Monográfico

Understanding addiction from a neuropsychological perspective

Comprendiendo la adicción desde una perspectiva neuropsicológica

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Received: 14/02/2022 · Accepted: 11/03/2022

Cómo citar este artículo/citation: Sampedro-Piquero, P. (2022). Understanding addiction from a neuropsychological perspective. *Revista Española de Drogodependencias*, *47*(1), 76-89.
https://doi.org/10.54108/10006

Abstract

The conception of addiction as a chronic brain disease has become prevalent promoting the idea that a person with an addictive disorder undergoes changes in the structure and functioning of his or her brain. Unfortunately, when these brain changes occur, the individual loses self-control over his/her behavior. From this biomedical model of addiction, people who abuse drugs are considered sick promoting their medical care and social consideration. Moreover, from this idea of addiction as a brain disease, the individual is more likely to externalize the reasons for relapses or dropouts during treatment showing little involvement in rehabilitation. Due to these assumptions, in recent years there has been a proliferation of studies questioning this model from methodological, ethical and sociological perspectives. Therefore, in this review we will highlight the idea that not everything is in the brain and that we must consider the interrelationship between the brain and the environment to provide a broader and more comprehensive understanding of addiction. To this end, we propose that neuropsychology and its study of cognitive processes is the best way to understand both the onset and the course of addictive disorders.

Keywords

Addiction, Cognition, Neuropsychology, Treatment.

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Resumen

La concepción de la adicción como una enfermedad crónica con base cerebral se ha hecho predominante en los últimos años. Desde ella, se promueve la idea de que una persona con un trastorno adictivo sufre cambios en la estructura y el funcionamiento de su cerebro haciendo que pierda el autocontrol sobre su comportamiento. Además, desde este modelo biomédico, las personas que abusan de las drogas son consideradas enfermas promoviendo su atención médica y su consideración social siendo así, el individuo más propenso a externalizar los motivos de las recaídas y de los abandonos y mostrando menos implicación en su rehabilitación. Debido a estas asunciones, en los últimos años han proliferado los estudios que cuestionan este modelo desde el ámbito metodológico, ético y sociológico. Por ello, en esta revisión pondremos en duda esta perspectiva reduccionista destacando la necesidad de considerar la interrelación entre el cerebro y el entorno para proporcionar una comprensión más amplia e integral de la adicción. Para ello, proponemos que la neuropsicología y su estudio de los procesos cognitivos es la mejor manera de entender tanto el inicio como el curso de los trastornos adictivos.

Palabras clave

Adicción, Cognición, Neuropsicología, Tratamiento.

The impact of substance use on the brain is also associated with cognitive impairments and, although there is variation in the neuropsychological profile observed, the research point to the fact that the deficits in memory and executive functioning are common across diferent substance types, as well as those who use multiple substances (Fernandez-Serrano, Perez-Garcia, & Verdejo-Garcia, 2011). Further, individuals with substance use disorder (SUD) present with greater prevalence of other risk factors for cognitive impairment, such as ADHD (Schellekens, van den Brink, Kiefer, & Goudriaan, 2020), intellectual disabilities (Vandernagel, van Duijvenbode, & van Horsen, 2019), traumatic brain injury (Cannella, McGary, & Ramirez, 2019), and other mental health disorders (Ogloff, Talevski, Lemphers, Wood, & Simmons, 2015). Moreover, there is evidence that certain cognitive impairments, particularly in the domain of inhibition, may predispose to developing SUD (Smith, Mattick, Jamadar, & Iredale, 2014). Therefore, cognitive deficits related to SUD is a diverse and complex phenomenon that must be considered to develop a specific and adequate individual approach.

1. THE EMERGENCE OF NEUROPSYCHOLOGY IN THE ADDICTION FIELD

As we mentioned before, the high prevalence of cognitive deficits in people with substance use disorders led to new approaches focused on improving the cognitive deficits observed in this population, as well as providing a more comprehensi-

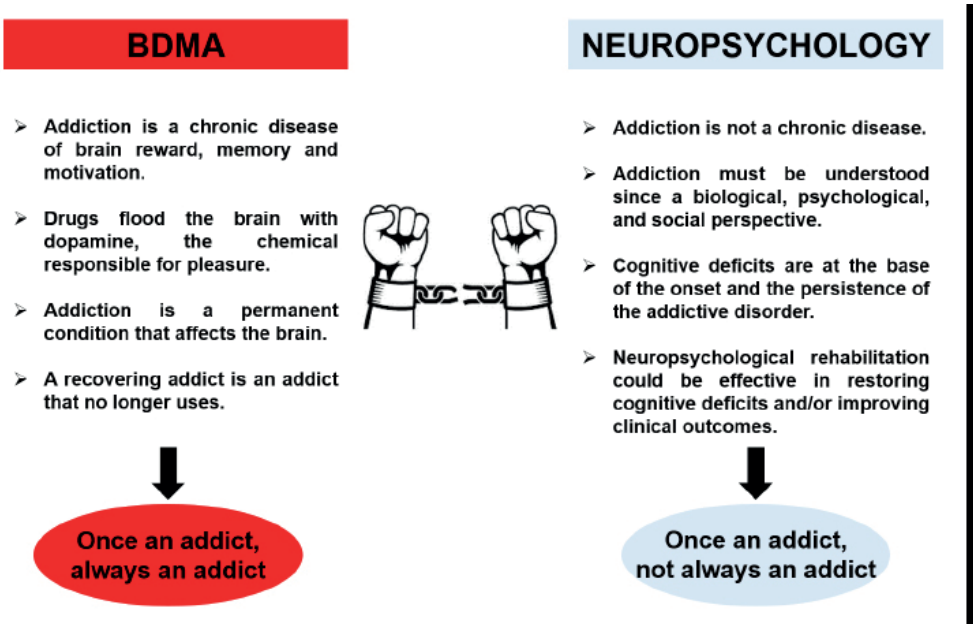
ve understanding of the addictive disorder (Bruijnen et al., 2019; Sampedro-Piquero et al., 2019). Consequently, neuropsychology, scientific discipline that originated around the middle of the 19th century, has shown to have a broad field of application in the context of addictive disorders (Bogousslavsky, Boller, & Iwata, 2019; Verdejo, 2018; Verdejo-García et al., 2018; Yücel, Lubman, Solowij, & Brewer, 2008). In the second half of the 20th century, the interest of neuropsychologists in addictive behaviours grew. However, it was in the last decade of that century, declared as the *Decade of the Brain*, when new tools to observe the brain in action were available and could be used to test different experimental paradigms. Neuropsychology considers the brain to be a highly plastic organ, in permanent contact with its environment and in continuously changing This change not only affects the structure and function of the brain but also considers the changes that the subject makes in his environment to achieve his goals. This perspective, which is interactive and necessarily dynamic, opens a great door to the knowledge of the mechanisms that underlie addiction. Thus, in this manuscript, we will focus on the role of cognition as the link between the biological, psychological, and social factors of addiction. Emphasising the role of cognition, we leave aside the reductionist BDMA in favour of the relationship between the brain and the environment, which promotes greater autonomy and the active participation of the person in his/her recovery.

In this framework of research, the concept of disease becomes profoundly irrelevant. Firstly, it refers to the field of medicine but is profoundly marginal to that of psychology. Secondly, the aim of Neuropsychology is to understand the neurological processes that underlie addiction, beyond the classification criteria that have characterised Psychiatry in recent decades. The emotions, cognitions, and behaviours linked to their physical substrates (mainly cerebral, but not only cerebral) are the object of knowledge pursued by this discipline (Berlucchi, 2009; Hall, O'Carroll, & Frith, 2010). Cognitive function is broadly defined as mental processing and includes the domains of learning, memory, emotions, executive function, language, and sensory-motor processing (Sachdev et al., 2014). Therefore, this psychological discipline could constitute an area of interest within addiction therapeutic environments in terms of deficit characterisation, functional impact, and recovery strategies.

2. NEUROPSYCHOLOGY AS AN ALTERNATIVE TO THE REDUCTIONIST BDMA

Neuropsychology is the psychological science that studies the relation between brain and behaviour, broadly encompassing research on the lateralisation and localisation of cognitive, emotional, and behavioural phenomena, neurodevelopment, ageing, and the brain, neuroplasticity, and related areas (Stringer, 2011). This widely accepted definition implies, in essence, an interdisciplinary character. Therefore, Neuropsychology is situated at the opposite end of the reductionism promoted by the BDMA, given that attempts to use neurobiological changes to explain behaviour can lead to very misleading explanations that are contradicted by behavioural data (Field, Heather, & Wiers, 2019) (Figure 1).

Figure 1. Conception of addiction from BDMA and neuropsychology



A large body of literature has established that substance addiction is broadly related to brain function in cognition, emotion, and behavioural interference with other significant activities, as well as to maintaining substance use despite negative consequences (Bruijnen et al., 2019; Cadet & Bisagno, 2013; Gould, 2010). In general, drugs of abuse are predominantly related to executive functions, such as working memory, mental flexibility, and reward-based decision making, which are essential to meeting treatment goals and successful social interactions (Verdejo-Garcia, Chong, Stout, Yücel, & London, 2018). Motor impulsivity, or impaired response inhibition, which is defined as the inability to refrain from initiating a response or difficulty in stopping a continuous response, also appears to be impaired in addicted individuals (Morein-Zamir & Robbins, 2015). Related to executive functions, the response inhibition and impaired salience attribution model (iRISA) was the first to propose that deficiencies in two neuropsychological functions, response inhibition and salience attribution, and their underlying neurobiological substrates contribute to the clinical symptomatology of substance addiction (craving, relapse, intoxication, and withdrawal) (Goldstein & Volkow, 2002, 2011; Zilverstand, Huang, Alia-Klein, & Golstein, 2018) Therefore, higher-order cognitive functions involved in the ability to track, update, and modulate the importance of a booster based on context and expectation and the ability to control and inhibit overbearing responses appear to be involved in drug addiction (Goldstein & Volkow, 2002). On the other hand, people with substance use disorders also show deficits in attention

and declarative memory, although in aspects that are at least partially related to executive control, such as the information coding process, recovery through the use of strategies, and sustained and selective attention (Vicario et al., 2020). All these deficits are exacerbated in polyconsumers who often show additive cognitive alterations (Capella, Benaiges, & Adan, 2015; Fernandez-Serrano, Perez-Garcia, & Verdejo-Garcia, 2011).

Another key question is whether the neurological, structural, and functional alterations that accompany the addictive process are a cause or a consequence of that process. In general, the BDMA has tended to interpret these alterations as consequences of addiction and therefore, evidence of their pathological nature (Volkow, Koob, & McLellan, 2016). However, it is entirely possible that such alterations happened previous to the addiction and constitute predisposing factors in establishing certain consumption patterns that led to an addiction. It should be remembered that higher brain functions are not implicit in the brain structure but are the product of education, learning history, and the life experiences of each individual (Zelazo, Müller, Frye, & Marcovitch, 2003). Thus, when a person reaches puberty, for example, without mature brain functioning, and encounters drugs, he or she is more likely to initiate abuse that can lead to addiction. This question can only be resolved by longitudinal studies, which are not always ethically viable. A recent proposal suggested that cognition sits at the interface of biological, psychological, and social drivers of addictive disorders, hinging on the interplay between nature and nurture and that this perspective overcomes the reductionism of the disease model (Verdejo-Garcia, 2020). Thus, it is likely that cognitive deficits derived from negative and maladaptive experiences favour addiction and, once established, it aggravates the disorders, causing a deficit loop that would be the basis for the persistence of the addictive problem (Grant & Chamberlain, 2014). When discussing the neuropsychological alterations associated with addiction, it is necessary to distinguish between those that are previous to the addictive process and those that are a consequence of the specific toxicity of each drug. Fernandez-Serrano et al. (2011) identified that episodic memory, emotional processing and the executive components of updating and decision-making were identified as general elements of addiction. However, these alterations were also present with specific conditions prior to drug use, such as poverty (Haft & Hoeft, 2017), stress (Watt, Weber, Davies, & Forster, 2017), or child abuse (Silveira et al., 2020). Therefore, it is possible that the alterations that are considered characteristic of addiction are actually disturbances of previous conditions that favoured its establishment.

One of the issues that has generated the most agreement is that people with addictions problems have deficits in decision making because they often prioritise short-term benefits without considering medium and long-term losses (Dominguez-Salas, Diaz-Batanero, Lozano-Rojas, & Verdejo-Garcia, 2016), which has been called *myopia for the future* (Bechara, Dolan, & Hindes, 2002). However, could the inability to estimate long-term consequences be a pattern learned before substance use? People who have learned during their development that the world is not a safe place and that nothing guarantees that medium and long-term goals can be achieved, tend to maximise immediate or short-term benefits. Drugs guarantee certain effects that, for the individual, are of incalculable value, such as the reduction of stress and discomfort in general, while care

provision proposes alternatives of uncertain utility and doubtful effectiveness (Lende & Smith, 2002). Furthermore, is not the culture of short-termism a sign of identity of our times? (Gallery & Gallery, 2009).

There are many topics whose research has been biased by the imposed need to interpret the results in the context of the BDMA, but they should have been approached since a neuropsychological perspective. Among them, one of the most important is the recovery from addiction. Erickson and White (2009) have proposed focusing efforts on understanding the pathways by which an addicted brain can cease to be addicted rather than understanding the pathological differences found in addicted brains. They recommend prioritising the neurobiology of recovery rather than the neurobiology of addiction. Many studies have found that after long periods of consumption, when abstinence has been established for a few months, there is a structural and functional recovery (Bartsch et al., 2007; Darke, McDonald, Kaye, & Torok, 2012; Maillard et al., 2020; Parvaz et al., 2017). Some studies observed that specific differences persisted after long periods of abstinence (Tanabe et al., 2009), but are they consequences of addiction or are they preconditions that explain a vulnerability that favoured its establishment?

3. HOW DOES THE NEUROPSYCHOLOGICAL CONTRIBUTE TO THE REHABILITATION OF ADDICTIVE DISORDERS?

Neuropsychology could be crucial in the treatment of people with addiction disorders. The fluctuating nature of substance use disorder makes its treatment inherently complicated due to the high relapse rate (up to 40-60%). For instance, a recent meta-analysis of 21 treatment outcome studies conducted between 2000 and 2015 found that fewer than 10% of treatment seekers were in remission in any given year following substance use disorder treatment (Fleury et al., 2016).

Altered cognitive functioning was identified as one of the main predictors of relapse and treatment drop-out (Brorson, Arnevik, Rand-Hendriksen, & Duckert, 2013). This also makes it difficult for follow-ups and commitment to psychological therapies (Dominguez-Salas et al., 2016). In this regard, Goldman (1990) described the state of cognitive alterations in alcohol-dependent people in the weeks following the achievement of abstinence, characterised by a transitory deterioration of attention, comprehension, and memory capacities known as *cognitive haze*, which negatively affects the active participation in treatment programmes. This state could be extended to other drug users because several studies have found that only a third of people, in the initial phases of treatment, showed cognitive performance according to their age and educative level. These deficits could be due to different causes, such as the effects of substances, environmental impoverishment or psychosocial stress, among other factors. Hence, several studies have shown that early intervention aimed at improving cognitive performance, not only improves cognition, but also favours the use of other activities (psychotherapeutic, educational, social reintegration, etc.) and improves the overall outcome of the treatment (Fals-Stewart & Lam, 2010; Rezapour, DeVito, Sofuoglu, & Ekhtiari, 2016). Treatments that include positive incentives and environmental improvements can both reduce drug con-

sumption and enable people with addictions to reduce drug use (Mckay, 2017). Hence, offering novel activities and establishing new habits as alternatives to drug consumption improves not only cognitive performance but also decreases the stress associated with failures and their impact on daily activities. This idea is entirely consistent with the principles derived from the *Environmental enrichment paradigm*, initially formulated in preclinical research which has now been applied in the prevention and treatment of addiction (Hannan, 2014; Solinas, Thiriet, Chauvet, & Jaber, 2010).

In clinical practice, these cognitive impairments often remain undetected despite the fact that early detection seems to be essential in maximizing treatment outcome. For example, impaired attention was related to poor retention in cocaine treatment (Aharonovich et al., 2006), while memory impairments were less common in completers versus non-completers among marijuana users in treatment (Aharonovich, Brooks, Nunes, & Hasin, 2008). Such findings make sense, given that attention and memory are needed to be successful in many forms of treatment (Carroll et al., 2011). Other research suggests that differences in cognition may contribute to differences in baseline motivation to change (Aharonovich et al., 2018). In a study examining motivation among alcohol users, it was found that verbal memory scores predicted the stage of change at baseline; lower-scoring individuals were more likely to be in the pre-contemplation phase while higher scoring individuals were more likely to be in the contemplation phase (Blume, Schmaling, & Marla, 2005).

For these reasons, neuropsychological assessment and the incorporation of cognitive rehabilitation should be generalised aspects in programmes for the treatment of addictive behaviours. It is possible that cognitive training during detoxification can take advantage of the neuroplasticity processes that accompany early abstinence. Another promising approach is overlapping cognitive training/rehabilitation interventions with other non-neuropsychological therapies that can synergise their effects, such as the regular practice of physical exercise training. Findings revealed that exercise training has a positive effect on reducing drug consumption (Nock, Minnes, & Alberts, 2017; Roberts, Maddison, Simpson, Bullen, & Prapavessis, 2012) and cravings (Taylor, Ussher, & Faulkner, 2007; Ussher, Sampuran, Doshi, West, & Drummond, 2004), as well as increasing both treatment adherence (Brown et al., 2010) and abstinence period (Berg et al., 2012). Interestingly, the beneficial effect of exercise was also found in psychopathological disorder symptoms often observed in these subjects, such as depression symptomatology and anxiety, among others (Cutter et al., 2014). For instance, individuals participating in exercise training programs showed greater decreases in anxiety compared with common forms of treatment, such as psychotherapy and pharmacotherapy (Wipfli, Rethorst, & Landers, 2008).

Unfortunately, the person most often initiates a pharmacological treatment that addresses the symptoms, while maintaining or aggravating the cognitive deficits. This aspect was categorically rejected by the highest authorities in american psychiatry (Insel, 2013), who had just published the Research Domain Criteria (RDoC) (Insel et al. 2010) with the aim of replacing symptom-based classifications (DSM V) with knowledge of the neurocognitive bases of addictive processes and all other psychological problems. In line with this research project, groups of

experts have recently proposed the central concepts of addiction that should be evaluated in order to formulate treatment programmes (Yücel et al., 2019), as well as a project to incorporate neuropsychological intervention in the treatment of addictive behaviours (Verdejo-Garcia et al., 2019).

3.1. Neuropsychological rehabilitation is not a panacea

Despite the promising results of neuropsychological intervention, we must take into account that there are still several impediments that block the implementation of this treatment in clinical settings. Besides, a lack of high quality studies of sufficient power, in addition to considerable heterogeneity of study designs, means that limited conclusions about the efficacy of cognitive rehabilitation within SUD treatment settings. These limitations, some of which will be mentioned below, highlight the need for standardisation of cognitive rehabilitation protocols and assessments of their effectiveness.

Firstly, the number and duration of the sessions required to produce cognitive enhancement and a generalised improvement in the patient's daily life, as well as adherence to the rest of the activities included in the treatment and the maintenance of abstinence are unknown. Concerning this, a study carried out with opioid-dependent subjects who participated in a multi-domain cognitive training programme (attention, processing speed, memory, executive functions) during 16 sessions, 1 hour each day over 2 months, showed a reduction in substance consumption along with cognitive improvements that lasted up to 6 months after completing inpatient treatment (Rezapour et al., 2019). Secondly, it is also unknown whether the extent of cognitive training would vary according to the type or degree of dependency of each subject. In this way, each individual has his or her own characteristics, needs, and expectations, which make it necessary to have a personalised rehabilitation training to satisfy the needs of each one of them. Thirdly, the duration of possible improvements, once rehabilitation has been completed, is also unknown. In this respect, two studies have shown the sustained effects of working memory training from one month (Houben, Wiers, & Jansen, 2011) to two months (Verbeken, Braet, Goossens, & van der Oord, 2013). Fourthly, if the effect disappears over time, it is necessary to determine whether booster sessions could be useful to facilitate the retention of the clinical improvements achieved. Finally, neuropsychological rehabilitation implies an active involvement by the subject and can be long and laborious; raising questions about the motivation techniques that would ensure compliance with the programme. Thus, more studies are needed to know what kinds of motivation are more effective in subjects under treatment in order to understand the mechanisms that lead to successful and sustained results over time (DiClemente, 1999). Therefore, motivational and affective domains should be considered in both neuropsychological assessments and rehabilitation.

4. CONCLUSIONS

Addiction must be considered as a complex biological, psychological and social disorder that must be addressed from various approaches. Neuropsychology, as a psychological discipline, is the best qualified to carry out this labour because it is capable of interpreting the brain functions that have favoured, established and maintained the addictive behaviour. Besides, neuropsycho-

logy is also interested in the integral and/or the restored cognitive functions that can favour the recovery. All this implies a change towards a neuropsychological perspective that considers cognitive aspects as the link between vulnerability to become dependent and the consequences of addiction, combined with a demedicalized and much more interdisciplinary approach to addiction.

Acknowledgements

I thank Antonio García Patiño and Eduardo Pedrero Pérez for give me the opportunity to participate in the monographic *Hacia un nuevo paradigma en adicciones*.

Conflict of Interest

Author declare no conflict of interest.

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