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Agnieszka Kałwa

Addiction Prevention and Treatment Unit, Institute of Psychiatry and Neurology, Warszawa
Head of the Department: dr n. med. B. Habrat

Summary

Alcohol addiction is a disease associated with unfavorable decision making, in spite of its negative consequences. Impulsivity plays an important role in decision making of alcohol-addicted individuals. It can be understood in terms of behavioral and/or cognitive flexibility disorders, that manifest in cognitive dysfunctions, making quick and adequate situation assessment and adjustment of behavior according to its condition, difficult or even impossible. Neurobiological and genetic studies indicate at the existing relationship between impulsivity and certain genetic predisposition. In alcohol addicts, impulsivity can be understood also in terms of specific personality traits. Although the concept of impulsivity itself, has been the main topic of many studies, not many of them concern also decision-making processes. In studies concerning decision making in alcoholism, the relationship between this processes and behavioral impulsivity defined in many different ways, has been noticed. Some of these works define disturbances in decision-making processes itself, as a feature of impulsivity. On the basis of the results of theoretical works and research studies, it seems that there would be worth to define more precisely the concept of impulsivity, in order to determine its effect on decision making. It would be also worth to assess, whether and to what extent, the two variables (impulsivity and decision making) can be considered as separate.

Key words: alcohol, impulsivity, decision making

Characteristics of decision-making processes

Decision-making processes in humans are conditioned by many different factors. Not only one's individual traits, but also the „external” context of behavior, are relevant. The situation evaluation is associated both with individual predisposition, personality traits and cognitive functioning that influence the ability of the correct perception and assessment of stimuli and adequate reaction on it. The person who makes the decision, needs some basic information concerning problem solving rules and potential solutions, to assess the situation. To do it, it is necessary to evaluate the potential risk, the aim value; through the prism of own experiences, expectations and current emotions, which often are crucial factors in the final choice, that might be inconsistent with the option that had been previously considered to be the most rational [1]. Ventromedial prefrontal cortex is thought to be the main brain area responsible for the „making” aspect of decision. However, other brain structures are involved in decision making processes as well. The neuroimaging studies underline the role of areas representing emotional states, e.g. insula and the ventral striatum, anterior cingulate gyrus and

supplementary motor area that is associated with the analysis of problem situation, giving the meaning to the external stimuli, and efficient integration of the significant information into the process.

The method increasingly being used in the assessment of decision-making processes, is the Iowa Gambling Task (IGT), used also in animal model studies [4]. The task reminds a simple gambling game. Every time, investigated individual needs to pick up one card from four sets of cards. After indicating one set, „gains” a certain sum of money and (after some time) also „loses” a sum of money. The aim of the task is to gain as much as possible and to lose as least as possible. The investigated person is informed that there are „better” sets that should be preferred, and „worst” sets that should be avoided in order to achieve the aim. Individuals with decision-making disorders prefer sets that „at a glance” are associated with gaining greater amounts of money, but in fact, lead to greater losses; ignoring the option of using sets that gives lower gains, but finally leading to better score.

Neuropsychological and neurobiological basis of impulsiveness in substance abusers

In the literature concerning decision making in substance abusers (alcohol and other substance use), the meaning of impulsiveness as a cause of risk-taking behaviors have been recently underlined, that are motivated by external reward stimuli; without considering the consequences of one’s behavior. Both impulsivity understood as neuropsychological correlates of specific brain function disorders, and in terms of personality traits, influence on decision making. The current research concern also the genetic aspect of impulsivity in addiction. Genes associated with dopaminergic system (e.g. dopamine receptor coding gene D4, D2, dopamine transporter gene DAT and catechol o’ methyltransferase COMT gene) are considered to be important in that field [quoting 5]. Also serotonergic system plays a key role in impulsivity of alcohol addicts; and serotonin lower concentration is associated with higher impulsivity. The meaning of C/C genotype in gene T102C HT2A polymorphism has been indicated [6]. The authors cite also other studies, indicating that described effect can be increased by the influence of serotonergic activity on dopaminergic, glutaminergic and GABA-ergic systems.

Bechara et al. indicate two types of impulsivity mechanisms in addiction. The first is associated with disorders of subcortical structures’ function, especially the amygdala; responsible for the tendency to emotional over-reaction for substance use-associated stimuli [7]. The second type of mechanisms are connected with prefrontal cortex function disorders, that include different aspects of this dysfunctions. It is associated with executive control disorders that manifest in incorrect inhibition reaction of the behavior focused on an immediate substance seeking. There are two types of such dysfunctions:

a) cognitive flexibility disorders (perceptual impulsivity) associated with dorsolateral prefrontal cortex activity disorders. They manifest in rigidity of thinking that leads to perseverate behavior, in spite of changing environmental circumstances. One of the most known neuropsychological tests used in this type of disorders, is the Wisconsin Card Sorting Test (WCST), in which cognitive flexibility is measured by the number of perseverative errors.

b) behavioral flexibility disorders (motor impulsivity); that manifest in:

- affective cognitive flexibility disorders in situation of emotional reward-related stimuli. They are connected with i.e. subgenual anterior cingulate function disorders. Addicted person selects behavior, that aims to use the substance, even if the previous goal was different. The example method used in neuropsychological examination is Go/no go test.
- behavior flexibility disorders, that have non-affective character; associated with disturbances in reaction inhibition, rituals associated with drinking. The method frequently used in evaluation of this type of disorders, is the Stroop Color Word Interference Test, in which investigated person reads color names printed in black; and then the task is to name the color of every word, inhibiting the reaction of color names reading.

The understanding of impulsive decision-making mechanisms in alcohol-addicted patients cannot be full without taking into account neurodevelopmental factors, related to early CNS impairment (e.g. psychoactive substance use by mother in her pregnancy period), as well as those that are associated with another stages of brain development. Those factors have a great influence on further development of addiction and the response for therapeutic treatment [8]. Neurobiological model proposed by Casey et al. [9] indicates at significant age-associated differences concerning impulsive behaviors, associated with different stages of cerebral cortex myelination. The authors indicated at increased thalamic and hippocampal activity, as well as of the basal ganglia- particularly nucleus accumbens, in children aged 7-11 years old, in comparison with adults (22-30 years old). Nucleus accumbens plays a key role in dopaminergic function of reward system, considered to be the biological basis of addiction, that is associated with motivational system. Excitation of dopamine neurons in the nucleus accumbens gives a strong reward reinforcement. Addiction is associated with increased activation of reward system and stronger need for the substance use. Nucleus accumbens hyperactivation results in diminished behavioral control (i.e. through weakness of neuronal pathways leading to prefrontal cortex) - difficulties in gratification delay and preferring immediate reinforcement. In children, increased activity of nucleus accumbens is additionally associated with the specific neurodevelopmental stage particularly related to prefrontal cortex function, which myelination occurs later compared to different brain structures. The first alcohol intoxication in childhood or early adolescence occurs in stage of immature myelination of the prefrontal cortex with not fully-developed top-down regulation function over subcortical structure processes. This additionally weakens executive control and might result in permanent behavioral changes associated with preferring more impulsive decision-making style in another periods of life.

Impulsivity as a personality trait

Impulsivity is associated with different traits of personality, that is often understood in terms of neurobiological mechanisms. Existing typologisms of alcoholism distinguish types associated with genetic predisposition for addiction; and types, in

which environmental influence is relevant. One of the most known is typology by Robert Cloninger, who distinguished type 1 of alcoholism („genetic-environmental”), connected with low need for experiencing new, exciting situations and a great need for the avoidance of stressful situations. In these individuals, alcohol overuse is the way of fear and anxiety reduction [10,11]. In type 2 alcoholism, genetic factors play greater role in the pathomechanism of addiction. It is associated with greater need for stimulation and euphoric states through alcohol consumption, and often with aggression and antisocial behavior. Similarly dichotomic, although based on different criteria, is the typology by Barbor [12, 13]. It distinguishes type of alcoholism associated with late onset of intense drinking, no or rare cases of alcoholism in the family, as well as with low severity of addiction (type A) and type associated with early drinking onset, alcoholism in the family and greater severity of addiction (type B). It has been proved that individuals with cluster B personality disorders, compared to addicted individuals without personality disorders; describe themselves as more impulsive and have greater reaction inhibition disorders in Go/no go test [14]. In typology by Cloninger, the most between-type differentiating feature is sensation/novelty seeking. This dimension is one of the most important parameters of Coningers’ Temperament and Character Inventory (TCI). Individuals reaching higher results in this scale, easily loose self-control, are impulsive, enthusiastic, full of life and vigor, they also have low boredom susceptibility. They enthusiastically involve in new, unknown, sometimes risk-taking behavior, that brings them rewards. If their expectations are not met, they stop the action under influence of anger. It has been repeatedly considered, that individuals with great need for stimulation drink often in higher amounts, until they reach certain level of arouse. It is associated with dopaminergic system functioning, first of all with the constant need of higher dopamine levels generating. Results of studies indicate, that this type of personality traits leads to unwanted and unconsidered consequences, often connected with the context of drinking. Sensation seeking can be measured also with 13-item Sensation Seeking Scale by Zuckerman and Kuhlman. Its various dimensions are presented as questions about risk-taking behaviors (e.g. riding on a motorcycle, the will of parachute jumping) or new sensations (the need for traveling) and boredom susceptibility (e.g. seeing the same faces everyday) [15].

It seems, that even in recently-drinking individuals, impulsivity understood as a predisposition for certain personality traits, can be relevant predictor of addiction. Such results were obtained in the research of Crucio et al., in which 317 occasionally-drinking students have taken part [16]. Impulsivity was measured by Sensation Seeking Scale and Zuckerman-Kuhlman Personality Questionnaire. In alcohol-drinking, but not addicted individuals, sensation seeking was a significant predictor of alcohol use. However, the only dimension associated with alcohol-related problems prediction, was negative urgency. Other known method used in personality assessment of alcohol addicted individuals is NEO-PI-R questionnaire, based on „Big Five” theory, by Paul Costa and. Robert Mc Crae. In the light of this conception, impulsivity is one of the subscales of neuroticism (the remaining scales are: extraversion, openness to experience, conscientiousness and agreeableness). In study of Wojnar, investigating 154 alcohol-addicted patients who were taking part in standard addiction therapy pro-

grams, positive correlation between impulsivity and neuroticism; as well as negative correlation between impulsivity and extraversion, were found [17]. These traits were measured with Barrat Impulsivity Scale and NEO-PI-R Questionnaire. Described associations were present only in women and were connected with early addiction onset, other psychoactive substance use and the experience of violence and sexual abuse in childhood.

Alcohol addiction often co-occurs with psychiatric disorders, that often manifest in impulsive behavior, e.g.: bipolar disorders, ADHD or borderline personality disorders. Until now, rarely used method in alcohol addicted individuals, is affective temperament questionnaire TEMPS-A that includes five types of temperament (depressive, cyclothymic, hyperthymic, irritable and anxious). In Turkish studies of patients with bipolar disorders, the association between alcohol addiction, anxiety disorders and cyclothymic temperament (associated with the tendency for mood changes), was found [18].

Impulsivity and decision-making research

So far, not many studies concern the relationship between impulsivity and decision making in alcohol addicts. Currently, not the addiction is the main area of investigators' interest, but addiction-leading problem behaviors or predisposition associated with other factors (biological, environmental). In the study of Lovallo et al. impulsivity is being understood in terms of reaction inhibition disorders (worse performance of the Stroop Test), and this feature is present even in healthy individuals with the family history of addiction [19]. Authors came to these results after investigating 175 subjects, among whom 87 had a family history of alcohol abuse and 88 had not, aged 18-30 years, who currently were not alcohol abusers. In subjects with family history of alcohol abuse, the style of decision-making did not correlate with behavioral impulsivity, but differed due to sex. In males, a significant tendency for preferring larger money gains was noticed, however the ability to change behavior adequately caused, that final results were not different from scores obtained by individuals, whose decision-making style was "more cautious". In the assessment of personality, no antisocial personality traits were found in these individuals. According to authors, in males the risk of addiction is more biologically conditioned than in females. The characteristic decision-making style (preferring larger money gains) may be its' feature, but does not mean decision-making disorders. Neuroimaging studies by the same authors showed that in individuals from families with the history of alcohol addiction, different brain areas were involved in decision-making processes, compared to subjects without such family history: left part of dorsal cingulate gyrus and left caudate nucleus [20].

It seems that the drinking period does not have to be long, for the appearance of mentioned disorders of decision-making processes [21]. Gourdian et al. investigated four groups of last year college students (using Iowa Gambling Task) indicating lower effectiveness of decision-making processes in individuals, who declared often binge drinking episodes, compared to students, who had less such episodes. Decision-making disorders were not significantly associated with impulsivity.

Much less is known about the association between impulsivity and decision-making processes in individuals with “advanced” alcohol addiction. The most dramatic decision, that can be made regardless to consequences, seems to be impulsive suicide attempt. In the study of Wojnar et al. higher level of behavioral impulsiveness was found in alcohol-addicted subjects, who were after spontaneous suicide attempt, compared to individuals with alcohol addiction, who planned suicide [22]. In this work, no method assessing decision-making processes was used.

The results of other studies indicate, that decision-making disorders are related not as much to the current drinking status, as to chronic addiction [23]. It can be assumed, that disorders of decision-making processes increase due to alcohol addiction progression. The relationship between decision-making and “behavioral” impulsivity measured with neuropsychological tests, seems to be relevant. Salgado et al. distinguished three types of impulsivity: motor impulsivity, impulsiveness associated with disturbances in planning and impulsivity related to attention disorders [24]. According to the authors, the Iowa Gambling Task itself assesses one of impulsivity dimensions, associated with non-adequate planning. The authors investigated 31 individuals with different length of abstinence duration period (15-120 days) and compared results to the controls. Independently from the abstinence duration, alcohol addicted individuals had greater impulsivity occurring in attention disorders, assessed with Continuous Performance Test, and had more perseverative errors in the Wisconsin Card Sorting Test (WCST). According to the investigators, this results can be treated as an indicator of impulsivity that occurs in the new information assessment disorders and “automatic” inefficient behavior repetition. The authors cite different prospective studies of individuals with alcohol addiction, in whom, based on WCST assessment (compared to their results from detoxification period), a significant improvement was found in decreased number of non-perseverative errors, associated with reduction of attention disorders; but not in improvement of cognitive flexibility (due to no reduction of perseverative errors).

The relationship between decision-making and impulsivity understood in terms of personality traits, is still not clear. Miranda et al. claimed that worse decision-making ability in individuals with alcohol addiction, is associated with psychopathic personality traits measured with Psychopathic Personality Inventory (PPI) [25]. One of recent works had shown, that in alcohol-addicted individuals, decision-making deficits do not decrease in spite of long (over three years-long) abstinence [26]. It was shown, that depending on the length of abstinence, different personality traits dominate in investigated subjects (TCI by Cloninger was used). In individuals with short abstinence period, harm avoidance turned out to be the dominant trait. The coping style in this subjects was more emotionally-focused. In the group with long period of abstinence, dominated such traits as self-directedness and cooperativeness. Impulsivity associated with novelty seeking did not occur as a trait significantly influencing on decision making.

Conclusion

Impulsivity in alcohol-addicted individuals is not a clearly defined concept. It can be understood in many ways: the part of researchers consider impulsivity as a feature

of specific manifestation of cognitive function and behavioral disorders associated with brain abnormalities caused by alcohol overuse. Impulsivity is sometimes described as manifestation of certain (in most cases associated with genetic predisposition) personality traits, that may change due to the length of abstinence. It is worth to indicate that in this population, decision-making process itself can be treated as a manifestation of multifactorial-conditioned impulsivity. Based on the results of theoretical works and research studies, it seems that it would be worth to define more precisely the concept of impulsivity, in order to determine its effect on decision making. It would be also worth to assess, whether and to what extent, the two variables (impulsivity and decision making) can be considered as separate.

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Corresponding address:

Agnieszka Kałwa

Institute of Psychiatry and Neurology

02-957 Warsaw, Poland, Sobieskiego St. 9

e-mail kalwa@ipin.edu.pl