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Temporal discounting and health behavior: a review

Abstract

This paper is a review of previously published studies in the field of decision making; in particular, it focuses on the role of temporal discounting in decisions related to health. Some of the empirical relations reported in the literature between temporal discounting and addictions, substance abuse and food related problems, are described. The text is written with the aim of showing, in a general way, contemporary research about temporal discounting as a predictor of unhealthy behaviors. The importance of the study of factors involved in decision making, such as temporal discounting, is highlighted given that health/disease is a complex relation relying on individuals choice behavior, that in turn, could make them prone to develop either risk behaviors, or, on the contrary, protective behaviors. An analysis and understanding of the behavior of choice within the framework of health will be potentially useful when generating effective prevention or intervention programs.

Keywords: delay discounting, impulsivity, risk behavior, health behavior

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Introduction

Several studies have shown that in choice situations between two alternatives associated with rewards of equal magnitude but that differ in delay until their receipt, organisms of different species tend to choose the one that is closest in time. It is relevant that even in some situations in which the sooner available alternative offers a smaller amount of reward, subjects continue to choose it over the larger but later one. Moreover, in choice situations between larger delayed, and smaller sooner loses, individuals tend to choose the larger but later consequence. This phenomenon has been called temporal discounting.[1,2] Likewise, it has been observed that risk associated with an outcome is a variable that could affect choice behavior. Usually, smaller gains associated with higher probabilities are preferred over larger gains with a lower probability.[3] In contrast, when alternatives consist of probabilistic losses, individuals tend to prefer those with a higher risk even when doing this implies the possibility of a greater loss occurring.[4,5]

The study of how time or probability can affect elections becomes especially relevant when attempting to explain some behaviors related to social problems. For example, some unhealthy behaviors such as nicotine or other substances abuse could involve the choice of an immediate reward instead of the future benefits of good health or, the preference for greater health losses with some probability over a certain smaller loss (such as quitting smoking). Furthermore, several studies have shown that individuals are not rational in their choices as economic model predicts, but often they show preference reversals.[6–8] That is, when both alternatives imply a waiting time, an individual could choose the one associated with the larger but more delayed outcome. However, as time passes, the individual may change his preference and choose the immediate one even if this involves shifting from his previous choice. These findings have important implications when it comes to explaining risky health decisions. For example, on Friday, someone might prefer to start exercising on Monday in order to have a healthier life, however, on Monday when the choice is between exercising and staying at home, the same individual could choose the second option even if this implied a reverse of his preference. The way in which a delayed reward loses its value has been described mathematically by different models, including normative economical models. The literature has shown however, that the discount of the value of a reward in both, humans and non–humans, implies a pattern well described by the hyperbolic equation proposed by Mazur.[9–11] This equation predicts that people will not discount the value of alternatives in a constant rate; instead individual rates of discounting will be steeper at shorter delays than at larger waiting times. The mathematical form of this function is the following: $V=A1+kD(1)$, where V represents the subjective value of a reward; A, the amount of the outcome available after a delay of D units of time, and k is a free parameter that represents the individual degree of discounting. Larger values of k indicate a steeper discounting or more rapid discounting as a function of time, on the contrary, a low value of this parameter represents little depreciation of the value with the passage of time. Therefore, k is an index that shows the degree to which a delay decreases the value of a reward, and has been extensively studied because it is considered an individual indicator of impulsivity that can constitute an underlined process in decision making.[12]

Considering temporal discounting as an underlying process of decision making, research has been carried out to compare the degree of discounting of people who maintain different risk behaviors. The individual differences between the values of k in the discounting tasks and their relationship with behaviors considered impulsive have turned out to be of great interest in the area since it has been found that individuals who abuse substances such as alcohol, nicotine or other drugs tend to show a greater degree of discounting than subjects who do not. In research with humans, it has been found that alcohol–dependent subjects tend to discount rewards more rapidly as a function of time than control subjects (non–drinkers or social drinkers).[13] Following these results, Field M[14] conducted a study with adolescents in which they evaluated temporal discounting rates of hypothetical monetary and alcoholic rewards of occasional drinkers and frequent drinkers (light drinkers and heavy drinkers) and found that frequent drinkers discounted both rewards more than occasional drinkers. Likewise, in a study with mice[15] the authors found higher k values in subjects that showed preferences for alcohol than in those that did not. Also, the degree of temporal discounting was studied in opioid–dependent and non–drug–using participants. Steeper discounting functions were found in opioid–dependent participant than in control individuals.[16] In a research involving current, never

and ex–smokers, Bickel W[17] assessed whether participants discounted both hypotetical cigarettes and monetary outcomes differently. The main findings were, first, that discounting of the value of the rewards was higher in smokers than in non–smokers and second, that rates of discounting were higher for cigarettes than for money. Additionally, Coffey S[18] compared the discounting rates of hypothetical monetary and cocaine rewards of people with cocaine dependence and people without dependence. The results indicated that cocaine–dependent individuals had higher discounting rates than non–users. Finally, with regard to rates of discounting of marijuana–dependent individuals and non–marijuana users, Johnson M[19] failed to find differences in discounting of hypothetical drug and money rewards, between the groups. However, marijuana was discounted more steeply than money by users of marijuana and a positive correlation between discounting of money and marijuana indicated that temporal discounting of money could be a predictor of marijuana abuse.

Additionally, in non–drug–use behaviors related to health, delay discounting has shown to be a potential explanatory factor. Weller RE[20] reported that obese women had greater discounting of monetary rewards than healthy–weight women and that the discounting rates could not be explained by differences in earnings, age or IQ. Similarly, Jarmolowicz DP et al.[21] found that delay discounting of monetary rewards was higher for obese and overweight participants than for healthy weight and underweight participants. A specific revision of studies that evaluate the discounting rate in people with different eating disorders can be found in McClelland et al.[22] When taken together, all the aforementioned studies indicate that temporal discounting of money could be a predictor of risky behaviors. However, it is not clear whether discounting precedes unhealthy behaviors, or conversely, the degree of discounting could be affected for such behaviors. In this regard, there are some authors that have assumed that discounting rates could be considered an endophenotype, that is, a genetically–influenced characteristic that can affect the probability of developing an addiction. MacKillop J[23] addressed this issue and suggested that even though there is some evidence that points to the idea that discounting could be a stable trait over time and a previous feature to the developing of addictions, there are still important methodological issues to be considered before reaching stronger conclusions. Perry JL[24] also considered the possibility that temporal discounting could precede drug addiction. In order to test their hypothesis, the authors measured the degree of discounting of rats in a task involving delayed food rewards. Subsequently, acquisition of cocaine self–administration was evaluated. Rats that were cataloged as more impulsive acquired cocaine self–administration faster than those who were classified as less impulsive. These results suggest that impulsivity could precede the use of cocaine. In addition, MacKillop J & Kahler CW[25] hypothesized that the degree of discounting could be a critical element in smoking cessation. The researchers performed a smoking cessation treatment with current smokers. The effectiveness of the treatment was evaluated as a function of participants discounting rates. The results suggested that the level of preference for delayed rewards could be a reliable predictor of smoking cessation. The importance of this study, in addition to those previously mentioned, relies in its ability to identify risk or protective factors for developing healthy behaviors. Besides, those findings could suggest that treatments could be more effective if individual characteristics of patients (as degree of discounting measures) were taken into account. These studies support the idea that higher temporal discounting rates can be a predictor of drug abuse or a poor treatment success.

However, there is also evidence suggesting that the degree of discounting may be affected as a result of regular consumption of substances, for example, Richards JB[26] evaluated the effect of meta–amphetamine on the degree of discounting of Sprague–Dawley rats and found that rats became less impulsive after acute doses of methamphetamine, whereas they became more impulsive after receiving repeated injections of the substance. This data shows that exposure period to methamphetamine could affect differently the rates of discounting. Given that the later results indicated that use of substances could alter discounting rates, Giordano L et al.[27] conducted a study to assess if also, opioid deprivation could have an effect on the discounting measures in situations of choice that involved hypothetical alternatives of money and heroin. In consistency with other studies[28] it was found that discounting rates for heroin were higher than those for monetary rewards. Moreover, the authors observed that when participants were opioid deprived they showed higher discounting rates for both domains than when they were satiated. Similarly, Field M et al.[29] evaluated whether smoking abstinence could affect the degree of discounting of both hypothetical cigarette rewards and money, compared to a smoking ad libitum situation. In consistency with the study conducted by Giordano L et al.,[27] the authors concluded that nicotine withdrawal could affect the degree to which participants discounted both money and cigarettes and that, in addition, the discounting of cigarettes was higher than that of monetary rewards. An additional support to the idea that rates of discounting might be modified, could be found in the study conducted by Black & Rosen.[30] They evaluated whether a money management intervention, Advisor–Teller Money Manager (ATM), could have an effect both on the use of cocaine and on the impulsive choices exhibited by the participants. The results indicated that ATM participants decreased their cocaine use and had lower discounting rates than other participants over time.

In such a way, the previous studies show that it is possible that measures of temporal discounting could be accurate predictors of healthy decisions but also, that some behavioral habits related to health could in turn, affect the degree of discounting. Finally, some authors have discussed the possibility that delay discounting could be a trait variable (i.e., a trait stable over time) or conversely, that it changes from one situation to another. Chapman GB & Elstein AS[31] compared the degree of discounting of monetary and health outcomes of university students and evaluated whether individuals who were more impulsive in scenarios that included monetary rewards also showed greater impulsivity in the health domain. The discounting rates for health rewards were generally higher than those for monetary results. Moreover, a very low correlation was found between domains, which indicates independence in the discounting rates, that is, the participants who discounted the most the health rewards did not necessarily had higher discounting rates when the alternatives implied monetary results. In 1996, Chapman GB[32] carried out another three experiments controlling some confounding variables. The results of the previous study (domain independence) were replicated. Correlations between health and monetary rewards were very low indicating that temporal discounting of monetary outcomes might not be an accurate predictor of discounting when using other types of outcomes such as health. Similarly, in order to evaluate if framing outcomes as gains or losses could affect the degree of discounting, Johnson M[33] obtained discounting rates from smokers and non–smokers (current, and never–before cigarette smokers) in different choice situations that included monetary, health and cigarette gains and losses. The authors found that discounting rates in monetary results were higher in smokers than non–smokers for losses

as well as for gains. Likewise, smokers showed higher degrees of discounting with health results, but differences were not statistically significant. Also, researchers reported higher discounting degrees of monetary losses than of health losses in both groups, while there were no differences in the discounting rates of health and monetary gains. This would indicate that, apparently, health losses are not as aversive as monetary losses. On the other hand, the discounting rates corresponding to cigarette losses and gains were higher than those of monetary and health outcomes. Besides, an interesting finding was that both smokers and non–smokers discounted gains more than losses in all three domains (money, health and cigarettes). This asymmetry between the discounting of gains and losses had been replicated in other studies such as the one carried out by Hardisty D & Weber E[34] who evaluated rates of discounting of health and monetary gains and losses and the one conducted by Odum A[35] with smokers, ex–smokers and non–smokers. The studies mentioned above show two interesting issues related to temporal discounting and health behavior. First, the data suggests that there is independence in the discounting of different domains such as money and health, that is, people that show higher rates of discount in scenarios that involve health outcomes might not discount monetary outcomes in a similar way. And, second, framing the results in terms of losses could be a useful tool to reduce impulsive choices.

Conclusion

The present review offered information about temporal discounting assessments in people who use some substances such as alcohol, opioids, nicotine, and cocaine; and people with eating disorders. It shows that people that exhibit substance abuse behaviors and eating disorders tend to show higher levels of discounting compared to people who do not show substance use or eating problems. These results reveal the importance of temporal discounting as a possible risk factor for developing some of the mentioned disorders. In addition, the importance of studying the factors involved in decision making, such as the temporal discounting, is highlighted given that health/illness is a complex relationship, which depends on complex processes that in turn depend on the behavior of choice of the individual, and therefore could make them prone to develop either risk behaviors or protective behaviors. An analysis and understanding of the behavior of choice within the framework of health will be potentially useful when generating effective prevention or intervention programs. Future research can be oriented to study the factors or variables that can reduce the level of impulsivity or discounting and with this, generate more effective intervention strategies in the applied fields.

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Conflict of Interest

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