



BEHAVIORAL ECONOMIC APPLICATIONS IN THE ASSESSMENT, PREVENTION, AND PSYCHOLOGICAL TREATMENT OF ADDICTIONS

Alba González-Roz, Roberto Secades-Villa, Víctor Martínez-Loredo and José Ramón Fernández-Hermida

Universidad de Oviedo

La Economía conductual es una disciplina que puede resultar útil para estudiar los aspectos implicados en la génesis y el mantenimiento de las conductas adictivas mediante la aplicación de los principios de la economía y la psicología. En el ámbito de las adicciones dicha disciplina ha mostrado ser útil para explicar y predecir su gravedad, pero también para el diseño de estrategias de prevención universal y selectiva y de programas de tratamiento. Sin embargo, el modelo descrito goza hoy de un gran desconocimiento entre los profesionales de la psicología. El objetivo de este trabajo es presentar los principios de la Economía conductual y acercar al lector a la metodología utilizada en este campo. Se presentan evidencias empíricas de su aplicación en el estudio de las conductas adictivas y se subrayan las aplicaciones clínicas para la evaluación, la prevención y el tratamiento psicológico.

Palabras clave: Economía conductual, Patología del refuerzo, Adicciones, Evaluación, prevención, Tratamiento psicológico.

Behavioral economics is a discipline that can be useful for studying the aspects involved in the genesis and maintenance of addictive behaviors through the application of the principles of economics and psychology. In the addictions field, this discipline has been beneficial not only in explaining and predicting the severity of addictions, but also in designing universal and selective prevention strategies, as well as treatments. However, the described model remains largely unknown among psychologists. The aim of this work is to present the principles of behavioral economics and bring the reader closer to the methodology used in this field. Evidence is presented of its application in the understanding of addictive behaviors. Clinical implications for assessment, prevention, and psychological treatment are highlighted.

Key words: Behavioral economics, Reinforcer pathology, Addictions, Assessment, prevention, Psychological treatment.

INTRODUCTION: GENERAL PRINCIPLES OF BEHAVIORAL ECONOMICS

Behavioral economics (BE) is a hybrid discipline that integrates principles of economics and psychology to explain human behavior, and to clarify how human beings make decisions and what the determinants of their preferences are (Hanoch, 2017). This theory represents a revolution in the field of neoclassical economics as it questions its central assumption: that human beings make decisions in a rational and selfish way, that they do not make systematic errors in their judgments, and that they have no limits when estimating the consequences of their behavior (Bernheim, DellaVigna, & Laibson, 2019). In contrast, BE is based on the idea that human decisions and choices are made in contexts of limited rationality, where a variety of psychological factors (e.g., emotions, thought or attentional biases, memories, values, and attitudes) come into play that alter the outcomes predicted by economic theory. According to Cartwright (2018), the fusion between economics and psychology has its origins in the text *The Theory of Moral Sentiments*, published by Adam Smith in

1759, which even back then advocated the influence of fashion, custom, prizes, and punishments in decision-making. Premack's principle (1959) and the matching law (Herrnstein, 1961) were also seminal milestones that underscored the importance of analyzing aspects of the object and situation of consumption, such as the relative power of different reinforcers to understand the maintenance of a behavior.

The principles of BE are governed by three main concepts: demand, price, and opportunity cost (Hursh, Galuska, Winger, & Woods, 2005). The concept of demand refers to three interrelated aspects: search behaviors, consumption behaviors, and the organism's response to price increases. The price refers to both the economic cost (per unit of the substance) and the personal cost (the effort associated with the acquisition of a substance). The opportunity cost refers to the alternative reinforcers lost as a result of a decision (e.g., to use drugs). Thus, a person with alcohol use disorder will have a high demand for alcohol at the expense of the personal (impaired family and social relationships) and economic costs associated with the behavior. Thus, the manipulation of price and opportunity cost is a demand determinant with important implications for prevention and treatment. In particular, increasing the price (economic, personal) and the opportunity cost (the loss of reinforcements) will favor a proportional decrease in demand.

Received: 1 December 2019 - Aceptado: 9 January 2020

Correspondence: Alba González-Roz. Grupo de Conductas Adictivas. Facultad de Psicología. Universidad de Oviedo. Plaza Feijóo, s/n. 33003 Oviedo. España. E-mail: albagroz@cop.es



CONCEPTUALIZATION OF ADDICTIONS BASED ON BEHAVIORAL ECONOMICS

BE conceptualizes addiction (genesis, maintenance, and relapse processes) as a disorder of choice (Bickel, Koffarnus, Moody, & Wilson, 2014) that is characterized by an overestimation of the reinforcing effects associated with drug use and a devaluation of the risks or negative consequences, usually delayed in time, that result from consuming (imprisonment, relational problems, economic cost, etc.), as well as the positive consequences of not consuming (health, quality of life), also produced in a delayed way. Whether or not an individual is addicted to a substance has a lot to do with the context, perceptions, and emotions. The “Rat Park” experiment conducted by psychologist Bruce Alexander and his colleagues (1978) is instructive from this point of view, since environmental enrichment seems to be a protective element for substance consumption. Therefore, in opposition to the medical model that conceptualizes addiction as a disease of the brain in a normal world, we can say that the choice model understands addiction as a normal functioning of the brain, in a dysfunctional world (Lamb, Maguire, Ginsburg, Pinkston, & France, 2016).

Within the BE model, excessive preference for drugs (or other addictions) over other alternatives may become a self-perpetuating process, a “reinforcer pathology” (Bickel & Athamneh, 2019): repeated drug use results in a reduction in the availability of other reinforcing alternatives, as well as a reduction in sensitivity to the reinforcing effects of these alternatives, which, in turn, increases the likelihood of continued drug use. This perpetuating process explains the supposed chronicity of the disorder and the high difficulty of quitting substance use.

So, what determines whether a person chooses to use drugs, even to the point of becoming an addict, when he or she is aware that the consequences can be fatal? Well, in addition to the objective value (magnitude or quantity) and physical properties of a reinforcer (the substance or other alternatives available in the context), the choice depends primarily on the subjective value (utility) for the person making the assessment, with specific individual characteristics (sex, sensitivity to the effects of substances, personal situation, etc.) and the presence of contextual factors, such as the availability of alternative reinforcers incompatible with drug use present at the time of the choice. This subjective evaluation, which explains the choice (in this case, whether or not to take drugs), is essentially determined by two reinforcement processes that constitute what is known as “reinforcer pathology” (Bickel & Athamneh, 2019): 1) an excessive valuation of the reinforcer, i.e. of the substance (high efficacy of the reinforcer) and/or, 2) an excessive preference for immediate reinforcers as opposed to delayed ones (high delay discounting, DD).

Studies conducted within the framework of BE have shown that drug use (high demand) is: 1) inversely proportional to the

restriction on its use, 2) inversely proportional to the availability of other alternative reinforcers and, 3) directly proportional to the restriction on access to these reinforcers. A classic study showing some of these predictions is the one carried out by Lee N. Robins in 1993 on the 1971 Vietnam War. In a highly stressful, novel, and hostile context, with a high availability of substances and limited alternatives, it was shown how substance consumption increased significantly among soldiers, whereas it was interrupted after they returned home.

On the other hand, DD is a measure of impulsivity, which involves a distortion in decision-making that causes two issues: 1) overestimating the immediate stimuli associated with the drug, and 2) underestimating the longer-term rewards. Walter Mischel’s famous experiments (the marshmallow tests) at Stanford University during the 1960s are illustrative of this process (Mischel & Metzner, 1962; Mischel, Grusec, & Masters, 1969). Their work helped to conceptualize drug-taking behaviors as behaviors that are learned and controlled by immediate consequences (hedonistic effects), rather than other less immediate reinforcers, of greater objective magnitude (good health, getting along with family, better financial situation, etc.).

EMPIRICAL EVIDENCE FROM BEHAVIORAL-ECONOMIC THEORY IN ADDICTIONS

The scientific evidence (in both laboratory and clinical studies) showing the close relationship between demand and DD with the different processes involved in drug use and addictive behaviors in general, is very broad and diverse (for a review, see the works of Audrain-McGovern et al., 2009; González-Roz, García-Pérez, Weidberg, Aonso-Diego, & Secades-Villa, 2019; Koffarnus & Woods, 2013; Strickland, Lile, & Stoops, 2017, among others). Both phenomena (demand and DD), constituents of reinforcer pathology, seem to sustain a two-way relationship with substance use, suggesting that these are reversible, context-dependent conditions that are highly influenced by consumption or abstinence status (Secades-Villa, Weidberg, García-Rodríguez, Fernández-Hermida, & Yoon, 2014; Yi, Mitchell, & Bickel, 2010). It has been observed that higher levels of demand and impulsive decision-making are associated with greater severity of substance addiction, both legal (alcohol, tobacco, and problem gambling) and illegal (cannabis, stimulants, and opiates) (Amlung, Vedelago, Acker, Balodis, & MacKillop, 2017). Furthermore, several studies have shown that substance users have higher DD (i.e., they are more impulsive) compared to non-users or former users (Konecky & Lawyer, 2015; Weidberg, Gonzalez-Roz, & Secades-Villa, 2017).

BEHAVIORAL ECONOMICS AND PSYCHOLOGICAL ASSESSMENT IN ADDICTIONS

Assessment of demand

Drug purchase tasks are reliable, valid, and cost-efficient measures to estimate the demand for a substance or its



reinforcing value for an individual or group of individuals based on price (González-Roz, Secades-Villa, Weidberg, Muñiz, & MacKillop, 2019). This reinforcing value is also known as relative reinforcing and is represented graphically by a demand curve that illustrates how, as the price increases, demand decreases significantly (see Figure 1).

In general terms, purchasing tasks evaluate the number of units (cigarettes, grams of cocaine, etc.) that a person would buy at different prices under a series of assumptions to be considered: habitual consumption, impossibility of accumulation, and availability of habitual income.

Purchasing tasks offer a multidimensional assessment by capturing several aspects involved in maintaining addiction, namely: 1) intensity or the amount of consumption under conditions of unrestricted or free access to a given substance; 2) O_{max} or the maximum expenditure of the person on a given substance; 3) P_{max} or the maximum price associated with the maximum expenditure made; 4) breakpoint or the substance cost that produces the cessation of consumption; and 5) demand elasticity, defined as the degree of sensitivity of demand to price increases. All the proposed indicators are observed, with the exception of elasticity which must be derived using a formula. Koffarnus and collaborators (2015) have carried out an excellent review of the procedure necessary to derive this indicator, which is specified as follows¹: $Q = Q_0 \times 10^{k(e^{-Q_0C} - 1)}$.

One of the advantages of purchasing tasks is the elimination of costs to the participant arising from repeated assessment in different trials, and of the ethical problems involved in assessing people with addictive disorders or in treatment. Purchasing tasks are versatile, since they can be used to evaluate demand as a "state" and as a "trait". Demand as a trait is conceptualized as the preference on a typical consumption day of the person being assessed (typically a 24-hour time frame), while demand as a state refers to the current moment, that of the assessment. In the field of addiction studies, trait demand has informed regulatory and pricing policies, but also at the individual level by identifying variations in substance preference in people with different psychological disorders (depression, post-traumatic stress disorder) (Dahne, Murphy, & MacPherson, 2017; MacKillop et al., 2012; Tripp et al., 2015).

4.2. Evaluation of the delay discounting

Different procedures are available for assessing DD, from the more traditional ones consisting of the presentation of pairs of choices systematically by the experimenter (Reed & Martens, 2011) or self-reporting through paper tasks (Beck & Triplett, 2009), to the computerized procedure (Mahalingam,

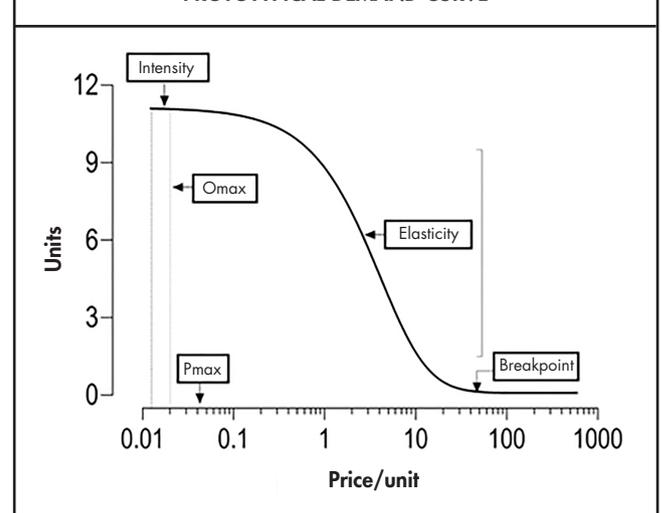
Palkovics, Kosinski, Cek, & Stillwell, 2016), the most used method at present.

All of them have in common the determination of the devaluation rate of a reinforcer (the substance or money generally) as time passes, following the hyperbolic function indicated below (Mazur, 1987): $V = A/(1+kD)$. This function can be represented by a curve as shown in Figure 2. In this curve, the discounting level of the reinforcer "money" increases, as time goes by, in a more accelerated way for the group of substance users compared with the group of non-users (control group). During the task, participants are instructed to make a series of decisions between receiving a small usually hypothetical amount (e.g., 800 €) now, and one of greater value, but delayed in time (e.g., \$1,000 tomorrow). Decision-making in the assessment context must be carried out under two essential assumptions: 1) certainty, i.e. there is no possibility of not receiving the delayed reinforcer if the latter is chosen, and 2) decision-making in the current context, in no case under other circumstances (e.g. changes in the economic situation or different emotional states).

4.3. Other relevant processes

The degree to which people are future-oriented is another variable that has been related to impulsive decision-making, and in particular to risk behaviors such as addictions (Bickel & Athamneh, 2019). The study of this variable in the field of addictions is not new, since already a decade ago Keough highlighted the relationship between future orientation and substance use (Keough, Zimbardo, & Boyd, 1999). There are several instruments for its assessment, the Consideration of

FIGURE 1
PROTOTYPICAL DEMAND CURVE



¹ Note that different macros (Kaplan, Gilroy, Reed, Koffarnus, & Hursh, 2019) and syntax or commands (<https://support.sas.com/rnd/app/ets/examples/simpelast/index.htm>) have also been developed to make this indicator easier to obtain.



Future Consequences Scale (Rappange, Brouwer, & Van Exel, 2009) being one of the most used. This scale assesses the degree to which people consider and are influenced by outcomes of a present behavior that are distant in time. The original version consists of 12 items and has good psychometric properties (Strathman, Gleicher, Boninger, & Edwards, 1994).

Another variable that has received attention is the level of reinforcement obtained from non-consumption activities. This variable has been identified as one of the most robust predictors of the amount of consumption and alcohol-related problems, even more so than other variables of incentive salience and executive control. An excellent review of the instruments available for the assessment of this variable has recently been carried out by Acuff and colleagues (2019). Among the most used are the Reward Probability Index (Collado, Castillo, Maero, Lejuez, & MacPherson, 2014) and the Environmental Reward Observation Scale (Barraca & Pérez-Álvarez, 2001), both validated in our environment.

IMPLICATIONS OF BEHAVIORAL ECONOMICS FOR THE PREVENTION AND PSYCHOLOGICAL TREATMENT OF ADDICTIONS

In recent years we have seen an increasing influence of BE tenets in public health policy formulation. In 2010, for example, the UK government created the "Behavioral Insights Team" explicitly dedicated to the application of the principles of BE to improve health in an efficient way. In 2016, the U.S. Food and Drug Administration Foundation funded over \$193

million to assess the impact of manipulating the nicotine content of cigarettes on tobacco demand, among other measures (FDA & HHS, 2018).

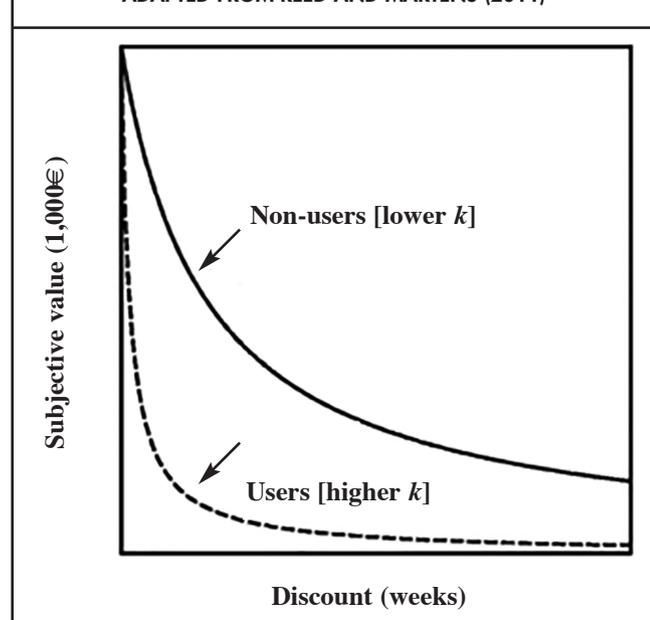
The central concept used by BE is the "nudge", a soft push or incentive to perform a specific behavior where a series of core concepts come into play for the design of government policies aimed at improving health. These concepts include the reversal of preferences over time, limited rationality, framing effects, availability heuristics, and social norms. Table 1 briefly describes these concepts and their application in the field of prevention and treatment of drug dependence.

What is known as "environmental prevention" accurately reflects the application in practice of the principles of BE in the field of addictions. It aims to limit the availability of opportunities for unhealthy or risky behavior (or to promote the availability of healthy behavior), by changing the physical, economic, or legal contexts that influence behavior. The underlying idea is that human beings are not *homo economicus* or, in other words, perfect calculators. Consequently, it is the simplification of decision making that enables contexts to be configured so that decisions maximize the benefits.

It is well known that substance use prevention programs are more effective when they are accompanied by social and legal norms that decrease social acceptance, supply, and restrict accessibility to these substances. Of these norms, the following are highlighted: a) economic measures that impact on the costs of healthy/risky choices through taxes, pricing policies, and subsidies, and b) legal measures, which directly control what is permissible or accessible, through diverse regulations: restrictions, surveillance, institutional standards, prohibitions, and exclusions. One such example is the restriction on gambling in Norway (Rossow & Hansen, 2016) where access to slot machines requires the use of a personal card which increases the costs associated with gambling (personal identification, minimum age for gambling, setting limits on losses, and self-exclusion via the register of gaming access bans). More recently, a large number of American states have incorporated the BE methodology to make evidence-based decisions in the face of the increasing scenario of cannabis legalization. Reducing its availability by limiting its procurement on the basis of weekly or monthly units purchased and imposing waits for repurchase, controlling the prices of competing or substituting reinforcing alternatives (illegal cannabis) have been some of the main measures proposed (Amlung et al., 2019; Kleiman & Ziskind, 2019).

Preventive measures linked to BE also involve increasing the availability (reducing the cost) of alternatives to drug abuse. Examples include alternative leisure programs, promoting social activities among young people, volunteering, etc. Just as drug use interferes with school performance, low academic achievement has been found to be a risk factor for adolescent substance use initiation (Henry, Smith, & Caldwell, 2006).

FIGURE 2
PROTOTYPICAL DELAY DISCOUNTING CURVE
ADAPTED FROM REED AND MARTENS (2011)





Thus, creating a greater bond between young people and the school environment helps to distance them from risk groups, to approach new peer groups, and to provide them with the possibility of carrying out alternative, healthier leisure activities. Therefore, programs aimed at increasing school engagement through authorized and individualized services should be intensified.

Additional measures also involve the development of campaigns to increase the social costs associated with the use of some substances, in particular alcohol and cannabis, by reducing social acceptance or increasing stigma (as is the case with heroin or cocaine), as well as the perception of risk of these substances. Given that the perception of risk associated with drug use seems to be a good protective factor for initiation (Cooper, Loukas, Case, Marti, & Perry, 2018; Kilmer, Hunt, Lee, & Neighbors, 2007), it would be a matter of informing and raising awareness in society to generate a culture of rejection of drugs in general, and alcohol and cannabis in particular, as the most widely used drugs and a gateway to other substances. In this regard, prevention campaigns should be specifically aimed at target groups, providing clear, credible, and evidence-based information.

With regard to treatment, the principles of BE have had great influence on the development of treatments aimed at increasing the price of substances and compensating for the loss of reinforcers associated with drinking or the use of other drugs (Murphy, Correia, & Dennhardt, 2013). Of particular importance are contingency management programs (Secades-Villa et al., 2013; Secades-Villa, García-Rodríguez, & Fernández-Hermida, 2015), which provide reinforcers contingent on abstinence, or behavioral activation and skills training (González-Roz, Secades-Villa, & Alonso-Pérez, 2019), which promote an increase in alternative sources of reinforcement to drug use and increase the associated cost of the latter.

Motivational interventions that promote awareness of the costs and consequences of alcohol and drug abuse also fit into the assumptions of BE. The decisional balance and objective and personalized feedback on the risks and costs associated with the use of alcohol and/or other drugs are very useful strategies with patients with low motivation, as is the case with most young consumers (Collins, Kirouac, Lewis, Witkiewitz, & Carey, 2014). From this point of view, it is crucial to provide frequent feedback on social, academic, etc. and therapeutic achievements (alternative reinforcers), through objective tests such as biochemical ones, especially at the beginning of treatment, without waiting for the end of the process.

Finally, given the importance of DD in the addiction processes, an essential component of treatment would be to reduce impulsive responses by increasing the value of delayed reinforcers. In recent years, interventions have been developed that help focus on positive future events such as

episodic future thinking (Bickel & Athamneh, 2019), which help reduce DD and promote healthy behaviors. In this arena, interventions have been developed that lead individuals to see their day-to-day decisions as part of a pattern of behavior with long-term implications, through personalized feedback (Neighbors, Larimer, & Lewis, 2004). However, most of the effects of these interventions have been shown in experimental settings and their efficacy in clinical or community settings has yet to be demonstrated.

CONCLUSION: BEHAVIORAL ECONOMICS AND ADDICTIONS

The application of BE, and especially that of the reinforcer pathology model to addictive behaviors, has different implications for assessment, prevention, and psychological treatment. As a theoretical guide in the research, it allows us to formulate an explanation of the acquisition, maintenance, and abandonment of drug dependencies and other addictive behaviors. In psychological assessment it allows us to characterize profiles of consumers or people at risk of increasing consumption. Consequently, it would be of great interest to incorporate behavioral-economic measures such as DD, demand, and the identification of the number and reinforcing value of activities linked and not linked to drug consumption in the assessment processes. In treatment, the reduction of the excessive valuation of the immediate reward and the increase of behavior patterns that lead to favoring the

TABLE 1
CENTRAL CONCEPTS IN BEHAVIORAL ECONOMIC
THEORY AND APPLICATION

Concept	Description	Application
Reversal of preferences	The preference between two options is reversed over time due to delay discounting	Use of deposits or incentives given after the performing of a behavior to increase its value
Limited rationality	Rationality of decisions is compromised by lack of information, limited time to make a decision, and cognitive limitations	Simplification and organization of information presented to prevent harm after abusive or unwanted consumption (pill testing)
Framing effect	Decisions are influenced by the way options are presented	Preventive messages aimed at the benefits of involvement in healthy behaviors and the negatives of not getting medical checkups
Availability heuristic	Evaluation of the frequency and probability of the occurrence of an event depending on the accessibility of information related to it	Prioritizing a behavior giving relevant examples for a target population (age, social group)

Adapted from Matjasko, Cawley, Baker-Goering, and Yokum (2016)



valuation of delayed reinforcers should be pursued. Preventive programs at the macro level should emphasize “nudges” by increasing the cost (effort and economic price) of drugs and reducing the efforts/costs to engage in drug-free alternatives.

ACKNOWLEDGMENTS

This work received support from the National Plan on Drugs (PNSD: Ref. MSSSI-17-20171036) and the Spanish Ministry of Science, Innovation, and Universities (BES-2015-073327; BES-2016-076663).

CONFLICT OF INTEREST

There is no conflict of interest.

REFERENCES

- Acuff, S. F., Dennhardt, A. A., Correia, C. J. & Murphy, J. G. (2019). Measurement of substance-free reinforcement in addiction: A systematic review. *Clinical Psychology Review, 70*, 79–90. doi: 10.1016/j.cpr.2019.04.003
- Alexander, B. K., Coombs, R. B. & Hadaway, P. F. (1978). The effect of housing and gender on morphine self-administration in rats. *Psychopharmacology, 58*, 175–179. doi: 10.1007/bf00426903
- Amlung, M., Reed, D. D., Morris, V., Aston, E. R., Metrik, J. & MacKillop, J. (2019). Price elasticity of illegal versus legal cannabis: A behavioral economic substitutability analysis. *Addiction, 114*, 112–118. doi: 10.1111/add.14437
- Amlung, M., Vedelago, L., Acker, J., Balodis, I. & MacKillop, J. (2017). Steep delay discounting and addictive behavior: A meta-analysis of continuous associations. *Addiction, 112*, 51–62. doi: 10.1111/add.13535
- Audrain-McGovern, J., Rodriguez, D., Epstein, L. H., Cuevas, J., Rodgers, K. & Wileyto, E. P. (2009). Does delay discounting play an etiological role in smoking or is it a consequence of smoking? *Drug and Alcohol Dependence, 103*, 99–106. doi: 10.1016/j.drugalcdep.2008.12.019
- Barraca, J. & Pérez-Álvarez, M. (2001). Adaptación española del Environmental Reward Observation Scale (EROS) [Spanish adaptation of the Environmental Reward Observation Scale (EROS)]. *Ansiedad y Estrés [Anxiety and Stress], 16*, 95–107.
- Beck, R. C. & Triplett, M. F. (2009). Test-retest reliability of a group-administered paper-pencil measure of delay discounting. *Experimental and Clinical Psychopharmacology, 17*, 345–355. doi: 10.1037/a0017078
- Bernheim, B. D., Dellavigna, S. & Laibson, D. (2019). *Handbook of Behavioral Economics - Foundations and Applications 2*. Amsterdam: North Holland.
- Bickel, W. K. & Athamneh, L. N. (2019). A Reinforcer Pathology perspective on relapse. *Journal of the Experimental Analysis of Behavior*. Advance publication. doi: 10.1002/jeab.564
- Bickel, W. K., Koffarnus, M. N., Moody, L. & Wilson, A. G. (2014). The behavioral- and neuro-economic process of temporal discounting: A candidate behavioral marker of addiction. *Neuropharmacology, 76*, 518–527. doi: 10.1016/j.neuropharm.2013.06.013
- Cartwright, E. (2018). *Behavioral Economics*. UK: Routledge.
- Collado, A., Castillo, S. D., Maero, F., Lejuez, C. W. & MacPherson, L. (2014). Pilot of the Brief Behavioral Activation Treatment for Depression in Latinos With Limited English Proficiency: Preliminary Evaluation of Efficacy and Acceptability. *Behavior Therapy, 45*, 102–115. doi: 10.1016/j.beth.2013.10.001
- Collins, S. E., Kirouac, M., Lewis, M. A., Witkiewitz, K. & Carey, K. B. (2014). Randomized controlled trial of web-based decisional balance feedback and personalized normative feedback for college drinkers. *Journal of Studies on Alcohol and Drugs, 75*, 982–992. doi: 10.15288/jsad.2014.75.982
- Cooper, M., Loukas, A., Case, K. R., Marti, C. N. & Perry, C. L. (2018). A longitudinal study of risk perceptions and e-cigarette initiation among college students: Interactions with smoking status. *Drug and Alcohol Dependence, 186*, 257–263. doi: 10.1016/j.drugalcdep.2017.11.027
- Dahne, J., Murphy, J. G. & MacPherson, L. (2017). Depressive symptoms and cigarette demand as a function of induced stress. *Nicotine and Tobacco Research, 19*, 49–58. doi: 10.1093/ntr/ntw145
- Fda & HHS. (2018). *Tobacco control act (Dollars in Thousands)*. Retrieved from: <http://www.fda.gov/TobaccoProducts/Labeling/TobaccoProductReviewEvaluation/SubstantialEquivalence/ucm304517.htm#3>
- González-Roz, A., García-Pérez, Á., Weidberg, S., Aonso-Diego, G. & Secades-Villa, R. (2019). Reinforcer pathology and response to contingency management for smoking cessation. *Psychology of Addictive Behaviors*. Advance publication. doi: 10.1037/adb0000500
- González-Roz, A., Secades-Villa, R. & Alonso-Pérez, F. (2019). Effects of combining contingency management with behavioral activation for smokers with depression. *Addiction Research & Theory, 27*, 114–121. doi: 10.1080/16066359.2018.1463371
- González-Roz, A., Secades-Villa, R., Weidberg, S., Muñoz, J. & MacKillop, J. (2019). Characterizing the reinforcing value of tobacco using a cigarette purchase task: an item response theory approach. *Experimental and Clinical Psychopharmacology*. Advance publication. doi: 10.1037/pha0000323
- Hanoch, Y. (2017). *Behavioral Economics and healthy behaviors: Key concepts and current research*. London: Routledge.
- Henry, K. L., Smith, E. A. & Caldwell, L. L. (2006). Deterioration of academic achievement and marijuana use



- onset among rural adolescents. *Health Education Research*, 22, 372–384. doi: 10.1093/her/cyl083
- Herrnstein, R. J. (1961). Relative and absolute strength of response as a function of frequency of reinforcement. *Journal of the Experimental Analysis of Behavior*, 4, 267–272. doi: 10.1901/jeab.1961.4-267
- Hursh, S. R., Galuska, C. M., Winger, G. & Woods, J. H. (2005). The economics of drug abuse: A quantitative assessment of drug demand. *Molecular Interventions*, 5, 20–28. doi:10.1124/mi.5.1.6
- Kaplan, B. A., Gilroy, S. P., Reed, D. D., Koffarnus, M. N. & Hursh, S. R. (2019). The R package beezdemand: Behavioral economic easy demand. *Perspectives on Behavior Science*, 42, 163–180. doi: 10.1007/s40614-018-00187-7
- Keough, K. A., Zimbardo, P. G. & Boyd, J. N. (1999). Who's smoking, drinking, and using drugs? Time perspective as a predictor of substance use. *Basic and Applied Social Psychology*, 21, 149–164. doi: 10.1207/15324839951036498
- Kilmer, J. R., Hunt, S. B., Lee, C. M. & Neighbors, C. (2007). Marijuana use, risk perception, and consequences: Is perceived risk congruent with reality? *Addictive Behaviors*, 32, 3026–3033. doi: 10.1016/j.addbeh.2007.07.009
- Kleiman, M. A. R. & Ziskind, J. (2019). Lawful access to cannabis: gains, losses and design criteria. *Journal of Illicit Economies and Development*, 1, 272–278. doi: 10.31389/jied.41
- Koffarnus, M. N., Franck, C. T., Stein, J. S. & Bickel, W. K. (2015). A modified exponential behavioral economic demand model to better describe consumption data. *Experimental and Clinical Psychopharmacology*, 23, 504–512. doi: 10.1037/pha0000045
- Koffarnus, M. N. & Woods, J. H. (2013). Individual differences in discount rate are associated with demand for self-administered cocaine, but not sucrose. *Addiction Biology*, 18, 8–18. doi: 10.1111/j.1369-1600.2011.00361.x
- Konecky, B. & Lawyer, S. R. (2015). Steeper delay discounting among substance-abusing and substance-dependent adolescents versus controls. *Journal of Child and Adolescent Substance Abuse*, 24, 207–211. doi: 10.1080/1067828X.2013.778801
- Lamb, R. J., Maguire, D. R., Ginsburg, B. C., Pinkston, J. W., & France, C. P. (2016). Determinants of choice, and vulnerability and recovery in addiction. *Behavioural Processes*, 127, 35–42. doi: 10.1016/j.beproc.2016.04.001
- MacKillop, J., Few, L. R., Murphy, J. G., Wier, L. M., Acker, J., Murphy, C., ... Chaloupka, F. (2012). High-resolution behavioral economic analysis of cigarette demand to inform tax policy. *Addiction*, 107, 2191–2200. doi: 10.1111/j.1360-0443.2012.03991.x
- Mahalingam, V., Palkovics, M., Kosinski, M., Cek, I. & Stillwell, D. (2016). A computer adaptive measure of delay discounting. *Assessment*, 25, 1036-1055. doi: 10.17863/CAM.7246
- Matjasko, J. L., Cawley, J. H., Baker-Goering, M. M. & Yokum, D. V. (2016). Applying behavioral economics to public health policy: Illustrative examples and promising directions. *American Journal of Preventive Medicine*, 50, S13–S19. doi: 10.1016/j.amepre.2016.02.007
- Mazur, J. E. (1987). An adjusting procedure for studying delayed reinforcement. In M. L. Commons, J. E. Mazur, J. A. Nevin & H. Rachlin (Eds.), *Quantitative analysis of behavior: The effects of delay and intervening events on reinforcement value*. Hillsdale, NJ: Erlbaum.
- Mischel, W., Grusec, J. & Masters, J. C. (1969). Effects of expected delay time on the subjective value of rewards and punishments. *Journal of Personality and Social Psychology*, 11, 363–373. doi: 10.1037/h0027265
- Mischel, W. & Metzner, R. (1962). Preference for delayed reward as a function of age, intelligence, and length of delay interval. *Journal of Abnormal and Social Psychology*, 64, 425–431. doi: 10.1037/h0045046
- Murphy, J. G., Correia, C. J. & Dennhardt, A. A. (2013). Behavioral economic factors in addictive processes. In P. M. Miller. (Ed.), *Principles of Addiction* (pp. 249–257). San Diego, USA: Elsevier.
- Neighbors, C., Larimer, M. E. & Lewis, M. A. (2004). Targeting misperceptions of descriptive drinking norms: Efficacy of a computer-delivered personalized normative feedback intervention. *Journal of Consulting and Clinical Psychology*, 72, 434–447. doi: 10.1037/0022-006X.72.3.434
- Premack, D. (1959). Toward empirical behavior laws: I. Positive reinforcement. *Psychological Review*, 66, 219–233. doi: 10.1037/h0040891
- Rappange, D., Brouwer, W. & Van Exel, N. J. A. (2009). Back to the consideration of future consequences scale: Time to reconsider? *Journal of Social Psychology*, 149, 562–584. doi: 10.1080/00224540903232324
- Reed, D. D. & Martens, B. K. (2011). Temporal discounting predicts student responsiveness to exchange delays in a classroom token system. *Journal of Applied Behavior Analysis*, 44, 1–18. doi: 10.1901/jaba.2011.44-1
- Robins, L. N. (1993). Vietnam veterans' rapid recovery from heroin addiction: A fluke or normal expectation? *Addiction*, 88, 1041–1054. doi: 10.1111/j.1360-0443.1993.tb02123.x
- Rosow, I. & Hansen, M. B. (2016). Gambling and gambling policy in Norway-an exceptional case. *Addiction*, 111, 593–598. doi:10.1111/add.13172
- Secades-Villa, R., García-Fernández, F., Peña-Suárez, E., García-Rodríguez, O., Sánchez-Hervás, E. & Fernández-Hermida, J. R. (2013). Contingency management is effective across cocaine-dependent outpatients with different socioeconomic status. *Journal of Substance Abuse Treatment*, 44, 349-354. doi: 10.1016/j.jsat.2012.08.018



- Secades-Villa, R., García-Rodríguez, O. & Fernández-Hermida, J. R. (2015). Contingency management for substance use disorders in Spain: Implications for research and practice. *Preventive Medicine, 80*, 82-88. doi: 10.1016/j.ypmed.2015.07.001
- Secades-Villa, R., Weidberg, S., García-Rodríguez, O., Fernández-Hermida, J. R. & Yoon, J. H. (2014). Decreased delay discounting in former cigarette smokers at one year after treatment. *Addictive Behaviors, 39*, 1087–1093. doi: 10.1016/j.addbeh.2014.03.015
- Smith, A. (1984). The Theory of Moral Sentiments. In D. D. Raphael & A. L. Macfie (Eds.), *Glasgow Edition of the Works and Correspondence of Adam Smith* (Vol.1, pp.1-403). Indianapolis: Liberty Fund (year of publication of original book 1759)
- Strathman, A., Gleicher, F., Boninger, D. S. & Edwards, C. S. (1994). The consideration of future consequences: weighing immediate and distant outcomes of behavior. *Journal of Personality and Social Psychology, 66*, 742–752. doi: 10.1037/0022-3514.66.4.742
- Strickland, J. C., Lile, J. A. & Stoops, W. W. (2017). Unique prediction of cannabis use severity and behaviors by delay discounting and behavioral economic demand. *Behavioural Processes, 140*, 33–40. doi: 10.1016/j.beproc.2017.03.017
- Tripp, J. C., Meshesha, L. Z., Teeters, J. B., Pickover, A. M., McDevitt-Murphy, M. E. & Murphy, J. G. (2015). Alcohol craving and demand mediate the relation between posttraumatic stress symptoms and alcohol-related consequences. *Experimental and Clinical Psychopharmacology, 23*, 324–331. doi: 10.1037/pha0000040
- Weidberg, S., González-Roz, A. & Secades-Villa, R. (2017). Delay discounting in e-cigarette users, current and former smokers. *International Journal of Clinical and Health Psychology, 17*. doi: 10.1016/j.ijchp.2016.07.004
- Yi, R., Mitchell, S. H. & Bickel, W. K. (2010). Delay discounting and substance abuse-dependence. In Madden, G. J. & Bickel, W.K. (Eds.), *Impulsivity: The behavioral and neurological science of discounting* (pp. 191-211).