognitive impulsivity, the results indicated that patients diagnosed with ADHD showed poorer performance on the Iowa Gambling Task, which assessed decision-making abilities (Malloy-Dinitz et al., 2007). These results highlight the importance of going beyond self-report measures, when assessing the concept of impulsiveness.

Furthermore, Bekker et al. (2005) examined the attentional and inhibitory deficits in patients diagnosed with ADHD using the Stop Signal Task and the Stop Change Task. The results showed that patients diagnosed with ADHD had significantly longer Stop Signal Reaction Times and made more choice errors in comparison to healthy volunteers. In order to assess, whether the slower SSRTs were due to impairment in attention or a lack of inhibition, authors further compared the SSRTs of these patients to the processing speed of the go-stimulus and found that there was a lack of inhibitory control that in general may affect the presentation of ADHD in adults (Bekker et al., 2005).

Impulsivity in adults diagnosed with ADHD was also studied using delay and probability discounting with regard to problematic gambling (Dai, Harrow, Song, Rucklidge, & Grace, 2016). Statistical analyses revealed that participants with ADHD showed steeper discounting curves of future outcomes and/or increased proneness to risk taking. Furthermore, probability discounting (not delay discounting) was shown to significantly predict money loss on a brief gambling simulation and explained significant variance on other measures assessing problematic gambling.

According to the results from these studies, patients diagnosed with ADHD have a tendency to obtain higher scores across different measures of impulsivity in comparison to healthy control groups. Nevertheless, participants for these studies were recruited predominantly from clinical and general populations.

The Prison population

A meta-analysis of the prevalence of ADHD within the inmate population showed that the highest estimated prevalence of this disorder was observed in Europe (32.1%), followed by North America (26.9%), and other Countries (17.6%) (Young et al., 2015). No significant differences were found in gender. The estimated prevalence of ADHD for male inmates was 30.3%, while the estimated prevalence for female inmates was 26.2%. Surprisingly, no significant differences were found for age in this population, where the estimated prevalence for youth was 30.1%, while the estimated prevalence for adults was 26.2% (Young et al., 2015).

Another common diagnosis for the population of incarcerated offenders is the Antisocial Personality Disorder. In a systematic review performed by Fazel and Danesh (2002), 47% of convicted male offenders and 21% of convicted female offenders were diagnosed with Antisocial Personality Disorder (APD). Furthermore, violent offenders diagnosed with APD were shown to have higher scores of impulsiveness and aggression, in comparison to

nonviolent offenders diagnosed with APD (De Tribolet-Hardy et al., 2011). With regard to the comorbidity of this diagnosis with ADHD, Black et al. (2010) conducted a study on 320 newly incarcerated offenders, and found that the diagnosis of Antisocial Personality Disorder was present in 35.3% of inmates, while 33% of these inmates had a comorbid ADHD diagnosis. Consistent with these facts and statistics, we conducted our first pilot study on a sample of incarcerated offenders with a history of aggressive behaviors.

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Impulsivity profile in the prison population – a comparative case-control study

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Abstract

Impulsivity tends to play an important role in many behavioral disorders, especially in the population of incarcerated offenders, where the prevalence of impulsivity is expected to be high. Prisoners sentenced for violent or property crimes, recruited from 12 participating prisons in the Czech Republic, completed self-reported questionnaires of impulsivity. Results were compared to a non-prison control group from the general population. Analyses pointed toward significantly higher levels of impulsivity in the prison population sample, particularly in terms of motor and non-planning impulsivity, emotion based rash action and sensation seeking, and impulsivity toward physical pleasures, social interactions and money. Findings were adjusted to demographic confounders. The relevance and importance of these findings within the forensic context is discussed.

Key words: impulsivity, prison sample, BIS-11, DGI, UPPS-P

Introduction

Impulsivity is often operationalized in various definitions. As a multidimensional construct that subsumes a number of behavioral features, impulsivity can range from impatience, indifference to the consequences to one´s behavior or the inability to suppress inappropriate behavior (Ainslie, 1975; Barratt & Patton, 1983; Eysenck, 1993; Reynolds, Ortengen, Richards & de Wit, 2006). Impulsivity has been studied in different populations, predominantly general and clinical populations, for its potentially desirable and detrimental qualities. It is integrated in many diagnostic criteria for psychiatric and personality disorders (DSM-5, American Psychiatric Association, 2013).

According to Chamorro and colleagues (2012) the lifetime prevalence of self-reported impulsivity in the general population of the United States was at 16.9%. Results showed that males and young adults were perceived as more impulsive. Higher levels of impulsivity in this sample were further associated with lower educational attainment and lower socioeconomic status. Furthermore, it has been shown that impulsive individuals had the tendency to engage in dangerous behaviors, including reckless driving, fighting, shoplifting, domestic violence or aggression (Chamorro et al., 2012). Hence, these acts may lead to various criminal offenses and potential incarceration.

Impulsivity has been frequently referenced in etiological theories of crime and criminal behaviors (Gottfredson & Hirschi, 1990; White et al. 1994). A recent systematic review confirmed that individual personality traits, such as psychopathy, low self-control (impulsivity), and difficult temperament (evidenced primarily by adverse childhood experiences and temperament factors related to poor emotional self-control) all contribute to criminality (Tarshini et al., 2021). In particular, dysfunctional impulsivity, defined by the Dickman Functional and Dysfunctional Impulsivity Survey as the style of responding to stimulus eliciting impulsive responses and causing difficulties (Dickman, 1990), was shown

to be a better predictor of crime in comparison to functional impulsivity (Wendel, Rocque, & Posick, 2022).

Although a number of studies evaluated impulsivity in the forensic setting, the assessment of impulsivity was viewed in the unidimensional context, regardless of the theoretical multidimensional construct and the higher prevalence of pathological impulsivity in this population (Bernstein et al., 2015; Fazel et al., 2016; Tonnaer et al., 2016; Værøy, 2016; Warren et al., 2012). For example, there is a strong relationship between impulsivity, institutional aggression and prison adjustment, where results showed that impulsivity was a stronger predictor of aggression in comparison to ethnicity or index violent offense, and contributed to the difficulties in institutional adjustment (Fornells, Capdevila, & Andres-Pueyo, 2002; Wang, & Diamond, 1999). In correctional settings, different facets of impulsivity are therefore associated with different problematic behaviors, including breaches of discipline (Gordon & Egan, 2011), physical aggression between inmates or toward correctional staff (Værøy, Western & Andersson, 2016), and self-harm (Gvion & Apter, 2011).

Thus, advanced understanding and detection of risk factors related to impulsivity can better inform both treatment needs and requirements in this population, and as a result lead to increased safety of the prison environment, and potentially reduce institutional infractions during incarceration (Fazel et al., 2016). However, the role of impulsivity in maladaptive or deviant behaviors remains unclear, predominantly due to the disagreements and inconsistencies in literature about how to define, operationalize and measure this construct.

For example, low self-control, defined in terms of the inability to delay gratification, has been identified as one of the leading determinants to criminal antisocial behavior (Moreira, 2022). Likewise, deficits in self-control have been associated with behavioral problems in individuals with a history of criminal convictions (DeLisi, 2013; DeLisi et al., 2008). The

choice between immediate rewards and prominent long term consequences in relation to five evolutionary significant domains of delay gratification was developed in the Delay of Gratification Inventory (DGI; Hoerger et al., 2012).

An integrated approach to self-report measures of impulsivity was adopted by Whiteside and Lynam (2001), who identified four discrete personality facets of impulsivity (UPPS-P Impulsive Behavior Scale). These included urgency (U), (lack of) premeditation (P), (lack of) perseverance (P) and sensation seeking (S). Likewise, these identified facets of impulsivity have been associated with poor self-control, affective liability or negative urgency, and lead to self-harm or excessive alcohol use (Dir et al., 2013).

Traditionally, the concept of impulsivity has been operationalized by the Barratt Impulsiveness Scale (11^{th} version; BIS-11; Barrat 1965, Patton et al. 1995). Although the reliability and criterion validity of this instrument has been verified, the three original factorial structure of BIS-11 was not supported in a systematic review (Vasconcelos et al., 2012). Nevertheless, the use of BIS-11 showed generally acceptable psychometric properties when used in a forensic sample of incarcerated juvenile offenders and showed statistically significant association with the age of crime onset, seriousness of the crime, conduct disorder and alcohol/drug use (Pechorro et al., 2015).

Extending on the theoretical concepts and limitations in the empirical research, the purpose of the current study was to analyze the multidimensional nature of impulsivity in a prison population sample and compare its various facets to a non-prison population sample. Referring to the results of previous studies, the authors anticipated to observe significantly higher scores of impulsivity in the prison population. As demographic variables (such as gender, age, and educational attainment) were expected to be associated with both levels of impulsivity and the target population (prisoners), the analyses were adjusted to the demographic confounders.

Methodology

Participants

Prison population

One hundred and forty-four inmates (63% males, 37% females) were recruited from 12 participating prisons that represent 34% of the total number of prisons in the Czech Republic. The identified criminal activities ranged from property crimes (e.g. theft, fraud, obstruction of justice) to violent crimes/felonies (e.g. robbery, grievous bodily harm, attempted murder or murder). Participating inmates were classified as medium or maximum security level, according to the duration of the sentence, the criminal nature (violence, drugs, and sex crimes), and the number of previous incarcerations. The majority of the participating inmates were males (63%). All participants were at least 18 years of age. The mean age of the sample was 35.7 years (SD = 12.0). In terms of their educational attainment, most inmates received only primary education (50.7%) or some type of vocational training (38.2%).

General population (Comparison/Control group)

Seventy-nine participants (23% males, 77% females) were recruited from a community sample in Prague via news-paper advertisements, fliers, and social media platforms. All participants were at least 18 years of age. The mean age of the sample was 41.7 years (SD = 15.8). The majority of this sample graduated from high school (40.5%), obtained a university degree (35.4%), or received some type of vocational training (19.0%).

Ethics

The following research was approved by the Ethics Committee of the National Institute of Mental Health in the Czech Republic (registered ID: 17-05791S). Prior to participating in the study, all participants signed an informed consent.

Procedures

Data were collected in participating prisons and in the National Institute of Mental Health via paper-pencil method. Participants completed all measures in a single session, which lasted approximately one hour. Treatment of the missing values included two steps. First, if two or more items per scale were missing in the questionnaires, a listwise deletion approach was invoked. Second, responses with one-missing item were handled with regression from the other items on the subscale and rounded to the nearest integer. However, this demand to correct for one-missing domain item was only minor (altogether 12 participants from the control group, none from the target/prison group). No pervasive responding was observed in the provided answers.

Measures of Impulsivity

The Barratt Impulsiveness Scale (BIS-11)

The BIS-11 is a 30-item measure of impulsiveness defined by six first-order factors (attention, cognitive instability, motor, perseverance, self-control, cognitive complexity) and three second-order factors (attentional, motor, nonplanning). Items are scored on a 4-point Likert-type scale (Patton et al., 1995). Internal consistencies of all subscales, measured by Cronbach's α, were above 0.7 with the exception of motor impulsivity (from the second order factorial structure) and cognitive complexity, perseverance and cognitive instability (from the first order factorial structure). The test-retest reliability showed varying strengths, however, all correlations were statistically significant at the level $p \leq 0.01$ (Stanford et al., 2009). The original structure of motor and attentional impulsiveness showed low internal consistency in forensic psychiatric patients (Haden & Shiva, 2008). Therefore, other alternative factor models of impulsivity were proposed by different authors (Haden & Shiva, 2008; Ruiz et al., 2010).

The Delay of Gratification Inventory (DGI)

The DGI is a 35-item measure with a 5-point Likert-type scale. This inventory defines impulsivity in terms of five domains of delayed behavior: i) food, ii) physical pleasures or the avoidance of unpleasantness, iii) social interactions, iv) money, and v) achievement. The psychometric properties of these domains were supported in terms of both internal consistency and test-retest reliability. Namely, the internal consistency ranging from 0.71–0.85, independently of gender or location, and the test-retest reliability across all factors, ranging from r = 0.74–0.90. Construct validity showed significant correlations with psychopathologic and adjustment impulsivity measures (Hoerger et al., 2011).

The UPPS-P Impulsive Behavior Scale

The UPPS-P is a 59-item measure of five different factors of impulsivity: i) positive urgency, ii) negative urgency, iii) sensation seeking, iv) lack of perseverance, and v) lack of premeditation. Items are scored on a 4-point Likert-type scale (Whiteside & Lynam, 2001). This instrument has been supported as a consistent and valid measure of impulsivity in clinical settings, particularly for disorders containing impulsiveness (Savvidou et al., 2017).

Statistical analyses

The analysis comprised several consecutive steps; all conducted in *Stata IC/15.1* statistical software. First, psychometric scores for each of the domains of the impulsivity measures (*BIS-11*, *DGI*, and *UPPS-P*) were computed for participants from both the prison and control group. The scores were computed as mean values of the responses across all items of the domain. In order to simplify the interpretation of the domain scores, the items were adjusted so that the increasing value of the resulting score indicated higher levels of impulsivity (some of the Likert-type responses, particularly those in the *DGI*, had to be reversed). Once the domain scores were established, differences in the level of impulsivity between the prison and control groups were tested in the second step of the analysis. These differences were tested using both the univariate and multivariate approaches.

In order to thoroughly examine the differences in impulsivity, we conducted a series of two-way between-subjects ANOVAs. The variables of interest were the mean scores of the identified impulsivity domains measured by *BIS-11*, *DGI*, and *UPPS-P* with sample (prisoners vs controls) and gender serving as the grouping factors. Participants were subdivided into male prisoners, male controls, female prisoners, and female controls, while these were used to estimate the descriptive statistics as well as the between-group differences, assessed for significance using Tukey's *p*, on each of the *BIS-11*, *DGI*, and *UPPS-P* subscales. We must note, however, that some participants did not complete all of the administered questionnaires, which led to some variations in the sample size. For precise sample size estimates of each group, please refer to Table 2.

Furthermore, correlation analyses between impulsivity domains including demographic variables such as age, gender, and education level of our participants were performed, as these were factors that could potentially influence impulsivity. It was important to consider them in our analyses to establish more comprehensive and accurate insights. Additionally, we addressed the variation in impulsivity across different population subsets. This was achieved by stratifying our correlation matrix into prisoners (N = 141) and control group of non-incarcerated individuals (N = 79). The chosen method of correlation was the Spearman rank correlation coefficient, which is a non-parametric measure that could provide a more accurate representation of the relationship between the variables observed in our study.

Results

Table 1 provides demographic characteristic of the participants, presented separately by the study group (target prisoners, control group) and for the total sample. Altogether, N = 223 individuals were included into the study; about two-thirds of the respondents were recruited from the target prison population (N_1 = 144; 65%), and one-third from the non-

prison control group (N_0 = 79; 35%). Comparing demographics between the two study groups, the prisoners were characterized by significantly higher share of males [$\chi^2(1) = 33.34$, $p < .001$], lower educational attainment [$\chi^2(3) = 104.17$, $p < .001$], and younger age [$t\ (221) = 3.20$, $p < .001$] than the participants from the control group. The demographic structure of the sample, as described in Table 1, was therefore used in calculating the correlation matrix.

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Table 1

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Table 2 provides descriptive statistics and *p*-values of the key measures of impulsivity and their partial domains consecutively for *BIS-11* through *UPPS-P* stratified by sample and gender. As the psychometric scores were computed as a mean of Likert-type responses of an individual across the set of items of a domain, the range of descriptive statistics averaged across all the individuals is also bounded within the same range of values. Namely, as the items of domains for *BIS-11* and *UPPS-P* used a four-point Likert scale, the descriptive statistics in Table 2 range between 1.0 and 4.0. Likewise, as the items of the *DGI* applied a five-point scale, the psychometric scores of its domains are bounded by 1.0 and 5.0.

Some of the respondents, particularly those from the prison group, refused to fill out or did not complete all three questionnaires on impulsivity. Therefore, the total number of observations for each of the measures was lower than the total sample size and varied between N_{BIS} = 88 and N_{UPPS} = 79 for male prisoners, and between N_{BIS} = 53 and N_{UPPS} = 39 for female prisoners.

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Table 2

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In Table 2, pairwise comparisons of the mean domain scores stratified by group (prisoners vs controls) and gender are presented. Here, mean values are compared between the groups. The comparisons are presented consecutively for each of the domains and measures of impulsivity. For most of the domains in Table 2, the mean comparisons specifying only sample as the grouping variable point to a significantly higher level of impulsiveness among the target group as compared to the controls. When introducing also gender as a grouping variable, the greatest number of significant differences across domains is visible between female prisoners and controls followed by female prisoners and male controls; interestingly, there were not as many significant differences between male prisoners and controls.

The correlation matrix of the three measures of impulsivity (particularly their domains) and age, gender, and education is available in Table 3. In the prisoners' group, the majority of the significant associations (*rho* < .05) were observable between the three impulsivity measures and age, whereas the least amount of measures were correlated with education. For age and educational level, all of the significant correlations were negative, whereas for gender the significant correlations were positive. Comparably to the target group, in the control group the majority of the significant associations (*rho* < .05) were observable between the three measures of impulsivity and age of the participants; yet, the least amount of significant correlations was between the impulsivity measures and gender of the participants. As for the prisoners' group, age and education were negatively correlated with the domains of the three measures of impulsivity. Furthermore, gender was positively correlated with Negative Urgency (*UPPS-P*), but negatively correlated with Sensation Seeking (also *UPPS-P*).

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Table 3

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Discussion

Results of this study identified and confirmed higher levels of impulsivity in the prison population. The significant domains of impulsivity in prisoners included all of the *BIS-11* domains aside from the Attention and Attentional scales (second order factor); Social Interactions and Money scales in the *DGI*, and Negative and Positive Urgency, Emotion Based Rash Action and Sensation Seeking scales in the *UPPS-P*. The comparison of male prisoners and controls showed significant differences in Self-Control, Cognitive Complexity, and Nonplanning scales in the *BIS-11;* Money scale in the *DGI;* and Negative Urgency, Positive Urgency, and Emotion Based Rash Action scales in the *UPPS-P*. Females, however, showed significant differences in all of the *BIS-11* subscales aside from the Attention, Cognitive Instability, and Attentional scales (second order factor); in Money scale (*DGI*); and in Negative and Positive Urgency, Emotion Based Rash Action, and in Sensation Seeking scales (*UPPS-P*).

These results provide an important insight into the issue of impulsivity and impulsive behavior of prisoners that in the previous studies were discussed only to a limited extent, whereas this type of assessment for the Czech Republic has been virtually non-existent. Furthermore, based on the type or domain of impulsivity the examiner would like to assess, he/she can select the appropriate measure required for the evaluation. In general, the *UPPS-P model* of impulsivity has been supported as one of the preferential scales recommended for use in practice due to its composite domains and good internal consistency (Hook et al., 2021). Furthermore, the *UPPS-P model* of impulsivity has been studied in terms of the prison population, specifically in relation to the association between aggression, negative urgency and coping deficits, which should be targeted in therapy interventions for this type of population (Bousardt et al., 2016).

One of the primary strengths of this study lies in the specificity of its target population, prisoners serving their sentence, which is not easily accessible in comparison to the general

population. Moreover, advanced understanding and research/data-driven detection of risk factors can better inform treatment needs and requirements in this type of population.

According to Alford and colleagues (2020) factors associated with increased levels of impulsivity in forensic population were a history of traumatic brain injury (TBI), substance/alcohol misuse, a history of traumatic events, and difficulty sleeping. Likewise, increased impulsivity in the prison population has been associated with violence (Fazel et al., 2016), aggression (Værøy, 2016), lifetime drug use (Bernstein et al., 2015), and various psychopathology, including personality disorders (Warren et al., 2012). Furthermore, self-reported measures of impulsivity have been shown to be a consistent predictor associated with problematic behaviors, specifically for substance use samples and for individuals with higher levels of psychopathology (Huddy, n.d.). Accordingly, interventions targeted at emotions based rash action, conscientiousness based impulsivity, and sensation seeking will help reduce not only institutional aggression and improve prison adjustment, but will further tap into different patterns of substance misuse in this population (Vassileva & Conrod, 2019; Værøy, Western & Andersson, 2016). Likewise, interventions aimed at rapid-response impulsivity could help with management of the Antisocial Personality Disorder, which is highly prevalent in the prison population, 71,9% in a European sample of prisoners (Azevedo et al., 2020; Swann et al., 2009). However, it is important to remember that in terms of Criminality other characteristics, such as Alienation and Interpersonal Problems (Kroner & Reddon, 1995) are equally as important as impulsivity and should be collectively targeted in the multidimensional treatment/prevention efforts.

Referring to the limitations of this study, it is essential to emphasize certain limitations that have potentially influenced our findings. One of the primary considerations pertains to the sample structure of our target and control groups. Regrettably, we were unable to achieve a fully balanced demographic distribution across these groups due to a combination of

logistical and unforeseen constraints. These disparities in demographic characteristics could potentially introduce confounding variables, thereby complicating our interpretation of the data. Therefore, two complementary statistical approaches were utilized. The first was to conduct multivariate analyses that controlled for demographic characteristics, thus adjusting our findings for potential confounding effects. The second was to use stratified analyses, which allowed us to compare the effect of impulsivity within each demographic subgroup. Despite this limitation, we believe in the value and validity of our substantive findings, which can still provide a solid foundation for future research.

In further limitations of this study, it should be noted that some of the prisoners did not complete or refused to finish all three self-reported questionnaires of impulsivity. One might hypothesize that this unwillingness could be associated with higher levels of impulsivity in this group, in terms of more impulsive individuals refusing to cooperate in longer assessments. Furthermore, regardless of the informed consent and guaranteed data anonymity, some of the prisoners likely feared the influence of the assessment on their conditional release, parole, or other benefits in the prison. Likewise, impulsive prisoners could have underreported their levels of impulsivity, in order to produce socially desirable responses and appear less impulsive, aggressive or problematic. Therefore, the measured levels of impulsivity in the prisoner group could be significantly higher than reported results with its corresponding effect size, making the differences of our results even more pronounced.

Impulsivity was assessed by self-report questionnaires. Due to the time constraints and anonymity, no clinical evaluation or information about the number of institutional infractions was obtained by the researchers. Furthermore, analyses based on the type of crime and criminal history were difficult since many of the participants had long standing history of crime, which included property crimes, such as theft, robbery or justice obstruction, as well as violent type of crimes, such as larceny, battery, bodily harm or grievous bodily harm.

Thus, future studies should incorporate other measures of impulsivity, such as the behavioral measures of risk taking or delay discounting, to mitigate the influence of social desirability and potential dissimulation. The self-reported measures of impulsivity could be also accompanied by clinical evaluation of the researchers or prison psychologists or assessed in the context of objective measures related to prison adjustment, such as the number of institutional infractions. Furthermore, the methodology of the assessment should be clear and concise, in order to avoid any unnecessary prolongation of the testing period.

In general, a better understanding of impulsivity in the prison population may lead to better psychoeducation of prisoners and correctional staff, better communication between prisoners and correctional staff, more effective and targeted interventions for problematic prisoners, and increased safety and security in the prison. For example, the relationship between impulsivity and emotion based rash action or sensation seeking could be incorporated into special programs or therapeutic groups for prisoners with behavioral problems, such as anger management, aggression, or drug abuse. One of these special programs in the Czech Prison Service is TP KEMP, which is based on the principle of cognitive behavioral therapy and focused on emotion regulation, impulsivity, conflict resolution, and crime (Prchal, 2021). The deconstruction of impulsivity in this type of program would allow for better in-depth assessment and examination of this concept. Likewise, this relationship could be clarified to correctional staff, in order to help identify factors leading to emergency and crisis situations in the prison.

Data availability statement:

The data that support the findings of this study are available from the corresponding author, K.P., upon reasonable request.

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Table 1. Demographic characteristics of the dataset, by the study group.

Categorical variables		Group				Total (N=223)	
		Prisoners (N_1=144)		Control group (N_0=79)			
		%	n	%	n	%	n
Gender	Males	63.2%	91	22.8%	18	48.9%	109
	Females	36.8%	53	77.2%	61	51.1%	114
Educational attainment	Primary	50.7%	73	5.1%	4	34.5%	77
	Secondary lower	38.2%	55	19.0%	15	31.4%	70
	Secondary upper	9.7%	14	40.5%	32	20.6%	46
	University	1.4%	2	35.4%	28	13.5%	30
Scale variable		Mean (Std. dev.)	Min. – Max.	Mean (Std. dev.)	Min. – Max.	Mean (Std. dev.)	Min. – Max.
Age		35.7 (12.0)	19 – 72	41.7 (15.8)	18 – 83	37.8 (13.7)	18 – 83

Table 2. Descriptive statistics and *p*-values of the input measures on impulsiveness.

	Mean				Std. dev.				$p_{\text{-Tukey}}$							
	Prisoners		Control		Prisoners		Control									
	Males	Females	Males	Females	Males	Females	Males	Females	Group	Gender	$M_c \times F_c$	$M_c \times M_p$	$M_c \times F_p$	$F_c \times M_p$	$F_c \times F_p$	$M_p \times F_p$
BIS-11	*N*=88	*N*=53	*N*=18	*N*=61	*N*=88	*N*=53	*N*=18	*N*=61								
Attention 1´OF	2.13	2.33	1.98	2.23	0.570	0.696	0.609	0.530	.184	.020*	.406	.758	.139	.764	.798	.223
Cognitive Instability 1´OF	1.88	1.97	1.57	1.82	0.685	0.600	0.456	0.613	.024*	.101	.480	.244	.102	.933	.572	.845
Attentional 2´OF	2.04	2.20	1.83	2.07	0.517	0.610	0.464	0.487	.052	.018*	.309	.423	.056	.975	.617	.319
Motor 1´OF	2.03	2.27	1.75	1.96	0.514	0.567	0.369	0.532	<.001*	.010*	.476	.164	.002*	.802	.009*	.054
Perseverance 1´OF	2.01	2.12	1.68	1.76	0.568	0.596	0.319	0.378	<.001*	.259	.934	.060	.011*	.018*	.002*	.650
Motor 2´OF	2.03	2.21	1.73	1.89	0.457	0.516	0.292	0.414	<.001*	.018*	.557	.053	<.001*	.240	<.001*	.085
Self-Control 1´OF	2.42	2.61	1.99	2.21	0.561	0.608	0.415	0.544	<.001*	.022*	.475	.018*	<.001*	.108	<.001*	.187
Cognitive Complexity 1´OF	2.60	2.63	2.13	2.32	0.518	0.570	0.434	0.479	<.001*	.204	.525	.003*	.003*	.006*	.010*	.995
Nonplanning 2´OF	2.50	2.62	2.06	2.26	0.472	0.558	0.381	0.431	<.001*	.037*	.387	.002*	<.001*	.013*	<.001*	.503
DGI	*N*=80	*N*=39	*N*=18	*N*=56	*N*=80	*N*=39	*N*=18	*N*=56								
Food	2.84	2.88	2.59	2.82	0.634	0.844	0.746	0.915	.235	.305	.677	.584	.564	.999	.989	.997
Physical	2.78	2.68	2.60	2.53	0.635	0.672	0.536	0.569	.106	.389	.970	.674	.970	.084	.632	.829
Social	2.93	2.77	2.65	2.60	0.558	0.640	0.465	0.556	.018*	.276	.991	.226	.874	.006*	.487	.468
Money	2.61	2.94	1.82	2.12	0.833	1.119	0.534	0.910	<.001*	.036*	.610	.005*	<.001*	.011*	<.001*	.230
Achievement	2.82	2.92	2.75	2.68	0.625	0.906	0.579	0.677	.181	.915	.985	.975	.831	.638	.369	.906
UPPS-P	*N*=79	*N*=39	*N*=18	*N*=59	*N*=79	*N*=39	*N*=18	*N*=59								
Negative Urgency	2.59	2.81	1.99	2.28	0.626	0.802	0.593	0.594	<.001*	.021*	.359	.003*	<.001*	.032*	<.001*	.332
Positive Urgency	2.38	2.77	1.83	1.86	0.618	0.753	0.592	0.667	<.001*	.059	.998	.008*	<.001*	<.001*	<.001*	.017*
Emotion Based Rash Action 2´OF	2.48	2.79	1.91	2.07	0.548	0.716	0.570	0.570	<.001*	.021*	.750	.001*	<.001*	<.001*	<.001*	.050*
Sensation Seeking 2´OF	2.89	2.84	2.66	2.02	0.676	0.886	0.488	0.830	<.001*	.007*	.010*	.666	.848	<.001*	<.001*	.987
(Lack of) Premeditation	1.98	2.18	1.88	2.03	0.599	0.933	0.412	0.625	.258	.124	.854	.943	.401	.979	.679	.422
(Lack of) Perseverance	1.88	2.08	1.85	1.98	0.542	0.744	0.402	0.553	.498	.083	.829	.997	.492	.732	.835	.280
Deficits in Conscientiousness ´OF	1.93	2.13	1.87	2.01	0.492	0.757	0.333	0.530	.298	.066	.788	.970	.332	.864	.679	.247

Note. The *BIS-11*, *DGI*, and *UPPS-P* domains are measures of impulsive behavior. Higher scores indicate higher levels of impulsivity. * = Statistically significant; M_c = male controls; M_p = male prisoners; F_c = female control; F_p = female prisoners.

The 2´OF states for a second-order domain, consisting of two first-order domains. The *UPPS-P* domain on *Sensation Seeking* acted as both first-order and seconder-order score, consisting of 12 items.

Table 3. Spearman rank correlation coefficients of the BIS-11, DGI, and UPPS-P domains scores with demographic confounders

	Prisoners (*N* = 141)						Control (*N* = 79)					
	Age		Gender		Education		Age		Gender		Education	
BIS-11	*rho*	*p*-value	*rho*	*p*-value	*rho*	*p*-value	*rho*	*p*-value	*rho*	*p*-value	*rho*	*p*-value
Attention 1´OF	-.183	.030*	.135	.110	-.024	.781	-.169	.136	.178	.117	-.016	.888
Cognitive Instability 1´OF	-.363	< .001*	.102	.228	-.065	.411	-.224	.047*	.173	.127	.078	.492
Attentional 2´OF	-.264	.002*	.124	.144	-.046	.587	-.219	.054	.206	.069	.047	.681
Motor 1´OF	-.245	.003*	.215	.010*	-.120	.157	-.208	.065	.172	.130	.057	.616
Perseverance 1´OF	-.136	.107	.090	.288	.013	.879	-.222	.050*	.121	.289	-.014	.902
Motor 2´OF	-.220	.009*	.171	.043*	-.080	.346	-.280	.012*	.149	.190	.041	.718
Self-Control 1´OF	-.201	.017*	.170	.044*	-.176	.037*	-.121	.289	.154	.176	-.024	.836
Cognitive Complexity 1´OF	-.367	< .001*	.023	.790	-.142	.093	-.149	.189	.170	.135	-.233	.039*
Nonplanning 2´OF	-.308	< .001*	.128	.130	-.182	.031*	-.153	.177	.182	.108	-.112	.324
DGI												
Food	-.243	.008*	-.093	.602	-.093	.313	-.048	.684	.136	.248	.149	.206
Physical	-.149	.105	-.078	.400	.028	.763	-.266	.022*	-.053	.656	.084	.476
Social	-.071	.446	-.114	.217	.073	.431	.064	.589	-.070	.556	-.233	.045*
Money	-.295	.001*	.144	.118	-.031	.741	-.276	.017*	.107	.363	-.045	.705
Achievement	-.076	.412	.006	.946	-.219	.017*	-.172	.144	-.030	.797	-.246	.035*
UPPS-P												
Negative Urgency	-.119	.199	.123	.184	-.078	.403	-.139	.229	.254	.026*	.014	.906
Positive Urgency	-.056	.544	.244	.008*	.049	.597	-.097	.399	.001	.990	.050	.668
Emotion Based Rash Action 2´OF	-.106	.254	.203	.027*	-.015	.873	-.115	.318	.146	.206	.062	.594
Sensation Seeking 2´OF	-.264	.004*	-.011	.905	.107	.249	-.452	< .001*	-.357	.001*	.116	.317
(Lack of) Premeditation	-.161	.082	.050	.594	-.045	.631	-.270	.017*	.093	.423	.045	.697
(Lack of) Perseverance	-.160	.084	.121	.191	-.020	.830	-.217	.058	.087	.454	-.051	.662
Deficits in Conscientiousness 2´OF	-.186	.043*	.086	.353	-.038	.685	-.277	.015*	.084	.466	.009	.936

Note. * = Statistically significant.

Additional Analyses

Table 1 provides demographic characteristic of participants, presented separately by study group (target prisoners, control group) and for the total sample. Altogether, N=223 individuals were included into the study; about two-thirds of the respondents were recruited from the target prison population (N_1=144; 65%), and one-third from the non-prison control group (N_0=79; 35%). Comparing demographics between the two study groups, the prisoners were characterized by significantly higher share of males [$\chi^2(1) = 33.34$, $p < 0.001$], lower educational attainment [$\chi^2(3) = 104.17$, $p < 0.001$], and younger age [$t(221) = 3.20$, $p < 0.001$] than the respondents from control group. The demographic structure of the sample, as described in Table 1, was therefore used as control variables in the second step of the analyses (regression modeling); including four levels of education (*Primary*, *Sec. lower*, *Sec. upper*, *Tertiary*) and quadratic specification form for age of respondent (*Age* and *Age squared*).

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Table 1

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Table 2 provides descriptive statistics of the key measures of impulsivity and their partial domains consecutively for *BIS-11* through *UPPS-P*. As the psychometric scores were computed as a mean of Likert-type responses of an individual across the set of items of a domain, the range of descriptive statistics averaged across all the individuals is also bounded within the same range of values. Namely, as the items of domains for *BIS-11* and *UPPS-P* used a four-point Likert scale, the descriptive statistics in Table 2 range between 1.0 and 4.0. Likewise, as the items of the *DGI* applied a five-point scale, the psychometric scores of its domains are bounded by 1.0 and 5.0.

Some of the respondents, particularly those from the prison group, refused to fill out or did not complete all three questionnaires on impulsivity. Therefore, the total number of

observations for each of the measures was lower than the total sample size and varied between N_{DGI}=193 for *DGI* and N_{BIS}=220 for *BIS-11*.

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Table 2

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In Table 3, pairwise comparisons of the mean domain scores of the target prison group against controls are presented. Here, crude mean values are compared between the groups; thus, unadjusted to demographic confounders. The comparisons are presented consecutively for each of the domains and measures of impulsivity.

For most of the domains in Table 3, the pairwise comparison point to a significantly higher level of impulsiveness among the target group as compared to the controls. The effect size of the difference, as estimated by Cohen's *d*, is also considerably high. In the case of *BIS-11*, the Cohen's *d* exceeds 0.5 in five of the nine domains. In the case of *UPPS-P*, three of the seven domains are even characterized by Cohen's *d* exceeding 0.9. There are, however, some domains characterized by a non-significant difference in the mean scores as well (three domains of *BIS*-11, three domains of *DGI*, and three domains of UPPS-*P*).

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Table 3

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Table 4 provides key outputs of the multiple regression models conducted in the second step of the analysis. In particular, regression coefficients testing for differences in the mean domain scores among the target prisoners as compared to the control group are provided. Here, differences in the scores were explicitly controlled for demographic confounders. In order to follow the effects of the adjustment, both the adjusted and the

unadjusted regression coefficients are presented. The unadjusted coefficients correspond to differences in the crude mean scores as presented in the previous Table 3.

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Table 4

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In general, the results in Table 4 are analogous to results in Table 3. However, there are some important changes that should be highlighted. First, some of the adjusted regression coefficients are larger than the unadjusted ones. Thus, after adjusting for demographic confounders, the observed differences in the level(s) of impulsivity were even more pronounced. Although the target group of prisoners was significantly younger and had lower education than the control group, its higher levels of impulsivity were not attributable to its demographic characteristics. In fact, if the demographics of the target group were similar to the control group, the observed differences would probably be even larger. Second, the corresponding *t*-statistics are also higher. Therefore, the statistical inference on the adjusted coefficients is shifted toward a more significant level of probability. In some of the domains, this shift substantially changed the conclusions of the significance on the differences in the scores between the two study groups.

The first part of Table 4 refers to the regression outputs conducted on the domains of *BIS-11* questionnaire. In the majority of the domains, the results confirm the significance of the prison group as that characterized by higher levels of impulsiveness. This was particularly the case for the following domains: *Motor 1′OF*, *Perseverance 1′OF*, *Self-Control 1′OF*, *Cognitive Complexity 1′OF* as the first-order domains and for two corresponding second-order domains of *Motor 2′OF* and *Nonplanning 2′OF*. In the case of *Cognitive Instability 1′OF*, the adjustment for demographic confounders shifted the significance of the difference in the mean scores under $p < 0.05$ level; thus, pointing to a higher level of impulsiveness

among the target prison group in this domain as well. The adjusted differences in both the *Attention 1´OF* and the *Attentional 2´OF* scores were not significant at the conventional $p < 0.05$ level.

Regarding the regression coefficients conducted on *DGI* in the second part of Table 4, the results confirmed significantly higher levels of impulsivity in three of the five domains. These were the domains of the *Physical*, *Social*, and *Money* facets of the *DGI*. Differences in scores of the *Food* and the *Achievement* domains remained non-significant in both the unadjusted and adjusted regression forms.

In terms of effect size, the significantly higher levels of impulsivity among the prison group was found particularly within the domains of the *UPPS-P* questionnaire, presented in the last part of Table 4. This was the case for the first-order domains of *Negative Urgency* and *Positive Urgency*, the *Emotion Based Rash Action 2´OF* as the second-order domain consisting of the former two ones, and the domain of *Sensation Seeking*. There were, however, also domains with a non-significant difference in the scores between the study groups: *(Lack of) Premeditation*, *(Lack of) Perseverance*, and *Deficits in Conscientiousness 2´OF* as the second-order domain.

Table 1. Demographic characteristics of the dataset, by the study group.

Categorical variables		Group				Total (N=223)	
		Prisoners (N_1=144)		Control group (N_0=79)			
		%	n	%	n	%	n
Gender	Males	63.2%	91	22.8%	18	48.9%	109
	Females	36.8%	53	77.2%	61	51.1%	114
Educational attainment	Primary	50.7%	73	5.1%	4	34.5%	77
	Secondary lower	38.2%	55	19.0%	15	31.4%	70
	Secondary upper	9.7%	14	40.5%	32	20.6%	46
	University	1.4%	2	35.4%	28	13.5%	30
Scale variable		Mean (Std. dev.)	Min. – Max.	Mean (Std. dev.)	Min. – Max.	Mean (Std. dev.)	Min. – Max.
Age		35.7 (12.0)	19 – 72	41.7 (15.8)	18 – 83	37.8 (13.7)	18 – 83

Table 2. Descriptive statistics of the input measures on impulsiveness.

Variable	Total obs.	Mean	Std. dev.	Min.	Max.	No. of domain items
BIS-11 domains scores						
Attention 1´OF	220	2.19	0.600	1.0	3.8	5
Cognitive Instability 1´OF	220	1.86	0.633	1.0	4.0	3
Attentional 2´OF	220	2.07	0.534	1.0	3.6	2 (8)
Motor 1´OF	220	2.05	0.539	1.0	3.7	7
Perseverance 1´OF	220	1.94	0.532	1.0	3.5	4
Motor 2´OF	220	2.01	0.470	1.1	3.3	2 (11)
Self-Control 1´OF	220	2.37	0.585	1.2	4.0	6
Cognitive Complexity 1´OF	220	2.49	0.538	1.0	4.0	5
Nonplanning 2´OF	220	2.43	0.505	1.1	3.9	2 (11)
DGI domains scores						
Food	193	2.82	0.775	1.0	5.0	7
Physical	193	2.67	0.620	1.0	4.4	7
Social	193	2.78	0.581	1.4	4.1	7
Money	193	2.46	0.957	1.0	5.0	7
Achievement	193	2.79	0.701	1.0	4.6	7
UPPS-P domains scores						
Negative Urgency	195	2.48	0.693	1.0	4.0	12
Positive Urgency	195	2.25	0.743	1.0	4.0	14
Emotion Based Rash Action 2´OF	195	2.37	0.659	1.1	3.9	2 (26)
Sensation Seeking 2´OF	195	2.59	0.844	1.0	4.0	12
(Lack of) Premeditation	195	2.03	0.674	1.0	4.0	11
(Lack of) Perseverance	195	1.95	0.582	1.0	3.9	10
Deficits in Conscientiousness 2´OF	195	1.99	0.557	1.0	3.7	2 (21)

Note: The *BIS-11*, *DGI*, and *UPPS-P* domains are measures of impulsive behavior. Higher scores indicate higher levels of impulsivity.

The 2´OF states for a second-order domain, consisting of two first-order domains. In brackets, a total number of first-order items for computation of the second-order domain is presented. The *UPPS-P* domain on *Sensation Seeking* acted as both first-order and seconder-order score, consisting of 12 items.

Table 3. Mean response scores of the input measures on impulsiveness, by the study group.

BIS-11 Questionnaire						
Variable (domain) / Group	Mean	Std. Dev.	Obs.	*t*-statistic	*p*-Value	Cohen's *d*
Attention 1´OF						
Control group	2.170	0.555	79	0.424	0.672	0.058
Prisoners	2.204	0.625	141			
Cognitive Instability 1´OF						
Control group	1.761	0.588	79	1.759	0.080	0.241
Prisoners	1.913	0.653	141			
Attentional 2´OF						
Control group	2.019	0.490	79	1.085	0.279	0.148
Prisoners	2.097	0.557	141			
Motor 1´OF						
Control group	1.910	0.505	79	2.907	0.004	0.402
Prisoners	2.122	0.544	141			
Perseverance 1´OF						
Control group	1.744	0.365	79	4.860	< 0.001	0.607
Prisoners	2.053	0.578	141			
Motor 2´OF						
Control group	1.850	0.393	79	4.089	< 0.001	0.544
Prisoners	2.097	0.487	141			
Self-Control 1´OF						
Control group	2.158	0.523	79	4.351	< 0.001	0.595
Prisoners	2.492	0.585	141			
Cognitive Complexity 1´OF						
Control group	2.278	0.473	79	4.788	< 0.001	0.653
Prisoners	2.613	0.536	141			
Nonplanning 2´OF						
Control group	2.213	0.426	79	5.198	< 0.001	0.699
Prisoners	2.547	0.507	141			

Notes: The *t*-statistics and Cohen's *d* compare mean response scores among the target Criminal group (1) against the Control group (0); i.e. (1) – (0).

Two-sample *t*-tests with unequal variances.

Cohen's *d* corrected for uneven groups.

Table 3. ***(cont.)*** **(Mean response scores of the input measures on impulsiveness, by the study group.)**

	DGI Questionnaire					
Variable / Group	Mean	Std. Dev.	Obs.	*t*-statistic	*p*-Value	Cohen's *d*
Food						
Control group	2.766	0.878	74	0.734	0.464	0.115
Prisoners	2.855	0.706	119			
Physical						
Control group	2.546	0.558	74	2.321	0.021	0.334
Prisoners	2.750	0.646	119			
Social						
Control group	2.616	0.533	74	3.230	0.001	0.470
Prisoners	2.881	0.589	119			
Money						
Control group	2.044	0.841	74	5.153	< 0.001	0.746
Prisoners	2.717	0.945	119			
Achievement						
Control group	2.695	0.652	74	1.572	0.118	0.228
Prisoners	2.854	0.726	119			

Notes: The *t*-statistics and Cohen's *d* compare mean response scores among the target Criminal group (1) against the Control group (0); i.e. (1) – (0).

Two-sample *t*-tests with unequal variances.

Cohen's *d* corrected for uneven groups.

Table 4. Outputs from multiple linear regression. Differences in the mean scores between study groups: i) unadjusted; ii) adjusted to demographic confounders.

Prisoners=1 *vs.* Control group=0 (reference group).

BIS-11 Questionnaire							
Dependent variable (domain)	Coef.	Cluster Robust SE	*t*-statistic	*p*-Value	95% Lower	95% Upper	Stand. Coef.
Attention 1´OF							
Unadjusted	0.035	0.097	0.36	0.725	-0.173	0.242	0.028
Adjusted	0.146	0.096	1.51	0.152	-0.061	0.353	0.117
Cognitive Instability 1´OF							
Unadjusted	0.151	0.081	1.87	0.083	-0.022	0.325	0.115
Adjusted	0.244	0.093	2.62	0.020	0.044	0.444	0.185
Attentional 2´OF							
Unadjusted	0.079	0.089	0.89	0.390	-0.111	0.268	0.071
Adjusted	0.170	0.086	1.99	0.067	-0.013	0.353	0.153
Motor 1´OF							
Unadjusted	0.212	0.121	1.76	0.101	-0.047	0.471	0.189
Adjusted	0.259	0.092	2.82	0.014	0.062	0.456	0.231
Perseverance 1´OF							
Unadjusted	0.310	0.080	3.85	0.002	0.137	0.482	0.280
Adjusted	0.315	0.087	3.61	0.003	0.128	0.503	0.285
Motor 2´OF							
Unadjusted	0.247	0.102	2.42	0.030	0.028	0.465	0.253
Adjusted	0.281	0.086	3.27	0.006	0.097	0.465	0.287
Self-Control 1´OF							
Unadjusted	0.334	0.131	2.54	0.023	0.052	0.616	0.275
Adjusted	0.378	0.092	4.09	0.001	0.180	0.576	0.311
Cognitive Complexity 1´OF							
Unadjusted	0.334	0.074	4.52	< 0.001	0.176	0.493	0.299
Adjusted	0.218	0.075	2.91	0.011	0.057	0.379	0.195
Nonplanning 2´OF							
Unadjusted	0.334	0.091	3.65	0.003	0.138	0.530	0.318
Adjusted	0.283	0.074	3.82	0.002	0.124	0.442	0.270

Table 4. ***(cont.)***

DGI Questionnaire							
Dependent variable (domain)	Coef.	Cluster Robust SE	*t*-statistic	*p*-Value	95% Lower	95% Upper	Stand. Coef.
Food							
Unadjusted	0.089	0.117	0.76	0.460	-0.162	0.339	0.056
Adjusted	0.078	0.110	0.71	0.490	-0.158	0.314	0.049
Physical							
Unadjusted	0.204	0.111	1.84	0.087	-0.033	0.441	0.160
Adjusted	0.258	0.104	2.47	0.027	0.034	0.483	0.203
Social							
Unadjusted	0.265	0.086	3.10	0.008	0.082	0.449	0.223
Adjusted	0.334	0.093	3.58	0.003	0.134	0.534	0.280
Money							
Unadjusted	0.673	0.179	3.76	0.002	0.289	1.056	0.341
Adjusted	0.704	0.172	4.10	0.001	0.336	1.073	0.357
Achievement							
Unadjusted	0.159	0.113	1.40	0.183	-0.084	0.401	0.110
Adjusted	-0.128	0.196	-0.66	0.522	-0.548	0.291	-0.089

Notes: Robust standard errors (SE) adjusted for clustering of responses within surveyed prisons.

Unadjusted regression coefficients compare crude mean scores of responses between the study groups.

Adjusted regression coefficients are adjusted for effects of the following demographic confounders: *Gender*, *Age*, *Age squared*, *Educational attainment*, and eventual *interactions* between the confounding variables.

Table 4. ***(cont.)***

	UPPS-P Questionnaire						
Dependent variable (domain)	Coef.	Cluster Robust SE	*t*-statistic	*p*-Value	95% Lower	95% Upper	Stand. Coef.
Negative Urgency							
Unadjusted	0.449	0.115	3.90	0.002	0.202	0.696	0.318
Adjusted	0.571	0.092	6.18	< 0.001	0.373	0.769	0.404
Positive Urgency							
Unadjusted	0.658	0.116	5.68	< 0.001	0.409	0.906	0.434
Adjusted	0.797	0.100	7.96	< 0.001	0.582	1.012	0.526
Emotion Based Rash Action 2´OF							
Unadjusted	0.554	0.111	4.98	< 0.001	0.315	0.792	0.412
Adjusted	0.684	0.090	7.58	< 0.001	0.491	0.878	0.509
Sensation Seeking 2´OF							
Unadjusted	0.702	0.113	6.19	< 0.001	0.459	0.945	0.408
Adjusted	0.679	0.146	4.65	< 0.001	0.366	0.993	0.394
(Lack of) Premeditation							
Unadjusted	0.054	0.108	0.50	0.623	-0.178	0.287	0.040
Adjusted	0.144	0.077	1.88	0.082	-0.021	0.309	0.105
(Lack of) Perseverance							
Unadjusted	-0.004	0.102	-0.04	0.966	-0.224	0.215	-0.004
Adjusted	0.030	0.092	0.32	0.751	-0.168	0.228	0.025
Deficits in Conscientiousness 2´OF							
Unadjusted	0.025	0.104	0.24	0.813	-0.197	0.247	0.022
Adjusted	0.044	0.078	0.56	0.581	-0.123	0.212	0.039

Notes: Robust standard errors (SE) adjusted for clustering of responses within surveyed prisons.

Unadjusted regression coefficients compare crude mean scores of responses between the study groups.

Adjusted regression coefficients are adjusted for effects of the following demographic confounders: *Gender*, *Age*, *Age squared*, *Educational attainment*, and eventual *interactions* between the confounding variables.

Supplementary materials

Appendix 1A: Pairwise correlations of the *BIS-11* domains scores with demographic confounders, Spearman rank correlation coefficients, N=220 respondents.

***BIS-11* (N=220)**	**Gender** (*Females*=0; *Males*=1)		**Age**		**Educational attainment** (*Primary*=0 through *Secondary upper*=3)	
	Spearman's *rho*	*p*-Value	Spearman's *rho*	*p*-Value	Spearman's *rho*	*p*-Value
Attention 1´OF	-0.133*	0.049	-0.193*	0.004	-0.014	0.841
Cognitive Instability 1´OF	-0.070	0.300	-0.332*	< 0.001	-0.076	0.260
Attentional 2´OF	-0.112^{+}	0.098	-0.264*	< 0.001	-0.036	0.593
Motor 1´OF	-0.102	0.132	-0.274*	< 0.001	-0.172*	0.011
Perseverance 1´OF	0.032	0.636	-0.197*	0.003	-0.195*	0.004
Motor 2´OF	-0.042	0.532	-0.277*	< 0.001	-0.212*	0.002
Self-Control 1´OF	-0.032	0.634	-0.221*	0.001	-0.283*	< 0.001
Cognitive Complexity 1´OF	0.054	0.424	-0.342*	< 0.001	-0.306*	< 0.001
Nonplanning 2´OF	0.009	0.893	-0.306*	< 0.001	-0.325*	< 0.001

* *p*-Value < 0.05; $^{+}$ *p*-Value < 0.1

Appendix 1B: Multiple linear regression of the *BIS-11* domain scores on group-membership and demographic variables, by *BIS-11* domain, N=220 respondents.

Dependent var.: **Attention 1´OF**	Coef.	Cluster Robust SE	t	P>|t|	Stand. Coef.
Group = Prisoners	**0.146**	**0.096**	**1.51**	**0.152**	**0.117**
Age (number of years since the age of 18 yrs.)	-0.008	0.003	-2.43	0.029	-0.193
Gender = Males	-0.125	0.099	-1.26	0.229	-0.104
Education = Secondary upper	0.415	0.065	6.36	< 0.001	0.282
Males * Secondary upper educ.	-0.412	0.121	-3.40	0.004	-0.174
Constant[a]	2.267	0.072	31.63	< 0.001	.

Adj. R^2 = 0.082

[a] Mean score for the combination of predictors: Control group, Females, Age of 18, education other than Secondary upper.

Dependent var.: **Cognitive Instability 1´OF**	Coef.	Cluster Robust SE	t	P>|t|	Stand. Coef.
Group = Prisoners	**0.244**	**0.093**	**2.62**	**0.020**	**0.185**
Age (number of years since the age of 18 yrs.)	-0.031	0.009	-3.39	0.004	-0.681
[Age (since 18)]^2	$4.1*10^{-4}$	$1.9*10^{-4}$	2.23	0.043	0.486
Gender = Males	-0.089	0.084	-1.06	0.306	-0.070
Education = Secondary lower	-0.161	0.134	-1.20	0.249	-0.119
Education = Secondary upper	0.164	0.165	0.99	0.337	0.105
Education = Tertiary	0.056	0.140	0.40	0.695	0.030
Constant[b]	2.136	0.105	20.39	< 0.001	.

Adj. R^2 = 0.110

[b] Mean score for the combination of predictors: Control group, Females, Age of 18, Primary education.

Dependent var.: **Attentional 2´OF**	Coef.	Cluster Robust SE	t	P>|t|	Stand. Coef.
Group = Prisoners	**0.170**	**0.086**	**1.99**	**0.067**	**0.153**
Age (number of years since the age of 18 yrs.)	-0.009	0.004	-2.66	0.019	-0.243
Gender = Males	-0.106	0.089	-1.20	0.251	-0.100
Education = Secondary upper	0.388	0.077	5.06	< 0.001	0.296
Males * Secondary upper educ.	-0.350	0.095	-3.67	0.003	-0.166
Constant[c]	2.141	0.068	31.64	< 0.001	.

Adj. R^2 = 0.110

[c] Mean score for the combination of predictors: Control group, Females, Age of 18, education other than Secondary upper.

Dependent var.: **Motor 1´OF**	Coef.	Cluster Robust SE	t	P>|t|	Stand. Coef.
Group = Prisoners	**0.259**	**0.092**	**2.82**	**0.014**	**0.231**
Age (number of years since the age of 18 yrs.)	-0.027	0.007	-3.95	0.001	-0.690
[Age (since 18)]^2	$3.6*10^{-4}$	$1.2*10^{-4}$	2.96	0.010	0.502
Gender = Males	-0.207	0.077	-2.70	0.017	-0.192
Constant[d]	2.305	0.111	20.69	< 0.001	.

Adj. R^2 = 0.122

[d] Mean score for the combination of predictors: Control group, Females, Age of 18.

Dependent var.: **Perseverance 1´OF**	Coef.	Cluster Robust SE	t	P>|t|	Stand. Coef.
Group = Prisoners	**0.315**	**0.087**	**3.61**	**0.003**	**0.285**
Age (number of years since the age of 18 yrs.)	-0.005	0.003	-1.99	0.067	-0.131
Gender = Males	-0.094	0.093	-1.01	0.328	-0.088
Constant[e]	1.886	0.075	25.14	< 0.001	.

Adj. R^2 = 0.090

[e] Mean score for the combination of predictors: Control group, Females, Age of 18.

Dependent var.: **Motor 2´OF**	Coef.	Cluster Robust SE	t	P>|t|	Stand. Coef.
Group = Prisoners	**0.281**	**0.086**	**3.27**	**0.006**	**0.287**
Age (number of years since the age of 18 yrs.)	-0.023	0.005	-4.36	0.001	-0.660
[Age (since 18)]^2	$3.0*10^{-4}$	$9.3*10^{-5}$	3.21	0.006	0.475
Gender = Males	-0.164	0.079	-2.08	0.056	-0.175
Constant[f]	2.180	0.088	24.91	< 0.001	.

Adj. R^2 = 0.141

[f] Mean score for the combination of predictors: Control group, Females, Age of 18.

Dependent var.: **Self-Control 1´OF**	Coef.	Cluster Robust SE	t	P>|t|	Stand. Coef.
Group = Prisoners	**0.378**	**0.092**	**4.09**	**0.001**	**0.311**
Age (number of years since the age of 18 yrs.)	-0.005	0.002	-2.80	0.014	-0.110
Gender = Males	-0.174	0.108	-1.61	0.130	-0.149
Education = Secondary lower	-0.272	0.098	-2.79	0.015	-0.217
Education = Tertiary	-0.188	0.051	-3.70	0.002	-0.111
Criminals * Tertiary educ.	-0.972	0.238	-4.08	0.001	-0.158
Constant[g]	2.427	0.080	30.41	< 0.001	.

Adj. R^2 = 0.172

[g] Mean score for the combination of predictors: Control group, Females, Age of 18, Primary or Secondary upper education.

Dependent var.: **Cognitive Complexity 1´OF**	Coef.	Cluster Robust SE	t	P>|t|	Stand. Coef.
Group = Prisoners	**0.218**	**0.075**	**2.91**	**0.011**	**0.195**
Age (number of years since the age of 18 yrs.)	-0.033	0.007	-4.34	0.001	-0.830
[Age (since 18)]^2	$4.4*10^{-4}$	$1.3*10^{-4}$	3.38	0.005	0.612
Gender = Males	-0.062	0.076	-0.81	0.433	-0.057
Education = Tertiary	-0.294	0.043	-6.86	< 0.001	-0.188
Constant[h]	2.810	0.081	34.9	< 0.001	.

Adj. R^2 = 0.200

[h] Mean score for the combination of predictors: Control group, Females, Age of 18, education lower than Tertiary.

Dependent var.: **Nonplanning 2´OF**	Coef.	Cluster Robust SE	t	P>|t|	Stand. Coef.
Group = Prisoners	**0.283**	**0.074**	**3.82**	**0.002**	**0.270**
Age (number of years since the age of 18 yrs.)	-0.024	0.004	-5.77	< 0.001	-0.652
[Age (since 18)]^2	$3.2*10^{-4}$	$7.7*10^{-5}$	4.23	0.001	0.479
Gender = Males	-0.117	0.088	-1.33	0.205	-0.116
Education = Secondary lower	-0.155	0.076	-2.04	0.061	-0.143
Education = Tertiary	-0.287	0.067	-4.28	0.001	-0.195
Constant[i]	2.676	0.068	39.31	< 0.001	.

Adj. R^2 = 0.210

[i] Mean score for the combination of predictors: Control group, Females, Age of 18, Primary or Secondary upper education.

Appendix 2A: Pairwise correlations of the *DGI* domains scores with demographic confounders, Spearman rank correlation coefficients, N=193 respondents.

***DGI* (N=193)**	**Gender** (*Females*=0; *Males*=1)		**Age**		**Educational attainment** (*Primary*=0 through *Secondary upper*=3)	
	Spearman's *rho*	*p*-Value	Spearman's *rho*	*p*-Value	Spearman's *rho*	*p*-Value
Food	-0.035	0.627	-0.164*	0.023	-0.056	0.439
Physical	0.128^{+}	0.075	-0.228*	0.001	-0.067	0.353
Social	0.175*	0.015	-0.066	0.366	-0.180*	0.012
Money	0.038	0.600	-0.327*	< 0.001	-0.271*	< 0.001
Achievement	0.046	0.529	-0.138^{+}	0.055	-0.212*	0.003

* *p*-Value < 0.05

$^{+}$ *p*-Value < 0.1

Appendix 2B: Multiple linear regression of the *DGI* domain scores on group-membership and demographic variables, by *DGI* domain, N=193 respondents.

Dependent var.: **Food**	Coef.	Cluster Robust SE	t	P>|t|	Stand. Coef.
Group = Prisoners	**0.078**	**0.110**	**0.71**	**0.490**	**0.049**
Age (number of years since the age of 18 yrs.)	-0.011	0.006	-2.00	0.065	-0.200
Gender = Males	-0.279	0.145	-1.92	0.075	-0.180
Males * Age (since 18)	0.009	0.006	1.46	0.166	0.142
Constant[a]	3.055	0.124	24.54	< 0.001	.

Adj. R^2 = 0.010

[a] Mean score for the combination of predictors: Control group, Females, Age of 18.

Dependent var.: **Physical**	Coef.	Cluster Robust SE	t	P>|t|	Stand. Coef.
Group = Prisoners	**0.258**	**0.104**	**2.47**	**0.027**	**0.203**
Age (number of years since the age of 18 yrs.)	-0.008	0.002	-4.17	0.001	-0.173
Gender = Males	0.104	0.084	1.23	0.238	0.084
Education = Secondary upper	0.298	0.095	3.14	0.007	0.204
Education = Tertiary	0.142	0.135	1.05	0.311	0.083
Constant[b]	2.522	0.124	20.41	< 0.001	.

Adj. R^2 = 0.062

[b] Mean score for the combination of predictors: Control group, Females, Age of 18, Primary or Secondary lower education.

Dependent var.: **Social**	Coef.	Cluster Robust SE	t	P>|t|	Stand. Coef.
Group = Prisoners	**0.334**	**0.093**	**3.58**	**0.003**	**0.280**
Age (number of years since the age of 18 yrs.)	$-2.1*10^{-5}$	$2.8*10^{-3}$	-0.01	0.994	-0.001
Gender = Males	0.137	0.058	2.36	0.033	0.118
Education = Secondary upper	0.395	0.073	5.45	< 0.001	0.289
Constant[c]	2.412	0.086	27.93	< 0.001	.

Adj. R^2 = 0.112

[c] Mean score for the combination of predictors: Control group, Females, Age of 18, education other than Secondary upper.

Dependent var.: **Money**	Coef.	Cluster Robust SE	t	P>|t|	Stand. Coef.
Group = Prisoners	**0.704**	**0.172**	**4.10**	**0.001**	**0.357**
Age (number of years since the age of 18 yrs.)	-0.018	0.004	-4.95	< 0.001	-0.263
Gender = Males	-0.342	0.159	-2.16	0.049	-0.178
Constant[d]	2.561	0.113	22.58	< 0.001	.

Adj. R^2 = 0.193

[d] Mean score for the combination of predictors: Control group, Females, Age of 18.

Dependent var.: **Achievement**	Coef.	Cluster Robust SE	t	P>|t|	Stand. Coef.
Group = Prisoners	**-0.128**	**0.196**	**-0.66**	**0.522**	**-0.089**
Age (number of years since the age of 18 yrs.)	-0.005	0.002	-3.17	0.007	-0.107
Education = Secondary lower	-0.256	0.111	-2.30	0.037	-0.165
Education = Secondary upper	-0.244	0.145	-1.68	0.115	-0.147
Education = Tertiary	-0.654	0.212	-3.09	0.008	-0.339
Constant[e]	3.211	0.200	16.06	< 0.001	.

Adj. R^2 = 0.064

[e] Mean score for the combination of predictors: Control group, Age of 18, Primary education.

Appendix 3A: Pairwise correlations of the *UPPS-P* domains scores with demographic confounders, Spearman rank correlation coefficients, N=195 respondents.

UPPS-P (N=195)	**Gender** (*Females*=0; *Males*=1)		**Age**		**Educational attainment** (*Primary*=0 through *Secondary upper*=3)	
	Spearman's *rho*	*p*-Value	Spearman's *rho*	*p*-Value	Spearman's *rho*	*p*-Value
Negative Urgency	0.017	0.811	-0.176*	0.014	-0.250*	< 0.001
Positive Urgency	0.067	0.354	-0.151*	0.035	-0.270*	< 0.001
Emotion Based Rash Action 2´OF	0.044	0.546	-0.184*	0.010	-0.277*	< 0.001
Sensation Seeking 2´OF	0.285*	< 0.001	-0.374*	< 0.001	-0.187*	0.009
(Lack of) Premeditation	-0.059	0.411	-0.197*	0.006	-0.005	0.943
(Lack of) Perseverance	-0.111	0.123	-0.185*	0.010	-0.009	0.901
Deficits in Conscientiousness 2´OF	-0.085	0.239	-0.220*	0.002	-0.009	0.907

* *p*-Value < 0.05

Appendix 3B: Multiple linear regression of the *UPPS-P* domain scores on group-membership and demographic variables, by *UPPS-P* domain, N=195 respondents.

Dependent var.: **Negative Urgency**	Coef.	Cluster Robust SE	t	P>|t|	Stand. Coef.
Group = Prisoners	**0.571**	**0.092**	**6.18**	**< 0.001**	**0.404**
Age (number of years since the age of 18 yrs.)	-0.030	0.008	-3.58	0.003	-0.598
[Age (since 18)]^2	$5.1*10^{-4}$	$1.3*10^{-4}$	3.89	0.002	0.563
Gender = Males	-0.230	0.102	-2.26	0.040	-0.167
Criminals * Tertiary educ.	-0.969	0.255	-3.80	0.002	-0.141
Constant[a]	2.553	0.106	24.01	< 0.001	.

Adj. R-squared = 0.162
[a] Mean score for the combination of predictors: Control group, Females, Age of 18.

Dependent var.: **Positive Urgency**	Coef.	Cluster Robust SE	t	P>|t|	Stand. Coef.
Group = Prisoners	**0.797**	**0.100**	**7.96**	**< 0.001**	**0.526**
Age (number of years since the age of 18 yrs.)	-0.031	0.013	-2.3	0.037	-0.581
[Age (since 18)]^2	$5.8*10^{-4}$	$2.2*10^{-4}$	2.65	0.019	0.589
Gender = Males	-0.246	0.123	-2.01	0.065	-0.166
Criminals * Tertiary educ.	-0.702	0.272	-2.59	0.022	-0.095
Constant[b]	2.172	0.147	14.81	< 0.001	.

Adj. R-squared = 0.239
[b] Mean score for the combination of predictors: Control group, Females, Age of 18.

Dependent var.: **Emotion Based Rash Action 2´OF**	Coef.	Cluster Robust SE	t	P>|t|	Stand. Coef.
Group = Prisoners	**0.684**	**0.090**	**7.58**	**< 0.001**	**0.509**
Age (number of years since the age of 18 yrs.)	-0.030	0.009	-3.19	0.007	-0.642
[Age (since 18)]^2	$5.4*10^{-4}$	$1.5*10^{-4}$	3.58	0.003	0.628
Gender = Males	-0.238	0.101	-2.36	0.033	-0.181
Criminals * Tertiary educ.	-0.836	0.098	-8.49	< 0.001	-0.128
Constant[c]	2.363	0.111	21.26	< 0.001	.

Adj. R-squared = 0.239

[c] Mean score for the combination of predictors: Control group, Females, Age of 18.

Dependent var.: **Sensation Seeking 2´OF**	Coef.	Cluster Robust SE	t	P>|t|	Stand. Coef.
Group = Prisoners	**0.679**	**0.146**	**4.65**	**< 0.001**	**0.394**
Age (number of years since the age of 18 yrs.)	-0.019	0.003	-6.27	< 0.001	-0.306
Gender = Males	0.261	0.146	1.78	0.096	0.155
Education = Secondary upper	0.352	0.103	3.41	0.004	0.174
Education = Tertiary educ.	0.262	0.107	2.44	0.028	0.112
Constant[d]	2.306	0.139	16.54	< 0.001	.

Adj. R-squared = 0.277

[d] Mean score for the combination of predictors: Control group, Females, Age of 18, Primary or Secondary lower education.

Dependent var.: **(Lack of) Premeditation**	Coef.	Cluster Robust SE	t	P>|t|	Stand. Coef.
Group = Prisoners	**0.144**	**0.077**	**1.88**	**0.082**	**0.105**
Age (number of years since the age of 18 yrs.)	-0.016	0.002	-7.17	< 0.001	-0.324
Gender = Males	-0.354	0.116	-3.06	0.009	-0.263
Education = Secondary upper	0.454	0.122	3.73	0.002	0.280
Males * Age (since 18)	0.014	0.005	3.08	0.008	0.262
Males * Secondary upper	-0.502	0.154	-3.25	0.006	-0.193
Constant[e]	2.237	0.062	36.06	< 0.001	.

Adj. R-squared = 0.085

[e] Mean score for the combination of predictors: Control group, Females, Age of 18, education other than Secondary upper.

Dependent var.: **(Lack of) Perseverance**	Coef.	Cluster Robust SE	t	P>|t|	Stand. Coef.
Group = Prisoners	**0.030**	**0.092**	**0.32**	**0.751**	**0.025**
Age (number of years since the age of 18 yrs.)	-0.008	0.002	-3.53	0.003	-0.181
Gender = Males	-0.185	0.098	-1.88	0.081	-0.159
Constant[f]	2.176	0.074	29.28	< 0.001	.

Adj. R-squared = 0.036

[f] Mean score for the combination of predictors: Control group, Females, Age of 18.

Dependent var.: **Deficits in Conscientiousness 2´OF**	Coef.	Cluster Robust SE	t	P>|t|	Stand. Coef.
Group = Prisoners	**0.044**	**0.078**	**0.56**	**0.581**	**0.039**
Gender = Males	-0.377	0.097	-3.88	0.002	-0.339
Age (number of years since the age of 18 yrs.)	-0.012	0.003	-4.76	0.000	-0.308
Males * Age (since 18)	0.010	0.004	2.75	0.016	.
Constant[g]	2.306	0.078	29.61	0.000	

Adj. R-squared = 0.060

[g] Mean score for the combination of predictors: Control group, Females, Age of 18.

The last section of the Supplementary materials shows between-gender inequalities in the domains of impulsivity, as stratified by the study group. We provide this information both for the sake of comprehensiveness and for further curiosity that can eventually arise for practical reasons in clinical settings. For formal assessment of statistical significance of the between-gender inequalities, we also provide *t*-tests of the differences in domain scores between the males and females of the study group.

As presented in the table of Appendix 4, females scored higher on majority of the domains, with a handful of domains found to be even statistically significantly higher compared to their male counterparts of the group. The only domain with significantly higher scoring among males was the sensation seeking (2n order domain), with significant gender differences namely among the respondents from the control group.

Appendix 4: Between-gender inequalities of the input measures on impulsiveness, by study group.

	Group												***t*-tests, by Group**					
	Prisoners						**Control group**						**Prisoners**			**Controls**		
	Males			Females			Males			Females			*t*-statistic	(df)	*p*-Value	*t*-statistic	(df)	*p*-Value
	Mean	(SD)	N	Mean	(SD)	N	Mean	(SD)	N	Mean	(SD)	N	[Males - Females]			[Males - Females]		
[column number]	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]
BIS-11 domains scores																		
Attention 1´OF	2.13	(0.570)	88	2.33	(0.696)	53	1.98	(0.609)	18	2.23	(0.530)	61	+ t = -1.843	(139)	0.067	+ t = -1.689	(77)	0.095
Cognitive Instability 1´OF	1.88	(0.685)	88	1.97	(0.600)	53	1.57	(0.456)	18	1.82	(0.613)	61	t = -0.789	(139)	0.432	t = -1.550	(77)	0.125
Attentional 2´OF	2.04	(0.517)	88	2.20	(0.610)	53	1.83	(0.464)	18	2.07	(0.487)	61	t = -1.639	(139)	0.104	+ t = -1.903	(77)	0.061
Motor 1´OF	2.03	(0.514)	88	2.27	(0.567)	53	1.75	(0.369)	18	1.96	(0.532)	61	* t = -2.502	(139)	0.014	t = -1.502	(77)	0.137
Perseverance 1´OF	2.01	(0.568)	88	2.12	(0.596)	53	1.68	(0.319)	18	1.76	(0.378)	61	t = -1.031	(139)	0.304	t = -0.834	(77)	0.407
Motor 2´OF	2.03	(0.457)	88	2.21	(0.516)	53	1.73	(0.292)	18	1.89	(0.414)	61	* t = -2.226	(139)	0.028	t = -1.511	(77)	0.135
Self-Control 1´OF	2.42	(0.561)	88	2.61	(0.608)	53	1.99	(0.415)	18	2.21	(0.544)	61	* t = -1.938	(139)	0.055	t = -1.551	(77)	0.125
Cognitive Complexity 1´OF	2.60	(0.518)	88	2.63	(0.570)	53	2.13	(0.434)	18	2.32	(0.479)	61	t = -0.234	(139)	0.816	t = -1.492	(77)	0.140
Nonplanning 2´OF	2.50	(0.472)	88	2.62	(0.558)	53	2.06	(0.381)	18	2.26	(0.431)	61	t = -1.318	(139)	0.190	+ t = -1.805	(77)	0.075
DGI domains scores																		
Food	2.84	(0.634)	80	2.88	(0.844)	39	2.59	(0.746)	18	2.82	(0.915)	56	t = -0.223	(117)	0.824	t = -0.994	(72)	0.324
Physical	2.78	(0.635)	80	2.68	(0.672)	39	2.60	(0.536)	18	2.53	(0.569)	56	t = 0.812	(117)	0.419	t = 0.494	(72)	0.623
Social	2.93	(0.558)	80	2.77	(0.640)	39	2.65	(0.465)	18	2.60	(0.556)	56	t = 1.407	(117)	0.162	t = 0.318	(72)	0.751
Money	2.61	(0.833)	80	2.94	(1.119)	39	1.82	(0.534)	18	2.12	(0.910)	56	+ t = -1.830	(117)	0.070	t = -1.319	(72)	0.191
Achievement	2.82	(0.625)	80	2.92	(0.906)	39	2.75	(0.579)	18	2.68	(0.677)	56	t = -0.651	(117)	0.516	t = 0.380	(72)	0.705

UPPS-P domains scores																				
Negative Urgency	2.59	(0.626)	79	2.81	(0.802)	39	1.99	(0.593)	18	2.28	(0.594)	59		t = -1.602	(116)	0.112	+	t = -1.802	(75)	0.076
Positive Urgency	2.38	(0.618)	79	2.77	(0.753)	39	1.83	(0.592)	18	1.86	(0.667)	59	*	t = -2.963	(116)	0.004		t = -0.178	(75)	0.859
Emotion Based Rash Action 2´OF	2.48	(0.548)	79	2.79	(0.716)	39	1.91	(0.570)	18	2.07	(0.570)	59	*	t = -2.529	(116)	0.013		t = -1.040	(75)	0.302
Sensation Seeking 2´OF	2.89	(0.676)	79	2.84	(0.886)	39	2.66	(0.488)	18	2.02	(0.830)	59		t = 0.337	(116)	0.737	*	t = 3.120	(75)	0.003
(Lack of) Premeditation	1.98	(0.599)	79	2.18	(0.933)	39	1.88	(0.412)	18	2.03	(0.625)	59		t = -1.419	(116)	0.159		t = -0.923	(75)	0.359
(Lack of) Perseverance	1.88	(0.542)	79	2.08	(0.744)	39	1.85	(0.402)	18	1.98	(0.553)	59	+	t = -1.691	(116)	0.094		t = -0.947	(75)	0.347
Deficits in Conscientiousness 2´OF	1.93	(0.492)	79	2.13	(0.757)	39	1.87	(0.333)	18	2.01	(0.530)	59	+	t = -1.748	(116)	0.083		t = -1.049	(75)	0.298

* *p*-Value < 0.05; + *p*-Value < 0.1

Note: Within the study-group, *t*-tests compare mean (SD) of given domain score as computed among Males against that computed among Females. Statistically significant differences are tagged by an asterisk (*), plus sign (+) eventually.

Domains of impulsivity as predictors of aggression in correctional settings – a Czech case-control study

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Abstract

The prevalence of prison violence is steadily increasing. Different theories of aggression attempted to explain and introduce specific models, structures, and predictors of aggressive behaviors, where impulsivity has been frequently cited as an important factor to violence. Thus, using the UPPS-P model of impulsivity and the Buss-Perry Aggression Questionnaire, the current study analyzed the self-reported levels of impulsivity and aggression in a prison population sample and a non-prion control group. The results showed impulsivity as a strong predictor of aggression in both groups, specifically in terms of the Emotion-based Rash Action. Another variable of interest for the prison population sample was Deficits in Conscientiousness. The recommendation for prevention/treatment efforts and future directions are also discussed in the article.

Key words: impulsivity, aggression, UPPS-P, BPAQ, positive urgency, negative urgency

Introduction

According to the World Health Organization the incidence of prison violence in the United States defined in terms of physical assaults is 18 times higher for male inmates and 27 times higher for female inmates in correctional settings in comparison to the general population (Modvig, 2014). Likewise, the Ministry of Justice in the United Kingdom registered 169 prisoner on prisoner assaults per 1,000 prisoners and 101 assaults on staff per 1,000 prisoners during the period of 2020 – 2021 (Ministry of Justice, 2022). The annual report of the Czech Prison Service recorded 45 assaults on staff by prisoners in 2021, and noted that the trend of assaults and violence in prison is steadily increasing (The Czech Prison Service, 2022). Furthermore, 1, 128 cases of inmate-on-inmate violence were recorded by the Czech Prison Service (2022) in 2021. The prevalence of impulsive aggression in a sample of European prisoners diagnosed with the Antisocial Personality Disorder was at 71.9% (Azevedo et al., 2020).

Aggression has been previously defined as an intentional behavior directed to cause harm to another person that is driven to avoid this harm, while violence has been operationalized as aggression with the potential to result in serious physical harm. (DeWall, Anderson, & Bushman, 2012). Various forms of aggression, such as physical, verbal or relational have been identified and studied by many researchers (Hahn et al. 2019; Coyne, & Ostrov, 2018). Accordingly, theories and conceptualizations of aggression attempted to explain the origins of aggressive behavior within its specific domains. A commonly used self-report questionnaire for aggression was refined by Buss and Perry (1992) and utilized four dispositional subtraits of aggression defined as: "*Physical and verbal aggression, which involve hurting or harming others, represent the instrumental or motor component of behavior. Anger, which involves physiological arousal and preparation for aggression, represents the emotional or affective com- ponent of behavior. Hostility, which consists of*

feelings of ill will and in- justice, represents the cognitive component of behavior'' (Buss & Perry, 1992, p. 457). Bryant and Smith (2001) later revised the original aggression questionnaire, while maintaining the initial four-subtrait structure that included physical aggression, verbal aggression, anger and hostility, and improving the statistical precision.

However, the most integrative approach to understanding aggression is provided by the general aggression model, presented by Anderson and Bushman (2002). According to the GAM, aggression is influenced by personality and situational factors (serving as input variables), interplay between cognition, affect and arousal, and outcomes defined by appraisal and decision processes. In this model, negative affect facilitates aggression by triggering the appraisal processes (Anderson & Bushman, 2018). The majority of personality theories recognize trait-like impulsivity as an important predictive factor of aggression (Derefinko et al., 2011; Miller, Zeichner, & Wilson, 2012; Bresin, 2019). Nevertheless, the multidimensional nature of impulsivity poses a challenge in determining lower-order unidimensional traits contributing to the externalizing behaviors, such as aggression or violence (Creswell et al., 2019).

Using the Five Factor Model (FFM) of personality as assessed by the NEO-PI-R (Costa & McCrae, 1992), Whiteside and Lynam (2001) identified four impulsivity-like personality traits indicating unique pathways to impulsive behavior that were based on the Neuroticism, Extraversion, and Conscientiousness factors. The impulsivity-like personality traits included: (negative) urgency, defined as the tendency to act rashly under negative emotion; sensation seeking, defined as the need to seek excitement; (lack of) premeditation, defined as the ability to plan prior to taking an action; and (lack of) perseverance, defined as the ability to persist in the task upon its completion. Additional research later identified positive urgency or the tendency to act rashly under positive emotion, as a distinct factor

contributing to impulsivity, leading to the five-factor model of impulsivity (Cyders & Smith, 2007).

Studies of the four/five-factor UPPS-P impulsivity model focused on its connection to psychopathology and risky behaviors, such as alcohol use and misuse (Coskunpinar et a., 2013), addiction related behaviors (Rømer Thomsen et al., 2018), Borderline Personality Disorder, ADHD, eating problems and risky sexual behaviors (Miller et al., 2003), or self-harm and non-suicidal self-injury (Dir et al., 2013). Several studies also examined the association between these impulsivity factors and violent behaviors or aggression.

In term of violence and aggression, lack of premeditation and sensation seeking were identified as important factors associated with general violence, while emotion based rash action (positive and negative urgency) predicted behaviors related to intimate partner violence (Derefinko, 2012). Likewise, Miller, Zeichner, and Wilson (2012) recognized conscientiousness-based impulsivity and neuroticism-related forms of impulsivity as important correlates of aggression. Specifically, a strong relationship between impulsivity and aggression, displayed by hostility or anger, was found in inmates sentenced for violent crimes, such as murder, attempted murder or violent crimes with sex-related components, while the level of urgency was identified as an important factor that increased the likelihood of committing violent crimes (Værøy, Western & Andersson, 2016).

The purpose of the current study was to analyze the five-factor model of impulsivity and self-reported aggression in a prison population sample and compare its relationship to a non-prison population sample. According to the available research, the authors anticipated to observe significantly higher scores for the prison population in terms of impulsivity, primarily in the domain of emotion based rash action, and aggressiveness, while the relationship was expected to be mediated by urgency.

Methodology

Participants

Prison population

One hundred and eighteen inmates (79 males, 39 females) participated in this study. The identified criminal activities ranged from property crimes (e.g. theft, fraud, obstruction of justice) to violent crimes/felonies (e.g. robbery, grievous bodily harm, attempted murder or murder). Participating inmates were classified as medium or maximum security level, according to the duration of the sentence, the criminal nature (violence, drugs, and sex offenses), and the number of previous incarcerations. All participants were at least 18 years of age. The mean age of the sample was 35.7 years (SD = 11.9). In terms of their educational attainment, most inmates received only primary education (49.2%) or some type of vocational training (39.8%).

General population (comparison/control group)

Seventy-seven participants (18 males, 59 females) were recruited from a community sample in Prague via news-paper advertisements, fliers, and social media platforms. All participants were at least 18 years of age. The mean age of the sample was 41.8 years (SD = 16.0). The majority of this sample graduated from high school (41.6%), obtained a university degree (36.4%), or received some type of vocational training (16.9%).

Measures

The UPPS-P Impulsive Behavior Scale is a 59-item measure of impulsivity (Whiteside & Lynman, 2001). Items are evaluated on 4-point Likert type scale, ranging from 1 (*strongly agree*) to 4 (*strongly disagree*). Studies confirmed good psychometric properties of this questionnaire (Cyders & Smith, 2007).

The Buss-Perry Aggression Questionnaire Short-Form (BPAQ-SF) is a 12-item self-report measure of aggression defined by physical aggression, verbal aggression, anger and

hostility with GFI = 0.94 (Bryant & Smith, 2001). Items are scored on 5-point Likert type scale ranging from 1 (*very unlike me*) to 5 (*very like me*). Studies showed good psychometric properties of this measure in general population of offenders, while the confirmatory factor analysis supported the original four factor structure (Diamond & Magaletta, 2006).

Statistical analysis

The analyses were conducted in *Stata IC/15.1* statistical software. First, pairwise correlation coefficients were computed for each of the UPPS-P domains of impulsivity and the BPAQ domains of aggression in both groups. According to the distribution of the data, Spearman´s rank correlation coefficients was used as the non-parametric test. Subsequently, partial correlations between the domains of impulsivity and aggression were calculated, in order to control for the potential demographic confounders (gender, age, and educational attainment).

Next, the log-linear multiple regression analyses of the impulsivity and aggression domains were computed for both groups. Within the regression analyses, significant heteroscedasticity in residuals was identified. Therefore, the log-transformed values of the dependent variables were used in the regression models rather than the original aggression scores. The log-transformation removed model specification issues and improved statistical inference on the estimated regression coefficients. The regression coefficients were also multiple adjusted to the respondent's demographic background (gender, age, and educational attainment), i.e. to the confounders that were considered in the previous steps of the analyses.

Subsequently, the Nested multiple regression models were computed with log-transformed values for the BPAQ-SF Total score. The partial (M1) and the full (M2) mediation analyses were preformed, controlling for demographic confounders and the Emotion-based Rash Action from the UPPS-P scale.

Results

Table 1 provides descriptive characteristics of the dataset and the key variables used in the analyses. The descriptive statistics (mean, std. dev, min-max) for aggression (BPAQ-SF) and impulsivity (UPPS-P) measures are available in detail for both 1st order and 2nd order domains. Reported is also the number of questionnaire items that were used for the computation of each domain. Data are presented separately for the prison group (N_1=118) and the non-prison comparison group (N_0=77) with included demographic characteristics of the two identified groups.

Referring to the mean values of the BPAQ-SF domains of aggression, the prisoners were characterized by a significantly higher level of aggression in comparison to the non-prison control group. This can be formally documented by *t*-test on the between-group differences of the total aggression score as well as its 1st-order domains (physical through hostility); two-sample *t*-tests with unequal variances: Total score (t=6.047, $d.f.$=193, p<0.001), Physical (t=6.214, $d.f.$=193, p<0.001), Verbal (t=3.610, $d.f.$=193, p<0.001), Anger (t=3.196, $d.f.$=193, p=0.002), Hostility (t=6.870, $d.f.$=193, p<0.001). Similarly, mean scores on the domains of impulsivity in the prisoners were higher; particularly in the UPPS-P domains of Emotion-based Rash Action and Sensation Seeking. However, no between-group differences were found in the Deficits in Conscientiousness and its two 1st-order domains (lack of premeditation and lack of perseverance).

In Table 2, pairwise relationship between the domains of aggression and impulsivity are presented, quantified by the Spearman´s rank correlation coefficients. This non-parametric coefficient is robust against the deviations of the data from a theoretical normal (Gaussian) distribution. However, it is unable to provide correlations adjusted for a set of presumable confounders. Therefore, the pairwise correlations in Table 2 are rather descriptive in nature and serve as a starting point for next steps of the analysis. Nevertheless, most of the pairwise correlations between the BPAQ-SF and UPPS-P domains are substantial in terms of both their

magnitude and associated *p*-values. This is particularly notable for the correlations between the UPPS-P domains of Emotion-based Rash Action (both 1st order and 2nd order) with aggression among both the group of prisoners and the non-prison comparison group. However, there are also some relatively low and non-significant correlations as well, particularly for the pairwise relationship between Sensation Seeking and domains of aggression in the non-prison comparison group.

Table 3 presents partial correlation coefficients between UPPS-P and BPAQ-SF domains controlled for socio-demographic variables and adjusted for the selected confounders that played significant role in this relationship. Namely, higher-order partial correlations presented and adjusted for age, gender, and educational attainment of the participants.[1] The analytical outputs were again derived separately for the target group of prisoners and for the non-prison comparison group.

Comparing the multiple-adjusted partial correlations in Table 3 and in Table 2, both outputs of the correlation analyses provide similar results. Although the correlation coefficients in Table 3 are lower in their magnitude[2], the results point to a strong relationship particularly between the UPPS-P domains of Emotion-based Rash Action with all of the BPAQ-SF domains of aggression among both group of prisoners and non-prison comparison group. Next to the Emotion-Based Rash Action, the partial correlations of Deficits in Conscientiousness (both 1st and 2nd order) with aggression are also substantial; particularly

[1] Generally speaking, the average level of both aggression and impulsivity increased not only with the group-membership of respondent (prisoners vs. non-prison comparison group) but was also related to selected demographic characteristics – specifically, younger age and lower education. For these reasons, the correlation analysis was performed not only separately according to the group of respondents (prisoners; comparison group), but also with an additional adjustment on the respondent's demographic background. Table 3 presents group-specific partial correlations that are multiple adjusted to respondent's: i) *Gender* (males, females), ii) *Age* (scale variable), and iii) *Educational attainment* (four levels of education); i.e. adjusted to the same demographic categories as presented in the initial Table 1.

[2] Strictly, the non-parametric Spearman´s rank correlations are not directly comparable with the (parametric) partial correlation coefficients. However, we note here that the zero-order correlations, as obtained by Pearson correlation coefficients, were similar to those presented in Table 2 and quantified by the Spearman´s rank method. The change in the magnitude of the higher-order coefficients that are presented in Table 3 is due to the fact that part of the covariance between the BPAG-SF and UPPS-P domains is taken away by the demographic confounders.

among the target group of prisoners, where all partial correlations are significant and exceed 0.200 for individual BPAQ-SF domains, and eventually 0.300 for the Total score. In contrast to the group of prisoners, the partial correlations of Deficits in Conscientiousness in the non-prison comparison group with domains of BPAQ-SF are not quite consistent; some correlations are significant (Lack of perseverance with all the BPAQ-SF domains) while some are not significant (Lack of premeditation with none of the BPAQ-SF domains). Similarly, the partial correlations of Sensation Seeking with the BPAQ-SF domains are significant only in the target group of prisoners (except for domain of Anger), in contrast to the non-prison comparison group, where none of the correlations are significant at the conventional $p<0.05$ level.

Table 4 shows the results of multiple regression analysis of the BPAQ-SF aggression scores on the UPPS-P domains of impulsivity. Again, the regression models were run separately for prisoners and for participants from the non-prison comparison group. Models were conducted on both the total aggression score and the partial BPAQ-SF domains (1. physical through 4. hostility) as dependent variables.

According to the outputs of the multiple regression models[3] presented in Table 4, several findings can be addressed. First, Emotion-based Rash Action is the main predictor of BPAQ-SF domains of aggression, both within the group of prisoners and in the non-prison comparison group. The higher the level of Emotion-Based Rash Action, the higher are the scores on the aggression scale with a substantial effect size of 0.386 on the Total aggression

[3] As a result of the log-transformation, the regression coefficients in Table 4 (denoted as *Coef.*) correspond to the expected change in logged-values of the dependent variable (aggression) associated with a one-unit increase in the independent variable. Analogically, the standardized regression coefficients (*Stand. Beta*) correspond to the associated change in logged values of the dependent variable, quantified in units of the standard deviation of the statistical distribution of these logged values, that is expected with an increase of the independent variable by its 1 standard deviation. Finally, the exponentiated coefficient, denoted as *exp(Coef)*, is the estimated multiplier of the expected value of the dependent variable associated with a one-unit increase in the independent variable. It tells how many times the expected value of the dependent variable increases with a one-unit change in the independent variable (e.g. value of 1.2 means an expected change by a factor of 1.2, i.e. 1.2fold higher value of the outcome).

score among prisoners, and 0.646 among the non-prison comparison group (reported effect sizes in terms of the *Stand. Beta* coefficient). Second, Deficits in conscientiousness were also a significant risk factor for aggression but only in prisoners, with a lower effect size of 0.237 on the Total aggression score. However, the only UPPS-P domain in the non-prison comparison group that was a significant risk factor for aggression was the Emotion-based Rash Action. Third, Sensation Seeking was found as a rather non-significant predictor for aggression after adjustment to the previous two UPPS-P domains. Fourth, these main findings were consistent for both the Total aggression score and for its three partial domains –Physical, Verbal, and Anger scales. For Hostility, as a partial domain of aggression, some deviations from these main findings were identified, suggesting its nuanced relationship with the UPPS-P domains of impulsivity[4]. Nevertheless, these specifics are of secondary importance and do not alter the primary findings from the regression analyses.

Table 5 presents the Nested multiple regression models, where the mean log-transformed value of aggression (BPAQ-SF Total score, Coef.= 0.268) is higher in Prisoners in comparison to the control group [exp. (0.268) = 1.307] with fairly significant effect size at the Stand. Beta = 0.394. For clarity, we can also compare the mean score values for both groups presented in Table 1, Index (34.10 / 25.86) = 1.3; Difference Ln (34.10) – Ln (25.86) = 3.529 – 3.253 = 0.27 = Coef.

The original regression coefficient in M0 (= 0.268) decreased after the addition of the demographic variables in M1 (= 0.176). Therefore, the M1 model shows partial mediation, where the regression coefficient Coef.=0.176** still remains statistically

[4] Specifically for Hostility in the target group of prisoners, Deficits in Conscientiousness at the first place (*Stand. Beta*=0.246) and Sensation Seeking in the second place (*Stand. Beta*=0.200) were found to be the risk factors rather than Emotion Based Rash Action. In the non-prison comparison group, the main finding of Emotion Based Rash Action as the major risk factor for Hostility was retained (*Stand. Beta*=0.501). Additionally to this, however, the effect of Deficits in Conscientiousness on Hostility was estimated in the surprisingly opposite direction than anticipated (higher deficits as "protective" against hostility). As this result contradicts both the results of correlation analysis carried out in the previous steps and the theory, we believe we deal at this point with a phenomenon referred to as the 'suppressor effect' (an artificially suppressed regression coefficient obtained from the multiple regression for the predictor that had no real effect on the dependent variable).

significant (p-Value = 0.007). The magnitude of this partial mediation is: 1 – [Coef.(M1) / Coef.(M0)] = 1 – (0.176 / 0.268) = 0.343 => 34.3%, at the level of significant effect-size Stand. Beta = 0.258. Once the Emotion-based Rah Action predictor was added in the M2 model, the value of the regression coefficient decreased to insignificant Coef. = -0.013, p-Value = 0.827. The M2 model presents full mediation, since all between-group inequalities in the dependent variable (log-values of Aggression Total score; Prisoners vs. Control-group) were explained by checking for: demographic confounders (already added in model M1); and an additional check for Emotion Based Rash Action (model M2). Furthermore, the M2 regression model explains 41.9% of the variability in terms of the dependent variable.

The addition of the remaining two predictors (Deficits in Conscientiousness and Sensation Seeking) in the M3 model did not add much to the resulting predictive power of the regression model, although the R2 slightly increased (from 0.419 in the M2 to 0.423 in the M3). However, the increase was no longer significant in comparison to the previous M2 model (F (2.185) = 1.60, p-Value = 0.205).

Discussion

The results of this study showed impulsivity as a strong predictor of aggression in both, the prison population as well as the control group. Furthermore, a separate analysis of the five-factor model of impulsivity measured by the UPPS-P showed Emotion-based rash action as the primary predictor of aggression in both groups. However, another domain of impulsivity, namely Deficits in Conscientiousness, predicted aggression only in the prison population sample. In contrast Sensation seeking was shown to be a rather non-significant factor.

Recent literature suggested (Cyders & Smith, 2008) that heightened emotional arousal, positive or negative, affects the ability to impartially apply acquired information, and can lead to engagement in rather risky behavior, which in this study was exhibited by higher levels of

self-reported aggression. However, the prison population can manifest other forms of risky behaviors under the influence of strong emotions, including but not limited to drug involvement or heavy drug use/addiction (Bernstein et al., 2015), risky sexual activity, binge eating or non-suicidal self-injury (Miller & Racine, 2022).

Furthermore, according to Hsieh and Chen (2017) there is an association between low inhibitory control and low emotion regulation leading toward aggression. Similarly, individuals that displayed physical or verbal aggression, hostility or anger were shown to engage in more maladaptive emotion regulation strategies, such as emotion suppression, awareness, clarity or nonacceptance strategies (Avila, 2021; Garofalo et al., 2018), which are frequently displayed in the prison population, and specifically in the impulsive or violent/aggressive type of prisoners (Værøy, Western & Andersson, 2016). Therefore, it is not surprising that increased levels of impulsivity and aggression were identified as risk factors leading to near-lethal self-harm behaviors in prisoners (Rivlin et al., 2013).

A recent meta-analysis of the five-factor model of impulsivity also highlighted the importance of the lack of premeditation and its association to aggression (Bresin, 2019), which in the present study was shown to be a significant predictor only in the prison population group. These results continue to support the conceptualization of the lack of forethought by Whiteside and Lynanm (2001), where individuals are more prone to act out aggressively because of their inability to plan or think about the future consequences.

The recommendations for the prevention of prison violence include the assessment of individual risk factors (mental health disorders, index criminal offenses, history of violent conduct or individual demographic variables) the examination of situational/institutional risk factors (security level, management, staff experience and training, mix of prisoners, overcrowding), and the involvement of prison health services (Modvig, 2014; Baggio et al., 2020). Furthermore, Dialectical Behavioral Therapy modified for correctional settings was

shown to be effective in reducing aggression, impulsivity, and general psychopathology (Shelton et al., 2009).

Limitations and Future Directions

Aggression was assessed by the Buss-Perry Aggression Questionnaire, which is a self-report measure that defines aggression in terms of physical aggression, verbal aggression, anger and hostility. Future studies should examine the role of impulsivity and emotion based rash action in inmates that behaviorally engage in various types of aggression inside the prison, such as physical or verbal violence reprimanded by citations or institutional infractions. Another good indicator of impulsive aggression in inmates diagnosed with the Antisocial Personality Disorder was related to higher levels of recidivism, defined by the number of times in jail (Martin et al., 2019). Therefore, future analyses should focus on the rates of recidivism and detailed inquiry into the criminal history of participating inmates.

Summary and Implications

The multidimensional assessment of impulsivity is vital in the conceptualization of violence, where aggression may arise not only as the result of low inhibition and poor self-control, but also in the presence of strong affect. The present study examined the five-factor model of impulsivity as a predictor of aggression in a prison and non-prison population sample. It was hypothesized that emotion based rash action and deficits in conscientiousness would be associated with aggressive behavior, while the results of the present study confirmed our hypothesis. In terms of the prevention efforts, correctional institutions should focus on the assessment of individual and situational risk factors, and the management of prison health services with emphasis put primarily on DBT and other modified treatments or therapies tailored specifically for correctional settings.

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Table 1: Descriptive statistics of the dataset and variables used in the analysis, by study group.

	Prisoners							Non-prison comparison group						
	Total obs.	Mean[1)]	Std. Dev.	Min.	Max.	Sum (n)[1)]	No. of domain items[2)]	Total obs.	Mean[1)]	Std. Dev.	Min.	Max.	Sum (n)[1)]	No. of domain items[2)]
Aggression Domains (BPAQ-SF)														
Total Score	118	34.10	10.39	16.0	56.0	.	4 (12)	77	25.86	7.33	13.0	42.0	.	4 (12)
1. Physical	118	7.41	3.41	3.0	15.0	.	3	77	4.71	2.08	3.0	10.0	.	3
2. Verbal	118	8.28	2.80	3.0	14.0	.	3	77	6.95	2.01	3.0	13.0	.	3
3. Anger	118	8.18	3.63	3.0	15.0	.	3	77	6.60	2.93	3.0	14.0	.	3
4. Hostility	118	10.24	2.57	4.0	15.0	.	3	77	7.60	2.71	3.0	14.0	.	3
Impulsivity Domains (UPPS-P)														
1. Emotion Based Rash Action (2nd order)	118	2.58	0.62	1.2	3.9	.	2 (26)	77	2.03	0.57	1.1	3.9	.	2 (26)
1a. Negative Urgency	118	2.66	0.69	1.2	4.0	.	12	77	2.21	0.60	1.0	3.9	.	12
1b. Positive Urgency	118	2.51	0.69	1.2	4.0	.	14	77	1.85	0.65	1.0	3.9	.	14
2. Deficits in Conscientiousness (2nd order)	118	2.00	0.60	1.0	3.7	.	2 (21)	77	1.97	0.49	1.0	3.4	.	2 (21)
2a. (Lack of) Premeditation	118	2.05	0.73	1.0	4.0	.	11	77	1.99	0.58	1.0	3.8	.	11
2b. (Lack of) Perseverance	118	1.95	0.62	1.0	3.9	.	10	77	1.95	0.52	1.0	3.7	.	10
3. Sensation Seeking	118	2.87	0.75	1.1	4.0	.	12	77	2.17	0.81	1.0	3.9	.	12
Gender														
Males	118	0.67	0.47	0.0	1.0	79	.	77	0.23	0.43	0.0	1.0	18	.
Females	118	0.33	0.47	0.0	1.0	39	.	77	0.77	0.43	0.0	1.0	59	.
Age	118	35.66	11.93	19.0	72.0	.	.	77	41.79	15.98	18.0	83.0	.	.
Educational Attainment														
Primary (or lower)	118	0.49	0.50	0.0	1.0	58	.	77	0.05	0.22	0.0	1.0	4	.
Secondary lower	118	0.40	0.49	0.0	1.0	47	.	77	0.17	0.38	0.0	1.0	13	.
Secondary upper	118	0.09	0.29	0.0	1.0	11	.	77	0.42	0.50	0.0	1.0	32	.
Tertiary	118	0.02	0.13	0.0	1.0	2	.	77	0.36	0.48	0.0	1.0	28	.

Notes: [1)] For the categorical variables (*Gender*, and *Educational attainment)*, the values of the mean correspond to a percentage share of the category (e.g. 0.67 for Males in the group of Prisoners corresponds to 67% share of the male gender within that group). The sum (n) corresponds to the number of respondents in each category.

[2)] In brackets, a total number of first-order items for computation of the second-order domain is presented.

Table 2: Pairwise correlations between the domains of impulsivity (UPPS-P) and aggression (BPAQ-SF), by study group. Spearman´s rank correlation coefficients (rho).

UPPS-P domains of impulsivity		BPAQ-SF domains of aggression, by study group									
		Prisoners (N_1=118)					Non-prison comparison group (N_0=77)				
		Total Score	1. Physical	2. Verbal	3. Anger	4. Hostility	**Total Score**	1. Physical	2. Verbal	3. Anger	4. Hostility
1. Emotion Based Rash Action (2nd order)	rho	**0.518**	0.382	0.471	0.542	0.338	**0.519**	0.353	0.353	0.506	0.355
	p-Value	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*0.002*	*0.002*	*<0.001*	*0.002*
1a. Negative Urgency	rho	**0.546**	0.425	0.494	0.564	0.319	**0.476**	0.288	0.306	0.474	0.344
	p-Value	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*0.011*	*0.007*	*<0.001*	*0.002*
1b. Positive Urgency	rho	**0.410**	0.269	0.382	0.430	0.315	**0.456**	0.326	0.340	0.438	0.294
	p-Value	*<0.001*	*0.003*	*<0.001*	*<0.001*	*0.001*	*<0.001*	*0.004*	*0.003*	*<0.001*	*0.010*
2. Deficits in Conscientiousness (2nd order)	rho	**0.387**	0.355	0.332	0.366	0.266	**0.269**	0.325	0.247	0.218	0.134
	p-Value	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*0.004*	*0.018*	*0.004*	*0.030*	*0.057*	*0.245*
2a. (Lack of) Premeditation	rho	**0.384**	0.367	0.355	0.360	0.228	**0.188**	0.277	0.212	0.172	0.006
	p-Value	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*0.013*	*0.101*	*0.015*	*0.064*	*0.135*	*0.959*
2b. (Lack of) Perseverance	rho	**0.344**	0.273	0.275	0.341	0.277	**0.286**	0.296	0.199	0.216	0.245
	p-Value	*<0.001*	*0.003*	*0.003*	*<0.001*	*0.002*	*0.012*	*0.009*	*0.083*	*0.059*	*0.032*
3. Sensation Seeking	rho	**0.227**	0.181	0.266	0.120	0.218	**0.150**	0.203	0.104	0.086	0.105
	p-Value	*0.014*	*0.051*	*0.004*	*0.195*	*0.018*	*0.193*	*0.077*	*0.366*	*0.456*	*0.363*

Table 3: Partial correlations between the domains of impulsivity (UPPS-P) and aggression (BPAQ-SF), by study group. Higher-order correlations adjusted to demographic confounders (gender, age, and educational attainment).

UPPS-P domains of impulsivity		BPAQ-SF domains of aggression, by study group									
		Prisoners (N_1=118)					Non-prison comparison group (N_0=77)				
		Total Score	1. Physical	2. Verbal	3. Anger	4. Hostility	**Total Score**	1. Physical	2. Verbal	3. Anger	4. Hostility
1. Emotion Based Rash Action (2nd order)	partial corr.	**0.491**	0.359	0.449	0.513	0.256	**0.570**	0.354	0.446	0.535	0.393
	p-Value	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*0.006*	*<0.001*	*0.002*	*<0.001*	*<0.001*	*0.001*
1a. Negative Urgency	partial corr.	**0.513**	0.400	0.452	0.536	0.255	**0.522**	0.321	0.381	0.514	0.357
	p-Value	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*0.007*	*<0.001*	*0.006*	*0.001*	*<0.001*	*0.002*
1b. Positive Urgency	partial corr.	**0.362**	0.240	0.349	0.379	0.202	**0.520**	0.326	0.433	0.465	0.361
	p-Value	*<0.001*	*0.011*	*<0.001*	*<0.001*	*0.032*	*<0.001*	*0.005*	*<0.001*	*<0.001*	*0.002*
2. Deficits in Conscientiousness (2nd order)	partial corr.	**0.369**	0.297	0.285	0.355	0.256	**0.263**	0.260	0.274	0.214	0.088
	p-Value	*<0.001*	*0.001*	*0.002*	*<0.001*	*0.006*	*0.026*	*0.027*	*0.020*	*0.071*	*0.463*
2a. (Lack of) Premeditation	partial corr.	**0.338**	0.305	0.287	0.298	0.203	**0.130**	0.210	0.183	0.115	-0.065
	p-Value	*<0.001*	*0.001*	*0.002*	*0.001*	*0.031*	*0.275*	*0.077*	*0.125*	*0.336*	*0.587*
2b. (Lack of) Perseverance	partial corr.	**0.308**	0.210	0.209	0.329	0.252	**0.344**	0.251	0.307	0.271	0.236
	p-Value	*<0.001*	*0.026*	*0.026*	*<0.001*	*0.007*	*0.003*	*0.033*	*0.009*	*0.021*	*0.046*
3. Sensation Seeking	partial corr.	**0.234**	0.199	0.242	0.107	0.249	**0.206**	0.075	0.132	0.187	0.212
	p-Value	*0.013*	*0.035*	*0.010*	*0.258*	*0.008*	*0.083*	*0.534*	*0.268*	*0.115*	*0.074*

Table 4: Log-linear multiple regression of the aggression domains on the main domains of impulsivity, by study group.

Independent variables (domains of impulsivity)		**Dependent variables: BPAQ-SF domains (log-transformed values)**									
		Total Score	1. Physical	2. Verbal	3. Anger	4. Hostility	**Total Score**	1. Physical	2. Verbal	3. Anger	4. Hostility
		Prisoners (N_1=118)					**Non-prison comparison group (N_0=77)**				
1. Emotion Based Rash Action (2nd order)	Coef.	0.199***	0.213**	0.202***	0.395***	0.037	0.323***	0.211*	0.229**	0.476***	0.336***
	(SE)	(0.045)	(0.077)	(0.053)	(0.074)	(0.044)	(0.063)	(0.096)	(0.071)	(0.102)	(0.090)
	p-Value	*<0.001*	*0.006*	*<0.001*	*<0.001*	*0.412*	*<0.001*	*0.031*	*0.002*	*<0.001*	*<0.001*
	exp(Coef.)	1.220	1.238	1.224	1.484	1.037	1.381	1.235	1.258	1.610	1.399
	Stand. Beta	0.386	0.270	0.351	0.488	0.082	0.646	0.306	0.454	0.606	0.501
2. Deficits in Conscientiousness (2nd order)	Coef.	0.127**	0.169*	0.120*	0.140^{+}	0.114**	-0.099	0.150	0.010	-0.177	-0.290**
	(SE)	(0.044)	(0.075)	(0.052)	(0.072)	(0.043)	(0.078)	(0.118)	(0.087)	(0.125)	(0.110)
	p-Value	*0.005*	*0.026*	*0.023*	*0.054*	*0.010*	*0.211*	*0.208*	*0.913*	*0.163*	*0.010*
	exp(Coef.)	1.135	1.184	1.127	1.150	1.121	0.906	1.162	1.010	0.838	0.748
	Stand. Beta	0.237	0.205	0.200	0.166	0.246	-0.170	0.188	0.016	-0.194	-0.374
3. Sensation Seeking	Coef.	0.043	0.061	0.065	-0.034	0.074*	-0.004	-0.067	-0.046	0.014	0.077
	(SE)	(0.036)	(0.061)	(0.042)	(0.059)	(0.035)	(0.049)	(0.073)	(0.054)	(0.078)	(0.069)
	p-Value	*0.240*	*0.315*	*0.126*	*0.567*	*0.039*	*0.928*	*0.365*	*0.398*	*0.855*	*0.265*
	exp(Coef.)	1.044	1.063	1.068	0.967	1.077	0.996	0.935	0.955	1.014	1.080
	Stand. Beta	0.100	0.093	0.137	-0.050	0.200	-0.013	-0.138	-0.130	0.026	0.163
Breusch-Pagan test for heteroskedasticity of residuals	χ^2 (df)	0.430 (1)	0.240 (1)	0.010 (1)	0.100 (1)	0.030 (1)	0.020 (1)	1.710 (1)	0.590 (1)	0.000 (1)	0.780 (1)
	p-Value	*0.511*	*0.624*	*0.941*	*0.752*	*0.857*	0.901	0.191	0.442	0.976	0.378
Adjusted R^2		0.358	0.232	0.292	0.316	0.181	0.286	0.144	0.126	0.257	0.206

Note: All regression coefficients are also adjusted to demographic confounders (gender, age, and educational attainment).

$^{+}$ *p*<0.1; * *p*<0.05; ** *p*<0.01; *** *p*<0.001; (SE) stands for standard error of the coefficient; exp(Coef.) is the exponentiated value of the coefficient

Table 5: Nested multiple regression models. Dependent variable: BPAQ-SF Total Score (log-transformed values). Combined dataset of N=195 respondents (N_1+N_0 = 118+77).

Independent variables / regression parameter estimates		Model M0 (default)	Model M1 (M0 + demographics)	Model M2 (M1 + Emotion Based Rash Action)	Model M3 (M2 + remaining dimensions)
Group of Prisoners (ref. = Non-prison comparison group)	Coef.	0.268***	0.176**	-0.013	-0.003
	(SE)	(0.045)	(0.064)	(0.059)	(0.060)
	p-Value	*<0.001*	*0.007*	*0.827*	*0.961*
	exp(Coef.)	1.307	1.192	0.987	0.997
	Stand. Beta	0.394	0.258	-0.019	-0.004
Gender of Males (ref. = Females)	Coef.	.	-0.059	0.006	0.008
	(SE)	.	(0.048)	(0.042)	(0.043)
	p-Value	.	*0.222*	*0.881*	*0.846*
	exp(Coef.)	.	0.943	1.006	1.008
	Stand. Beta	.	-0.089	0.009	0.013
Age (scale variable, number of years since the age of 18)	Coef.	.	-0.002	-0.002	-0.001
	(SE)	.	(0.002)	(0.001)	(0.001)
	p-Value	.	*0.119*	*0.188*	*0.434*
	exp(Coef.)	.	0.998	0.998	0.999
	Stand. Beta	.	-0.104	-0.075	-0.048
Secondary lower Educational Attainment (ref. = Primary or lower)	Coef.	.	-0.146**	-0.140**	-0.137**
	(SE)	.	(0.056)	(0.048)	(0.048)
	p-Value	.	*0.010*	*0.004*	*0.005*
	exp(Coef.)	.	0.864	0.869	0.872
	Stand. Beta	.	-0.203	-0.195	-0.190
Secondary upper Educational Attainment (ref. = Primary or lower)	Coef.	.	-0.148*	-0.206**	-0.211***
	(SE)	.	(0.072)	(0.062)	(0.062)
	p-Value	.	*0.042*	*0.001*	*0.001*
	exp(Coef.)	.	0.862	0.814	0.810
	Stand. Beta	.	-0.185	-0.257	-0.263
Tertiary Educational Attainment (ref. = Primary or lower)	Coef.	.	-0.255**	-0.249***	-0.245***
	(SE)	.	(0.085)	(0.072)	(0.073)
	p-Value	.	*0.003*	*<0.001*	*<0.001*
	exp(Coef.)	.	0.775	0.780	0.783
	Stand. Beta	.	-0.277	-0.270	-0.267
Emotion Based Rash Action (2nd order, score)	Coef.	.	.	0.265***	0.235***
	(SE)	.	.	(0.031)	(0.037)
	p-Value	.	.	*<0.001*	*<0.001*
	exp(Coef.)	.	.	1.303	1.265
	Stand. Beta	.	.	0.524	0.465

Deficits in Conscientiousness (2nd order, score)	Coef.	.	.	.	0.066
	(SE)	.	.	.	(0.037)
	p-Value	.	.	.	*0.078*
	exp(Coef.)	.	.	.	1.068
	Stand. Beta	.	.	.	0.111
Sensation Seeking (score)	Coef.	.	.	.	0.009
	(SE)	.	.	.	(0.028)
	p-Value	.	.	.	*0.737*
	exp(Coef.)	.	.	.	1.009
	Stand. Beta	.	.	.	0.024
Constant	Coef.	3.213***	3.465***	2.916***	2.809***
	(SE)	(0.035)	(0.077)	(0.092)	(0.113)
	p-Value	*<0.001*	*<0.001*	*<0.001*	*<0.001*
Model fit statistics					
N		195	195	195	195
Adjusted R^2		0.151	0.202	0.419	0.423
Root MSE		0.307	0.298	0.254	0.253
F-test	F(df1, df2)	F(1, 193) = 35.43	F(5, 188) = 3.48	F(1, 187) = 71.20	F(2, 185) = 1.60
	p-Value	*<0.001*	*0.005*	*<0.001*	*0.205*
Breusch-Pagan test	χ^2 (df)	1.200 (1)	0.360 (1)	1.130 (1)	0.510 (1)
	p-Value	*0.273*	*0.551*	*0.288*	*0.474*

Note: By the shaded region, the mediation of between-group inequalities in the dependent variable (BPAQ-SF Total Score, log-transformed value) via the inequalities in predictors added in models M1 and M2 are highlighted. The F-test compares the regression model with its previous nested model specification (for M0, it compares the model with intercept-only specification). The Breusch-Pagan test checks for heteroskedasticity of residuals – its non-significant values support the assumption of homoscedasticity.

* $p<0.05$; ** $p<0.01$; *** $p<0.001$; (SE) stands for standard error of the coefficient; exp(Coef.) is the exponentiated value of the coefficient

Methodology

Participants

One hundred and forty inmates (62.9%, $N = 88$, males, 37.1%, $N = 52$, females) were recruited from 12 participating prisons that represent 34% of the total number of prisons in the Czech Republic. The identified criminal activities ranged from property crimes (e.g., theft, fraud, obstruction of justice) to violent crimes/felonies (e.g., robbery, grievous bodily harm, attempted murder or murder). Participating inmates were classified as medium or maximum-security level, according to the duration of the sentence, the criminal nature (violence, drugs, and sex crimes), and the number of previous incarcerations. The majority of the participating inmates were males (62.9%). All participants were at least 18 years of age. The mean age of the sample was 35.3 years ($SD = 11.7$). In terms of their educational attainment, most inmates received only primary education (49.3%) or some type of vocational training (39.3%).

Procedures

Data were collected in participating prisons via paper-pencil method. Participants completed all measures in a single session, which lasted approximately one hour. Treatment of the missing values included two steps. First, if two or more items per scale were missing in the questionnaires, responses were excluded altogether from the study. Second, responses with one-missing item were handled by considering only responses from the non-missing items from the identified scale/domain. However, this demand to correct for one-missing domain item was only minor (altogether 23 participants). No pervasive responding was observed in the provided answers.

Measures

The Barratt Impulsiveness Scale (BIS-11)

The BIS-11 is a 30-item measure of impulsiveness defined by six first-order factors (attention, cognitive instability, motor, perseverance, self-control, cognitive complexity) and three second-order factors (attentional, motor, nonplanning). Items are scored on a 4-point Likert-type scale (Patton et al., 1995).

Internal consistencies of all subscales, measured by Cronbach's α, were above .7 with the exception of motor impulsivity (from the second order factorial structure) and cognitive complexity, perseverance and cognitive instability (from the first order factorial structure). The test-retest reliability showed varying strengths, however, all correlations were statistically significant at the level $p < .01$ (Stanford et al., 2009).

The original structure of motor and attentional impulsiveness showed low internal consistency in forensic psychiatric patients (Haden & Shiva, 2008). Therefore, other alternative factor models of impulsivity were proposed by different authors (Haden & Shiva, 2008; Ruiz et al., 2010).

The Delay of Gratification Inventory

The DGI is a 35-item measure with a 5-point Likert-type scale. This inventory defines impulsivity in terms of five domains of delayed behavior: i) food, ii) physical pleasures or the avoidance of unpleasantness, iii) social interactions, iv) money, and v) achievement. The psychometric properties of these domains were supported in terms of both internal consistency and test-retest reliability. Namely, the internal consistency ranging from 0.71–0.85, independently of gender or location, and the test-retest reliability across all factors, ranging from r =.74–.90. Construct validity showed significant correlations with psychopathologic and adjustment impulsivity measures (Hoerger et al., 2011).

The UPPS-P Impulsive Behavior Scale

The UPPS-P is a 59-item measure of five different factors of impulsivity: i) positive urgency, ii) negative urgency, iii) sensation seeking, iv) lack of perseverance, and v) lack of

premeditation. Items are scored on a 4-point Likert-type scale (Whiteside & Lynam, 2001). This instrument has been supported as a consistent and valid measure of impulsivity in clinical settings, particularly for disorders containing impulsiveness (Savvidou et al., 2017).

The Adult ADHD Self-Report Scale (ASRS)

A self-report questionnaire developed by the World Health Organization (WHO) evaluating the occurrence of ADHD symptoms in adults. The ASRS is an 18-item measure scored on a Likert type scale ranging from ´never´ to ´very often´. Studies have shown good psychometric properties of this measure with high internal consistency and validity (Adler et al., 2006).

Statistical Analyses

The analysis comprised several consecutive steps; all conducted in *Stata IC/15.1* statistical software. First, psychometric scores for each of the domains of the impulsivity measures (*BIS-11*, *DGI*, and *UPPS-P*) were computed for all participants. The scores were computed as mean values of the responses across all items of the domain. In order to simplify the interpretation of the domain scores, the items were adjusted so that the increasing value of the resulting score indicated higher levels of impulsivity (some of the Likert-type responses, particularly those in the *DGI*, had to be reversed). Once the domain scores were established, the levels of impulsivity were compared between the ADHD and the non-ADHD groups.

In order to thoroughly examine the differences in impulsivity, we conducted a series of independent samples *t*-tests or *U*-tests, if the data were not parametric. Our variables of interest were the mean scores of the identified impulsivity domains (*BIS-11*, *DGI*, and *UPPS-P*) and sample (AHDH vs non-ADHD) as the between-subjects factor.

Results

Table 1 provides demographic characteristic of the participants, presented separately by the group (AHDH vs non-ADHD) and for the total sample. Altogether, $N = 140$

participants were included into the study; majority being in the non-ADHD group ($N = 117$; 83.6%).

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Table 1

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Table 2 provides descriptive statistics and *p*-values of the key measures of impulsivity and their partial domains consecutively for *BIS-11* through *UPPS-P*. As the psychometric scores were computed as means of Likert-type responses of participants across the set of domain items, the range of descriptive statistics averaged across all participants is also bounded within the same range of values. Namely, as the items of domains for *BIS-11* and *UPPS-P* used a four-point Likert-type scale, the descriptive statistics in Table 2 range between 1.0 and 4.0. Likewise, as the items of the *DGI* applied a five-point scale, the psychometric scores of its domains are bounded by 1.0 and 5.0. About half of the domains did not violate the Shapiro-Wilk assumption of normality ($p > .05$) and, thus, for those we conducted a student's *t*, whereas for the rest of the domains we proceeded with the nonparametric testing.

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Table 2

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Table 3 shows the independent samples *t*-tests, which specifies ADHD vs. non-ADHD as the grouping factor. Seventeen out of twenty-one domains displayed statistically significant mean differences ($p < .05$), majority of which were < .001; thus, demonstrating that there is a significant difference in impulsivity when it comes to ADHD and non-ADHD groups.

Table 1

Descriptive Statistics for the Demographics

		Group				Total (*N* = 140)	
		ADHD (*N* = 23)		Non-ADHD (*N* = 117)			
		%	***N***	**%**	***N***	**%**	***N***
Gender	Males	7.9%	11	55%	77	62.9%	88
	Females	8.6%	12	26.6%	40	37.1%	52
Education	Primary	8.6%	12	40.7%	57	49.3%	69
	Lower Secondary	5%	7	34.3%	48	39.3%	55
	Upper Secondary	2.9%	4	7.1%	10	10%	14
	University	0%	0	1.4%	2	1.4%	2
		M	***SD***	***M***	***SD***	***M***	***SD***
Age		31.5	10.2	36	11.8	35.3	11.7

Table 2

Descriptive Statistics for the Measured Variables

	Non-AHDH	ADHD	Total
	M (*SD*)	*M* (*SD*)	*M* (*SD*)
UPPS-P (*N* = 117)			
Emotion Based Rash Action 2'OF	2.50 (.598)	2.98(.586)	2.58(.619)*
Sensation Seeking 2´OF	2.89(.718)	2.85(.861)	2.88(.738)
Deficits in Conscientiousness 2´OF	1.89(.527)	2.58(.643)	2.00(.599)
Negative Urgency	2.57(.659)	3.08(.681)	2.65(.685)*
Positive Urgency	2.43(.683)	2.88(.607)	2.50(.689)
(lack of) Premeditation	1.95(.700)	2.61(.658)	2.05(.730)
(lack of) Perseverance	1.83(.514)	2.56(.743)	1.94(.612)
BIS-11 (*N* = 139)			
Attentional 2´OF	1.98(.491)	2.67(.542)	2.09(.560)*
Motor 2´OF	2.02(.446)	2.44(.539)	2.09(.487)
Nonplanning 2´OF	2.46(.463)	2.96(.514)	2.54(.507)*
Attention 1´OF	2.06(.547)	2.90(.549)	2.20(.628)
Cognitive Instability 1´OF	1.83(.613)	2.29(.734)	1.91(.655)
Motor 1´OF	2.05(.498)	2.48(.645)	2.12(.547)
Perseverance 1´OF	1.97(.562)	2.38(.522)	2.04(.574)
Self-Control 1´OF	2.38(.549)	2.97(.504)	2.48(.583)*
Cognitive Complexity 1´OF	2.54(.501)	2.96(.594)	2.61(.538)*
DGI (*N* = 118)			
Food	2.82(.725)	3.10(.557)	2.86(.706)*
Physical	2.71(.630)	2.95(.727)	2.75(.649)*
Social	2.82(.580)	3.20(.548)	2.88(.590)*
Money	2.58(.917)	3.31(.738)	2.71 (.928)*
Achievement	2.73(.664)	3.41(.737)	2.84(.717)

Note. * Shapiro-Wilk $p > .05$

Table 3

Independent Samples T-Tests

		Statistics	*p*	Effect Size
UPPS-P				
Emotion Based Rash Action 2'OF	Student's *t*	-3.151	.002	-0.8073
Sensation Seeking 2´OF	Mann-Whitney *U*	870	.874	0.0241
Deficits in Conscientiousness 2´OF	Mann-Whitney *U*	-4.948	< .001	0.5847
Negative Urgency	Student's *t*	-3.021	.003	-0.7741
Positive Urgency	Mann-Whitney *U*	-2.615	.006	0.4052
(lack of) Premeditation	Mann-Whitney *U*	-3.677	< .001	0.5241
(lack of) Perseverance	Mann-Whitney *U*	-5.146	< .001	0.5988
BIS-11				
Attentional 2´OF	Student's *t*	-6.067	< .001	-1.3848
Motor 2´OF	Mann-Whitney *U*	-4.008	< .001	0.4355
Nonplanning 2´OF	Student's *t*	-4.734	< .001	-1.0805
Attention 1´OF	Mann-Whitney *U*	-6.656	< .001	0.7155
Cognitive Instability 1´OF	Mann-Whitney *U*	-3.153	.004	0.3722
Motor 1´OF	Welch's *t*	-3.033	.005	-0.7484
Perseverance 1´OF	Mann-Whitney *U*	-3.204	.002	0.4108
Self-Control 1´OF	Student's *t*	-4.737	< .001	-1.0812
Cognitive Complexity 1´OF	Student's *t*	-3.535	< .001	-0.8068
DGI				
Food	Student's *t*	-1.608	.111	-0.4027
Physical	Student's *t*	-1.459	.147	-0.3654
Social	Student's *t*	-2.631	.010	-0.6590
Money	Student's *t*	-3.253	.001	-0.8149
Achievement	Mann-Whitney *U*	-3.977	< .001	0.4912

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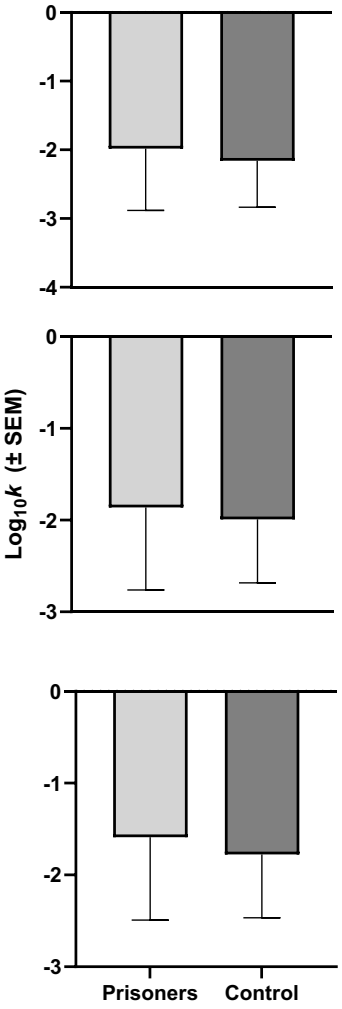
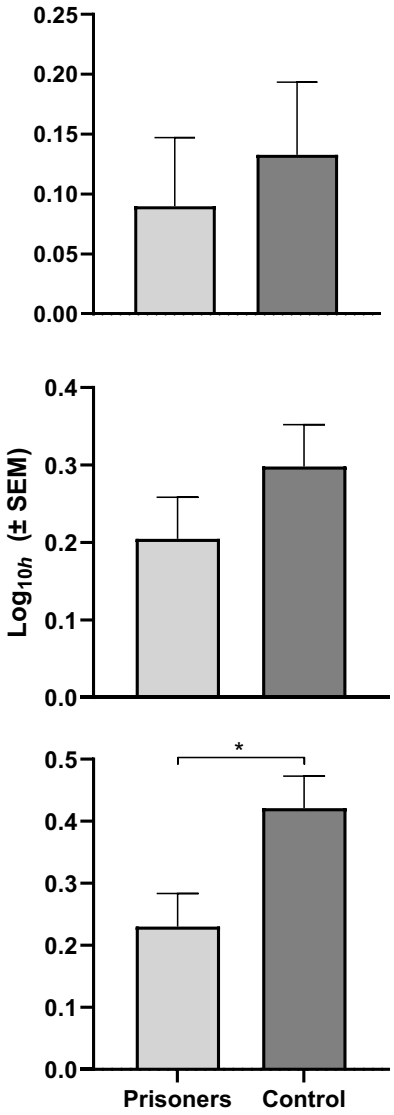
Data Analyses for Prisoner vs. Control Comparisons Samples:

MCQ and PDQ



Comparison of Prisoners (N = 129) and Controls (N = 74) log10 transformed k values (Delay Discounting).



Comparison of Prisoners (N = 129) and Controls (N = 74) log10 transformed h values (Probability Discounting).

T-Test

Group Statistics

	Prisoners or Control or Food sampl	N	Mean	Std. Deviation	Std. Error Mean
MCQ_log10_largek	Prisoners	129	-1.9802	.89565	.07886
	Control	74	-2.1570	.67790	.07880
MCQ_log10_medk	Prisoners	129	-1.8593	.89539	.07883
	Control	74	-1.9920	.69164	.08040
MCQ_log10_small	Prisoners	129	-1.5943	.90020	.07926
	Control	74	-1.7752	.69092	.08032
PDQ_log10_large	Prisoners	125	.0879	.63712	.05699
	Control	74	.1329	.52095	.06056
PDQ_log10_medium	Prisoners	125	.2047	.59629	.05333
	Control	74	.2982	.46253	.05377
PDQ_log10_small	Prisoners	125	.2282	.59679	.05338
	Control	74	.4212	.44401	.05162

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means							
						Significance				95% Confidence Interval of the Difference	
		F	Sig.	t	df	One-Sided p	Two-Sided p	Mean Difference	Std. Error Difference	Lower	Upper
MCQ_log10_largek	Equal variances assumed	7.718	.006	1.472	201	.071	.143	.17675	.12005	-.05998	.41347
	Equal variances not assumed			1.585	186.019	.057	.115	.17675	.11148	-.04319	.39668
MCQ_log10_medk	Equal variances assumed	9.022	.003	1.100	201	.136	.273	.13266	.12063	-.10520	.37052
	Equal variances not assumed			1.178	183.898	.120	.240	.13266	.11260	-.08950	.35482
MCQ_log10_small	Equal variances assumed	4.283	.040	1.494	201	.068	.137	.18084	.12108	-.05791	.41960
	Equal variances not assumed			1.603	184.576	.055	.111	.18084	.11284	-.04178	.40347
PDQ_log10_large	Equal variances assumed	4.775	.030	-.514	197	.304	.608	-.04502	.08752	-.21762	.12758
	Equal variances not assumed			-.541	177.558	.294	.589	-.04502	.08316	-.20912	.11908
PDQ_log10_medium	Equal variances assumed	8.152	.005	-1.159	197	.124	.248	-.09355	.08075	-.25279	.06569
	Equal variances not assumed			-1.235	183.018	.109	.218	-.09355	.07573	-.24297	.05587
PDQ_log10_small	Equal variances assumed	12.758	<.001	-2.413	197	.008	.017	-.19294	.07997	-.35064	-.03524
	Equal variances not assumed			-2.598	186.835	.005	.010	-.19294	.07425	-.33942	-.04645

Magnitude Effects across Groups

Magnitude effects for small, medium, and large outcomes for the DD and PD tasks within each of the groups were analyzed using one-way ANOVA with log10-transformed k and h values.

Money Delay Discounting

Analyses for Prisoners

The one-way ANOVA was significant. Post hoc comparisons of the groups found differences between small and medium and small and large, but not between medium and large amounts.

Ordinary one-way ANOVA ANOVA results	
Table Analyzed	MCQ Magnitude effects Prisoners only (for analysis)
Data sets analyzed	A-C
ANOVA summary	
F	6.360
P value	0.0019
P value summary	**
Significant diff. among means (P < 0.05)?	Yes
R squared	0.03206

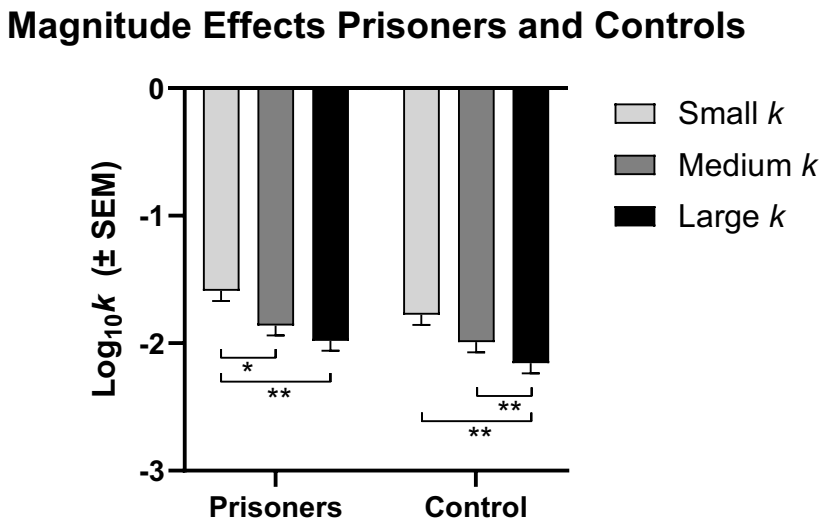
Number of families	1					
Number of comparisons per family	3					
Alpha	0.05					
Tukey's multiple comparisons test	**Mean Diff.**	**95.00% CI of diff.**	**Below threshold?**	**Summary**	**Adjusted P Value**	
Small *k* vs. Medium *k*	0.2700	0.006334 to 0.5337	Yes	*	0.0433	A-B
Small *k* vs. Large *k*	0.3902	0.1265 to 0.6539	Yes	**	0.0016	A-C
Medium *k* vs. Large *k*	0.1202	-0.1435 to 0.3839	No	ns	0.5317	B-C

Analyses for Controls

The one-way ANOVA was significant. Post hoc comparisons of the groups found differences between small and large, but not between medium and large amounts or medium and small amounts.

Ordinary one-way ANOVA ANOVA results	
Table Analyzed	MCQ Magnitude effects Control only (for analysis)
Data sets analyzed	A-C
ANOVA summary	
F	147.2
P value	<0.0001
P value summary	****
Significant diff. among means (P < 0.05)?	Yes
R squared	0.5735

Number of families	1					
Number of comparisons per family	3					
Alpha	0.05					
Tukey's multiple comparisons test	**Mean Diff.**	**95.00% CI of diff.**	**Below threshold?**	**Summary**	**Adjusted P Value**	
Small *k* vs. Medium *k*	0.2168	-0.04972 to 0.4833	No	ns	0.1356	A-B
Small *k* vs. Large *k*	-1.560	-1.826 to -1.293	Yes	****	<0.0001	A-C
Medium *k* vs. Large *k*	-1.776	-2.043 to -1.510	Yes	****	<0.0001	B-C



Probability Delay Discounting

Analyses for Prisoners

Although there were trends, the one-way ANOVA was not significant. There were no significant magnitude effects for prisoners on the Money PD measure.

Ordinary one-way ANOVA ANOVA results	
Table Analyzed	PDQ Magnitude effects Prisoner (for analysis)
Data sets analyzed	A-C
ANOVA summary	
F	1.907
P value	0.1499
P value summary	ns
Significant diff. among means (P < 0.05)?	No
R squared	0.01015

Analyses for Controls

The one-way ANOVA comparing log10 k values across magnitudes was significant for the control group, but only when comparing the small and large magnitudes.

There were no significant magnitude effects for controls on the Money PD measure. Although visual inspection of the data suggest a trend, the differences were not significant.

Ordinary one-way ANOVA ANOVA results	
Table Analyzed	PDQ Magnitude effects control (for analysis)
Data sets analyzed	A-C
ANOVA summary	
F	6.803
P value	0.0014
P value summary	**
Significant diff. among means (P < 0.05)?	Yes
R squared	0.05849

Number of families	1					
Number of comparisons per family	3					
Alpha	0.05					
Tukey's multiple comparisons test	**Mean Diff.**	**95.00% CI of diff.**	**Below threshold?**	**Summary**	**Adjusted P Value**	
Small *h* vs. Medium *h*	0.1230	-0.06210 to 0.3081	No	ns	0.2617	A-B
Small *h* vs. Large *h*	0.2883	0.1032 to 0.4734	Yes	***	0.0009	A-C
Medium *h* vs. Large *h*	0.1653	-0.01980 to 0.3504	No	ns	0.0907	B-C