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Critical appraisal of the discussion on delay discounting by Bailey et al. and Stein et al.: A scientific proposal for a reinforcer pathology theory 3.0

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ABSTRACT

Delay discounting is one of the most studied phenomena in Psychology in the last decades. Recently, it has been proposed as a transdiagnostic variable accounting for several psychopathological problems. A review of current practices and clinical application (Bailey et al., 2021) and a response article (Stein et al., 2022) have been recently published. Despite both of them being stimulating, the articles raise issues needing further discussion. The first part of the present article critically appraises both publications by highlighting their strengths/limitations and offers an alternate perspective that clarifies some theoretical issues and allows new lines in research. In the second part, one of these new lines of research is presented by describing a research proposal based on the analysed critiques and current developments in both psychopathology and addiction research. This article contributes to the discussion on delay discounting suggesting alternative interpretations and future studies to improve theoretical models.

1. Introduction

Recently, Bailey et al. (2021) published a paper critically reviewing the evidence on delay discounting (DD) as a transdiagnostic variable, and the current practices and clinical applications stem from this evidence. In the literature, DD has been defined differently, although one commonly accepted definition is 'the preference for smaller-immediate over larger-delayed rewards' (Amlung et al., 2019). This plurality of definitions derives from the limited knowledge about what we are observing experimentally and from the sparse theoretical development to explain experimental results. In this vein, the Bailey et al. paper concludes that there has been a premature theoretical acceptance of DD as a transdiagnostic variable in psychopathology, which is leading to a growing disconnection between the empirical evidence and its proposed use in clinical practice.

Bailey et al.'s critique focuses on three issues: limited convergent validity, lack of divergent validity with validated measures and limited generalisability to other decision-making behaviours. This three-fold critique has been addressed by Stein et al. (2022), based on Bailey et al.'s biased position against DD, supported by one-sided evidence.

As we should avoid 'in pursuit of progress, weakening the measures we seek to refine' (Stein et al., 2022, p. 1), the aim of this manuscript is to highlight some interesting points of both, as well as problems to be addressed in future research and theoretical development in the field of psychopathology in general, and of addiction in particular, to improve our understanding of DD. Based on the present appraisal, a new line of research in the addiction area is suggested, which is generalizable to other areas of psycho(patho)logy. Specifically, the proposal is aimed at unifying the network model in psychopathology and the reinforcer pathology (RP) model.

2. Part I: The discussion on delay discounting

In this first section, some relevant points of both the Bailey et al. and the Stein et al. papers will be commented. Both papers cover four main topics, which will be discussed hereafter.

2.1. Convergent validity

The first critique relates to the claim that the DD rate measures impulsivity and self-control, variables associated with several psychological problems, including addiction (Amlung et al., 2019). Bailey et al. (2021) highlighted the modest (despite their significance) correlations of DD with addiction severity (e.g., Amlung & MacKillop, 2014; Gowin et al., 2019; Martinez-Loredo et al., 2018a; Strickland et al., 2021) and the evidence of no, low or inconsistent associations with other relevant psycho(patho)logical phenomena (Cheng et al., 2021; Farris et al., 2017; Martinez-Loredo et al., 2019). Against this background, the question

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about how 'core' could DD rates be for psychopathology is of great importance.

Instead of denying its relevance, the thesis of the present paper is that *because* it may be a 'core' process, its effect on different behaviours should not be direct or evident. The number of studies reporting significant associations between discounting rates and indicators of substance use and other psychological problems (Amlung et al., 2017; Barlow et al., 2017; Kraplin et al., 2020; Weinsztok et al., 2021) merits a more in-depth analysis of this concept to determine its essence. This need for further research is also suggested by the dynamical nature of DD, as higher discounting rates have been identified, both as a risk factor for future substance use or problems (Isen et al., 2014; Martinez-Loredo et al., 2018b; Richardson & Edalati, 2016) and as a consequence of extended patterns of substance use (Ivanov et al., 2021; Tucker et al., 2022). Indeed, not only past experience with reinforcers may modify discounting rates but different levels of discounting rates may also modify the effect of other contingencies affecting behaviours (Athamneh et al., 2021; Martinez-Loredo et al., 2018a; Snider et al., 2020).

Also, there is consistent evidence about the absence of correlations with other impulsivity measures (Cyders & Coskunpinar, 2011, 2012; Sharma et al., 2014; Stahl et al., 2014). This lack of correlation between impulsivity-related variables highlights the diversity of phenomena included under the label 'impulsivity', which further precludes from establishing a univocal definition of DD. Considering this issue, Bailey et al. recommend more experimental and theoretical work before continuing with translational research. However, they did not specify or further elaborate on the nature of such problem. From the present perspective, the problem is not derived from the tasks settings themselves (which is true that they generate heterogeneity) but from the current tendency of science to produce papers without enough theoretical grounds or developments (Altbach & de Wit, 2019; Kiai, 2019). This tendency creates problems of interpretability and reification fallacies as, for example, considering different impulsive *behaviours* as facets of *the* impulsivity or *the* self-control, as if they were parts of the same phenomenon and could be located, described and divided into different parts *expressed* through different topographies. This perspective neglects the functionality of those diverse (classes of) behaviours and precludes an effective broaching of the problem.

Similar to Bailey et al., who stated that impulsivity in the context of decision-making reflects numerous processes, Stein et al. explain the absence of correlations between DD and other impulsivity measures due to the 'multifactorial' nature of this construct. This very same argument is used to justify the low association of DD with psychological problems, as it is consistently replicated at behavioural and neurobiological level. Finally, the authors support the relevance of the concept due to its incremental validity over other behavioural measures, that is, DD tasks would capture a unique aspect of 'impulsivity'. Here we find the same limitations mentioned in the last paragraph regarding Bailey et al.'s critique. First, the concept of impulsivity is not a univocal term, referring to very different kinds of behaviours (Strickland & Johnson, 2021). Thus, describing its nature as 'multifactorial', instead of assuming it refers to multiple different behaviours, not only hinders its study but also represents an oblique explanation to the low association between DD and other 'impulsivity' measures or psychological problems (note that Stein et al. called these measures *putative* forms of impulsivity, which implies they are not *truly* impulsivity measures).

Regarding the consistent, albeit low, associations at different levels (a fact raised by Bailey et al.) as a fact that supports the 'multifactorial' nature of DD (Stein et al.'s argument), it is important to note that it is indeed difficult to find orthogonal variables in the same organism, precisely because *it is* the same organism (e.g., consider the unfruitful pursuit of ideal orthogonal personality factors; Thielmann, Moshagen, Hilbig, & Zettler, 2021). Lastly, the 'incremental' validity of DD over other behavioural tasks (highlighted by Stein et al.) evades the evidence regarding the absence of correlation with self-reported measures and evinces, once again, the problem in which we are involved: the use of the same term for referring to different phenomena.

2.2. Divergent validity

Regarding divergent validity, Bailey et al.'s critique mainly focused on the association between discounting rates and a plethora of phenomena which require, from their standpoint, different explanations for each one (or at least, for each cluster of phenomena). This is a very important point because it highlights the main bifurcation between theoretical positions. Nonetheless, Bailey et al. missed the opportunity of raising potential solutions or interpretations for such fact (i.e., the relationship between steeper discount and both externalising/internalising problems), describing it as an empirical question. However, there is no empirical question without implying, explicitly or implicitly, theoretical (and even philosophical) assumptions. Thus, before trying to answer these questions empirically, it is important to theoretically establish the correct place of discounting rates and their relationship with other concepts and phenomena in the psychological field.

Bailey et al. made an interesting critique on the use of DD as an assessment tool in clinical populations. Indeed, it is possible that, as the authors stated, steeper discounting rates are *simply* associated with a general psychopathological factor. Despite agreeing with this critique, we disagree with the description of this association as simple. On the contrary, this association may indicate an *essential* association between the discounting of reinforcers and the presence of all the associated psychopathology. This essential association may help us to understand the relationship between discounting rates and different psychopathology without reifying the concept of "self-control" (as an underlying instance explaining levels of discounting) or needing different explanations for different associations. For instance, psychological problems may be the effect of higher levels of discounting of certain reinforcers maintaining those problems, compared to others controlling functional behaviours. Existing dispositional conditions (i.e., drug use, narrow behavioural repertory, family/social environment, socioeconomic status, unpleasant mood, etc.) affect the discounting rates of different available reinforcers, which would ultimately lead to different problems depending on the specific context of each person.

Bailey et al. used the example of depression as a condition associated to higher discounting rates where an explanation based on self-control deficits is unlikely, in contrast to externalising behaviours. Using the term 'equifinality', these authors suggest that different processes may result in a single mediating alteration (high DD), which subsequently produce diverging problems. More parsimoniously, if we consider self-control deficits as behaviours controlled by sooner-available low-magnitude reinforcers over delayed higher reinforcers, the same explanation used for externalising problems will work for depression. Indeed, depression denotes a group of behaviours characterised by reduced activation (implication with relevant value-oriented activities of daily life, maintaining contact with sources of reinforcement) and increased avoidance patterns, which lead to increased depressed mood and other clinically relevant symptoms (Hopko et al., 2003).

In line with Bailey et al., the proposed essential association between DD and problem behaviours would also hinder the direct use of discounting rates in clinical/technological applications, based on its supposed role as a 'biomarker' or 'endophenotype'. It is precisely because the relationship between discounting rates and psychological problems is essential (and not simple, as suggested by Bailey et al.) that the direct translation of DD tasks to clinical settings as technological tools may be illegitimate. This use would imply the direct application of a phenomenon pertaining to the scientific field (whose relationship with other phenomena is not yet understood), without adequately developing devices or procedures for using this knowledge technologically. Analogously, it would be as pursuing the technological direct application of the detection of the antibody-antigen bond without understanding completely the process of bonding and without developing immunoassay techniques.

In other words, this direct translation neglects the difference between the operations within a scientific field (which would lead to a theoretical understanding of the relationship of different phenomena) and the technological application of the knowledge derived from these operations (which would lead to the development of different tools/techniques).

Against the lack of evidence of divergent validity, Stein et al. (2022) argued that research is providing emerging evidence of such validity. Nonetheless, this is true only for anorexia, where people suffering from this disorder show lower discounting rates (Amlung et al., 2019). Furthermore, Stein et al. wisely noted that DD being widely associated with several phenomena may be a strength, as it represents a single process relevant to a wide range of disorders. Although it is true that lack of divergent validity is not necessarily a concern, it is not necessarily a strength either. As stated regarding Bailey et al.'s oblique response, more theoretical work is necessary without falling in reifications (*the* impulsivity, individual*'s* discounting rate) or in grandiloquent but muddled and confusing statements[1] (e.g., synergistic effect, multidimensionality, endophenotypes) that are not clearly defined or have not univocal definitions. For example, the first version of the RP model (Bickel et al., 2011; Weidberg et al., 2019) stated that the discounting of a commodity and its reinforcing efficacy have a 'synergistic' effect in predicting addiction severity, without specifying the very process by which this 'synergistic' effect occurs.

2.3. Generalisability problems

The last point of Bailey et al.'s critique focuses on the generalisability problems, as discounting rates of different commodities are not explained by a single discounting factor and they are modifiable by experimental manipulations. This point is relevant for many reasons but Bailey et al. only discussed one of them. Specifically, these authors stated that 'the generalisability and value of discounting rates have been drastically overstated given their inability to robustly predict other decisions made either in the lab or real life' (Bailey et al., 2021, p. 4) and DD is not a summary measure of general intertemporal choice or molar decision-making pattern. Here again, a reification of discounting is operating in both supporters and deniers of its generalisability. Indeed, DD is not a trait or individual characteristic but a *relationship* between two phenomena: time and magnitude of reinforcement; and this relationship is based on the interaction between a given commodity (assumed reinforcer) and an organism (and its history of reinforcement; their biography, in human terms). But in any case, DD would be a trait of the commodity being discounted or of the context (which includes the individual's previous experiences with the commodity) in which the commodity operates; thus, DD is a co-determined phenomenon (Pérez-Álvarez, 2018). Relatedly, these authors wisely point to the factual phenomenon observed: impulsive choices increase the likelihood of maladaptive behaviours. Reducing all impulsive choices to 'high discounting rate' may be an illegitimate logical jump, which also conceals the fact that discounting rate is not something that the individual *has* but something that *happens* when the reinforcing effect of a given reinforcer is considered as a function of time. This misunderstanding is a consequence of focusing on the topography of behaviours instead of on their function; a consequence of the reification fallacy mentioned above. Thus, more than a property or characteristic of the individual, the DD is a property of the reinforcer itself, which would explain why different commodities have different discounting rates for the same individual (Odum et al., 2020; Pritschmann et al., 2021), why discounting of different commodities is not explained by a single discounting factor (Kvam et al., 2021) and why discounting rates can be modified by experimental manipulations (Rung & Madden, 2018; Scholten et al., 2019). Considering the co-determination of DD, changes in the context alter the subject-object relationship (in molar terms) and thus the actual discounting of competing reinforcers.

Stein et al. responded regarding the invoked lack of generalisability focused on the utility of knowing the discounting rates of a given commodity, as it may inform on how *likely* it is that other commodities will be discounted (Odum et al., 2020). The relationship pointed at by Stein et al. is easily assumable by the thesis proposed here. Also, they highlighted the advantages of using money as the measured commodity ('Universally' valued, easily quantifiable, etc.) but pointed to the need of future research on non-monetary commodities. Here there can be no doubt, as money is a generalised conditioned reinforcer in our societies. Following the perspective examined in this paper, the use of non-monetary commodities in DD tasks, if they are part of the behaviour of interest, would allow to add more context to participants' behaviour and, thus, information about functionality of each choice, which should be subsequently analysed.

2.4. Improving measurement and construct validity

The last section of the papers discussed focused on delimiting lines of research to improve measures and theoretical interpretation of DD. A major concern pointed out by Bailey et al. regarding construct validity is the group-based analyses of treatment effects on DD. This approach precludes interpretations at individual level to legitimately ascribe changes in the clinical conditions or DD to treatment effects. They also highlight the lack of diagnostic or dimensional specificity of DD as a caveat for considering it a valid transdiagnostic process. This pertinent critique serves to emphasise the relevance of idiographic measures (Wright & Woods, 2020) and specifically of the function analysis of behaviour, as a fundamental tool for understanding psychological phenomena (Barlow & Eustis, 2022; Hofmann & Hayes, 2019). The focus on function over topography as well as the awareness of reifications of the phenomena studied may assist scientists when dealing with the above-mentioned problems.

Finally, Bailey et al., suggested that more complex and ecologically valid tasks need to be developed to fill the gap between basic experimental tasks and the complex behaviours they are trying to model. In this regard, the (geographical) ecological momentary assessment [(G)EMA)] may be an adequate procedure to gather information about the context in which DD tasks are completed (McCarthy et al., 2018). GEMA allows to gather real time individual data regarding behaviours' antecedents and consequences, and other contextual factors that would improve the quality of single case designs (Vilardaga et al., 2014). Using this procedure, it may be possible to identify contextual and individual variables, including relational repertories, determining the adopted decisions during brief DD tasks and, hence, to understand the functionality of behaviours and associated reward discounting in that precise situation.

Once both theoretical articles have been critically discussed, a line of research synthetizing the contributions of Bailey et al.'s critique and Stein et al.'s response will be proposed in part II. For that purpose, an alternative model (network model) to the current disease model will be firstly presented. This alternative model helps to highlight the *essential* nature of DD by considering it a node of a network representing the *psychological distance*, or a subject-object relationship. Secondly, a model for addictive behaviours using DD as one of its 'core' processes (RP theory) is described, as it is widely present in the current research. As an essential variable, DD would not be only relevant for substance use but for other behaviours. Its implication in the psychological distance may be crucial not only to understand variations in the relative reinforcing efficacy of competing reinforcers but also the presence of co-occurring

[1] In philosophical materialism (Pérez-Jara, 2022), the term *concept* is used to designate those configurations of phenomena that achieve clarity (they allow that group of phenomena to be distinguished from others that are outside the concept) and distinction (they allow the internal parts of that set to be differentiated). In this context, a given phenomenon could be described as muddled/clear and confusing/distinct.

disorders. Lastly, several ways of improving the last version of the RP model (RP 2.0), both theoretically and experimentally, will be proposed by unifying the network and RP model toward a RP 3.0. This last section delves in from the consideration of DD not as a characteristic of individuals but reinforcers or, at least, the context (consistent with the theory's notion of 'temporal window'). This conception implies that there are no generalisability problems and highlights the relevance of analysing the effect of different classes of reinforcers or situations, as well as the influence of other variables that affect the discount of reinforcers.

3. Part II: A proposal for a new line of research

3.1. Limitations of the disease model in psychopathology and alternatives: The network proposal

The available psychiatric classifications are not suitable to understand the etiological processes of disorders to be targeted in treatment or preventive interventions, as they are based on the latent variable disease model (Hofmann et al., 2016). It represents an essentialist vision of mental disorders providing tautological arguments and several fallacies (Hyman, 2010; Wright & Woods, 2020). Within this model, the supposed underlying disorder is inferred from, and at the time an explanation of, the observed symptoms, described from a mere clinical phenomenological standpoint. In addition to these epistemological problems (Markon, 2013), the disease model is unable to produce translational science for the prevention of health risk behaviours due to two key elements. Firstly, it creates nosological systems based on a polythetic structure of symptoms, where a person qualifies for a diagnosis if a subset of a range of criteria are met (Fellowes, in press). This approach does not indicate and it even prevents the detection of the most important or central variables, processes or symptoms necessary to develop the disorder (Wilshire et al., 2021). Secondly, the model does not allow to establish the order of symptoms or the first-occurred symptoms, which may lead to early detection and prevention or treatment.

There is a growing interest in overcoming the latent disease model and its nosological systems. Among other alternatives, the network model in psychopathology is one of the most promising alternatives (Borsboom & Cramer, 2013). One central concept of the latent variable model is that symptoms are indicative of an underlying causal factor. Nonetheless and in contrast to biomedical disorders or illnesses, where it is possible to be ill but asymptomatic, mental disorders are impossible without the presence of any symptom. Considering this fact, the network model of psychopathology establishes causal relationships between symptoms themselves and not necessarily between symptoms and an assumed latent common cause (Bringmann & Eronen, 2018).

As such, discovering central nodes in a given disorder would allow to develop specific clinical interventions to target those nodes. It also would allow to develop strategies to prevent the presence or growth of those nodes by targeting either their early stages or variables from the external field related to them. Additionally, the concurrent presence of different mental disorders is not explained by this model through two distinct etiological processes (as the classic model) but through specific nodes shared by two disorders that act as causal bridges influencing and triggering nodes from both networks (Cramer et al., 2010). As a corollary, interventions targeting those bridge nodes would reduce comorbidity or, at least, would prevent its strengthening. Finally, this model also fills the gap of the common cause model regarding the absence of symptoms' order in the development of a given disorder. As the network model conceives disorders as dynamic complex systems, different levels of severity or stages can be modelled to understand how a disorder is developed (Groen et al., 2019). Despite this model having been applied to several mental disorders (Isvoranu et al., 2020; Savelieva et al., 2021; Smith et al., 2018), research in addictive behaviours is still in its infancy (Rhemtulla et al., 2016; Wasil et al., 2020).

Upcoming studies should address three major unsolved issues: The first one related to which are the most relevant variables to be included as network's nodes. Although the current practice is to use the DSM criteria, the use of theory-based variables or processes would improve our current understanding of addictive behaviours. Secondly, it is important to find adequate procedures to measure relevant variables to be included in the networks and to establish a clear distinction between them. To solve these issues, the present paper proposes the application of the network model in psychopathology to RP (Bickel et al., 2014, 2017). The third unsolved issue relates to the common practice of estimating network models from cross-sectional data (Epskamp, 2020) and the use of a nomothetic (i.e., based on individual differences) approach. As all human behaviours are supposed to be ruled by the same behavioural laws, and the majority of clinical theories and practices highlights within-person processes (Wright & Woods, 2020), there is a need to explore this research topic following an idiographic approach based on time series data and functional analysis of behaviour (Hofmann & Hayes, 2019). The use of EMA may be useful for this purpose.

3.2. Understanding excessive behaviours engagement: The reinforcer pathology model

The first two unsolved issues could be addressed by merging the RP and the network models. The RP model proposes two processes to explain the excessive involvement in different behaviours resulting in deleterious consequences: 1) high overvaluation of drug due to its relative reinforcing efficacy and 2) high preference for immediate smaller rewards over delayed greater ones due to a high DD of rewards.

The original model, often referred as RP 1.0 (Bickel et al., 2011), posited a "synergistic" effect of both processes predicting severity. As such, individuals' levels of demand and discounting would be associated with a specific probability of presenting substance use disorder (Bickel et al., 2014; Epstein et al., 2014; MacKillop, 2016; Weidberg et al., 2019). Nonetheless, advances in experimental interventions and clinical treatments suggested that both processes were not independent processes, but the level of reward discounting determines the length of temporal window along which different reinforcers are integrated, ultimately determining the value of the reinforcer of interest. This interpretation is known as the RP Theory 2.0 (Bickel & Athamneh, 2020; Bickel et al., 2020). Despite this improved version providing a better explanation of results from a new line of translational research (Mellis et al., 2018; Snider et al., 2020; Stein et al., 2018; Sze et al., 2017), the specific role of each process and their interaction is not completely understood.

3.3. On the role of other variables: Toward the RP 3.0

The RP model has not incorporated yet other important variables experimentally related to substance use problems. In light of the present thesis about the relational nature of DD (contrary to its conception as individuals' trait or biological marker), these other potentially relevant variables may have an effect on how the reinforcing efficacy of a given reinforcer is discounted over time.

One relevant variable involved in risk behaviour is negative urgency (NU; Cyders et al., 2007), defined as rash behaviours in the presence of intense negative emotions. Intense emotional affect is a powerful motivating operation that increases the salience of drug-related cues (Coskunpinar et al., 2013) and enhances the reinforcing efficacy of rewards (Hogarth et al., 2015; Kiselica & Borders, 2013; Rousseau et al., 2011). Some evidence suggests that both DD and urgency promote substance use and other risk behaviours in the presence of craving, which has been shown to increase the reinforcing efficacy of drugs (Acker & MacKillop, 2013; Amlung & MacKillop, 2014; Metrik et al., 2016). This effect may determine substance use through the Pavlovian-instrumental transfer, independently of severity (Hogarth & Field, 2020). It is possible that the "temporal window" suggested by the

RP theory 2.0 may expand or contract (analogously to space-time distortion in Einstein's General Relativity Theory) by emotional statuses. Preliminary results support the effect of emotions in both DD (Lawyer & Jenks, 2020) and reinforcing efficacy (Dorison et al., 2020). Thus, NU may be shown in individuals under intense negative affect if such negative affect contracts the "temporal window" enough, increasing the discounting and thus reducing the number and magnitude of reinforcers integrated in the individuals' context.[2] As NU refers to a broader dispositional variable not necessarily linked to substance use, it may add explanatory power over the two processes proposed by the RP model. Specifically, while those processes would explain the 'attraction' of substances, the inclusion of NU in the model may help to understand the 'repulsion' of alternative behaviours associated to larger-later substance-free rewards.

The RP model is theoretically grounded on the Premack's Principle and Herrnstein's Matching Law. Following the latter, the rate of involvement in risk behaviours over time would depend on the schedules of contingencies associated to both risk and alternate behaviours. Against this background, the substance-related reinforcement ratio (Acuff et al., 2019) may be a relevant variable to be included in the RP model (Bickel & Athamneh, 2020). Relatedly, levels of behavioural Activation may be another key variable in understanding increased levels of the so-call RP, as increased levels of activation have been associated to lower substance use in the general population (Galaj, Barrera, & Ranaldi, 2020; Martinez-Vispo et al., 2018), which is consistent with the abovementioned behavioural laws. Besides, Activation seems to be the active ingredient of therapies aimed at treating emotional disorders (Fernandez-Rodriguez et al., 2022). Despite potential overlaps, it is important to note relevant differences between substance-free reinforcement (included in the denominator of the substance-related reinforcement ratio) and Activation. The first refers to any activity not associated to or performed under the influence of substances. The reinforcement ratio between substance-related and substance-free activities would determine the frequency of both kind of activities, according to the matching law.[3] On the other hand, Activation refers to the implication with relevant (value-oriented) activities of daily life, which allows to maintain contact with important experiences in life and high-quality sources of reinforcement (Manos et al., 2010). Activation denotes the presence of behaviours maintained by high-quality molar reinforcers, linked to the Aristotelian concept of *final* cause (Tucker et al., 2022). Thus, if substance-free activities do not promote Activation, long-term abstinence would be unlikely.

Finally, recent research has suggested that environmental variables are potentially relevant for preventing substance use and mental health issues. Indeed, cumulative evidence links environmental and social variables such as neighbourhood socioeconomic status (Karriker-Jaffe, 2013), presence of green spaces (Martin et al., 2019; Wiley et al., 2020), density of betting venues (Badji et al., 2020), among others, to severity of addiction. Fig. 1 shows a graphical representation of the proposed model.

As a conclusion, the present article critically appraised main rationales supporting and opposing DD as a key variable in clinical psychology. Despite not being intrinsically problematic, a synthetic point of view is presented that supports the relevance of DD as a "core" variable but denies its consideration as an individual "inner" variable. This article offers a 'Copernican shift' in the conception of DD, from a trait or individual characteristic to a relationship between time and magnitude

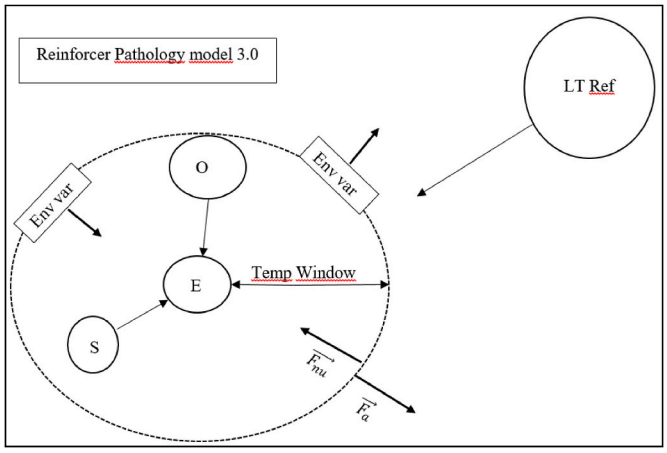

Fig. 1. Graphical representation of the proposed Reinforcer Pathology model 3.0. The temporal window (dotted circle) represents the space affected by the effect of substance-related (S) and –free (O) reinforcers, despite their discounted value. Those long term-reinforcers (LT Ref) highly discounted that do not influence a given individual (E) are placed out of the temporal windows. The window can be contracted by the effect of negative urgency (F_{nu}) or environmental variables. The latter together with Activation (F_a) can also expand the temporal window. The temporal window allows to integrate all reinforcing effects of different behaviours, which can be related via the substance-related (vs substance-free) reinforcement ratio.E: Ego; S: substance; O: substance-free reinforcer; Temp Window: temporal window; Env var: environmental variable; LT Ref: long-term substance-free reinforcers; F_{nu}: negative urgency; F_a: Activation.

of reinforcement, dependent on differential reinforcing efficacy of available reinforcers. In this alternative conception of DD as a measure of psychological distance, it would be, in any case, a characteristic of the commodity/reinforcer being discounted or of the context in which it operates. The role of negative affect in altering the psychological distance between reinforcers is highlighted, as it may imply changes in the discounting of reinforcers and their efficacy. These former changes will depend in turn on other relevant variables (Urgency, Reinforcement ratio, Activation). A promising new line of research is also presented, which not only assumes this synthetic position but shows its utility by enabling the unification of two of the current most promising models in psychopathology (network model) and addiction (RP model) research. By seing reinforcing efficacy and DD as properties of the reinforcers and not of the individual, a RP network may be built by including additional variables clarifying contextual relations between the functionality of behaviours and differential discounting of competing reinforcers, together with environmental variables acting as external perturbations triggering network activation via increased negative affect and the generation of pathological loops.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

[2] Mathematically, the total reinforcing efficacy of substances within the temporal window could be described as $\int_E^{V_0} f(RE) = (RES_{n-1}xDD_{n-1}) + (RES_nxDD_n)$

[3] Considering the effect of discounting and reinforcing efficacy, the reinforcement ratio could be adequately described as $RR = \frac{\sum RES=(RES_{n-1}xDD_{n-1})+(RES_nxDD_n)}{\sum RES+\sum REO}$

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