On the Complexity of Discounting, Choice Situations, and People

Leonard Green¹ · Joel Myerson¹

Published online: 11 June 2019

© Association for Behavior Analysis International 2019

Abstract

Although steep delay discounting is associated with various behavioral problems, perhaps most prominently substance abuse, we argue that it is best not conceived of as a character flaw such as impulsivity. Such a view, although part of a centuries-old tradition, does not distinguish between actions whose outcomes involve gains and losses, or between delayed outcomes and probabilistic outcomes, nor does it acknowledge that how steeply an individual discounts one of these kinds of outcome appears to be independent of how steeply they discount other kinds. Therefore, we advocate an approach that does not require making judgments about the character of the individuals involved. We show that when drug-dependent individuals are compared with controls, a substantial number of the drug-dependent individuals discount delayed monetary rewards less steeply than the average (median) member of the control group. Moreover, a substantial number of the controls discount more steeply than the average drug-dependent individual. Finally, we point out that many everyday choice situations differ from those studied in most discounting experiments in that they involve both gains and losses as well as qualitatively different outcomes that may be both delayed and probabilistic. Past research on discounting that focused on simple choice situations has provided a solid foundation, but research on more complicated situations is now needed. We believe that the principles revealed by such research will both inform the choices of treatment providers and improve our understanding of the complicated decisions that people face every day.

Keywords Discounting · Impulsivity · Drug-dependence · Delay · Probability · Gains · Losses

✉ Leonard Green
lgreen@wustl.edu

¹ Department of Psychological & Brain Sciences, Washington University in St. Louis, Campus Box 1125, St. Louis, MO 63130, USA

To many people, behavior problems are seen as reflecting on the character of the individual. For example, choosing a smaller, sooner reward rather than “delaying one’s gratification” and receiving a larger, albeit delayed, reward is frequently viewed as being impulsive and not “having” self-control. From this perspective, the ability to somehow avoid “succumbing to temptation,” as represented by such immediate rewards, is central to the concept of self-control. Indeed, self-control has been viewed as the triumph of reason over impulse since the time of Plato, and the traditional definition of impulsiveness focuses on a lack of forethought or acting without careful deliberation. Whether due to one’s “passions” or irrationality, as in Aristotle’s claim that “the incontinent man, knowing that what he does is bad, does it as a result of passion, while the continent man, knowing that his appetites are bad, refuses on account of his rational principle to follow them” (Aristotle, *Nicomachean Ethics*, 1145b, 12–14, in McKeon, 1941), the failure to engage in behavior that is in one’s long-term best interest is most often viewed as a failing within the individual.

Moreover, even if impulsivity were a failing within the individual, it would not necessarily follow that self-control involves an effort of will or ego strength, and that it could or should be strengthened like a self-control muscle (Muraven & Baumeister, 2000). In fact, research suggests that those best at “self-control” do not exert more effort resisting temptation, but rather may be more successful at avoiding temptation in the first place (Hofmann, Baumeister, Förster, & Vohs, 2012; Milyavskaya & Inzlicht, 2017). Nevertheless, the association of certain psychological disorders (e.g., substance use disorder, binge eating disorder) with steep discounting of delayed rewards is a robust finding, and research on explicating this phenomenon and studies examining its implications for treatment are both clearly needed.

Discounting as a Trait

Perhaps the iconic behavioral evidence of the relation between self-control and behavioral problems is the finding that at the group level, substance users and abusers consistently discount delayed rewards more steeply than controls (MacKillop et al., 2011), suggesting to some that they cannot resist the temptation posed by immediate drug rewards even though that means they will be foregoing greater long-term rewards. This view motivates much recent research on the effectiveness of interventions aimed at reducing the degree of delay discounting (e.g., framing, episodic future thinking; for a review, see Rung & Madden, 2018). It should be noted, however, that the utility of such interventions is independent of the underlying philosophical perspective. That is, reducing an individual’s discounting could have positive effects on problem behavior regardless of whether or not the problem is viewed as resulting from a lack of self-control, ego strength, will power, or (alternatively) excessive impulsivity.

Part of the appeal of the view that steep discounting and certain behavioral problems represent the same character flaw (whatever term one uses to describe it) is that it implies that changing an individual’s discounting in one situation means that one has corrected a fundamental character flaw and that this will be reflected in many situations, potentially alleviating many of their problems that result from the same general failing. This, of course, represents not only a source of the appeal of the character flaw view, it also represents a way to test it. That is, if “impulsivity” (to pick one term) represents a

single unitary trait, and delay discounting is an indicator of that trait, then impulsive behavior should, by definition, be transsituational (Mischel, 1973). Indeed, the assumption of such transsituationality underlies a treatment approach in which one modifies discounting in one “training” situation with the belief that the behavior change then will transfer to the everyday situations in which a problem occurs.

The evidence for such transsituationality is mixed, however (for a review, see Green & Myerson, 2013). For example, Mejía-Cruz, Green, Myerson, Morales-Chainé, and Nieto (2016) examined the discounting of several different kinds of outcomes, including both consumable and nonconsumable delayed and probabilistic rewards, as well as delayed and probabilistic losses. There were three groups of participants: a cocaine-dependent group, a marijuana-dependent group, and a control group. Consistent with previous findings, the cocaine-dependent group discounted delayed rewards significantly more steeply than controls, but the marijuana-dependent group did not differ from the controls (e.g., Coffey, Gudleski, Saladin, & Brady 2003; Heil, Johnson, Higgins, & Bickel., 2006, Johnson et al., 2010). It is important note that a factor analysis (using Varimax rotation) revealed that multiple delayed rewards (i.e., two amounts of money, preferred leisure activity, preferred drink) all loaded on a single factor, consistent with the notion that discounting of delayed rewards represents a single trait (see Table 1). However, probability discounting of the same four rewards loaded on a separate factor. Moreover, delayed and probabilistic monetary losses loaded on yet a third factor. Consistent with the existence of three separate factors, cocaine-dependent individuals did not differ from controls in the degree to which they discounted probabilistic rewards, or in their discounting of either delayed or probabilistic losses, despite the fact that they differed significantly from controls in their discounting of delayed rewards.

Table 1 Rotated Factor Loadings for Discounting Measures (AuCs) from the Different Conditions in Mejía-Cruz et al. (2016)

Outcome Type	Factor		
	Delay	Probability	Loss
<i>Delayed Gain</i>			
Money (small)	.853	.057	.105
Money (large)	.800	.123	-.095
Liquid	.798	.006	-.023
Leisure	.608	.095	.276
<i>Probabilistic Gain</i>			
Money (small)	.031	.756	-.109
Money (large)	-.086	.727	-.321
Liquid	.209	.639	.041
Leisure	.090	.722	.224
<i>Monetary Loss</i>			
Delayed	.111	.018	.619
Probabilistic	-.030	-.086	.752

Note: Factor loadings greater than 0.50 are in bold

This pattern of results raises the question of what is meant by “impulsivity” and “impulsiveness.” Although they suggest that one could define such terms, operationally at least, in terms of steep discounting of delayed rewards, this does not seem to capture what is meant by these terms outside the discounting literature. Dictionaries tend not to define impulsivity, but rather the adjective “impulsive,” which is said to describe acting without forethought, or controlled by impulse rather than reason or careful deliberation, implying that “impulsive” individuals would make “better” decisions if they just devoted more time to it. Dictionary definitions make no distinction, however, between actions involving gains and losses as outcomes, or between delayed outcomes and probabilistic outcomes, whereas these distinctions are clearly central to understanding the observed behavior (Green & Myerson, 2010; Myerson, Green, Hanson, Holt, & Estle, 2003).

The observed behavioral distinctions are also inconsistent with the way that psychometricians use the term (e.g., “a predisposition toward rapid, unplanned reactions to internal or external stimuli without regard to the negative consequences of these reactions to the impulsive individuals or to others”; Moeller, Barratt, Dougherty, Schmitz, & Swann, 2001). Moreover, in a factor-analytic study with over 1,000 participants that examined the relations among psychometric impulsiveness, delay discounting, and response inhibition, MacKillop et al. (2016) found that a person’s tendency to discount delayed rewards (which they referred to as “impulsive choice”) was completely independent of how they scored on psychometric tests of impulsiveness, as well as being independent of how effectively they inhibited a prepotent response.

Complexities

Taken together, the differing definitions and empirical findings suggest that it may be better to forego the use of the term “impulsivity” in the present context, and instead use separate terms (e.g., “impatience,” “risk-taking”) for what appear to be separate constructs. Separate terms for different constructs would also highlight the implications for treatment of behavioral problems associated with discounting. That is, although differences in discounting rates have been related to various maladaptive behaviors (for reviews, see Madden & Bickel, 2010), the existence of multiple factors implies that an intervention that successfully targets one type of discounting does not guarantee a similar change to other types. For example, if an intervention that changes the degree of delay discounting is effective in modifying other “impatient” behaviors, it still might not be effective in modifying “risk-taking” behaviors. Further, an intervention that affects the discounting of delayed rewards might not affect the discounting of delayed losses. This point is critical with respect to substance use and abuse because the major problem with such behavior, both for the individual and society, is not that it interferes with one’s acquiring larger rewards later, although it may do so, but rather that it may lead to a variety of delayed and/or probabilistic negative consequences, including overdose, disease (e.g., HIV and HCV, both of which are associated with intravenous drug use), and, of course, the possibility of imprisonment.

We also would call attention to the fact that although psychologists, philosophers, economists, and politicians often assume that an individual’s choice of a smaller, sooner

reward, rather than a larger, later one represents a problem, in some situations there are reasons that the individual should focus on the short-term consequences of their choices (Green & Myerson, 2018). In behavioral biology, the classic problem is that of small birds in winter that have high metabolic rates and need constant food to survive, particularly in cold weather. As a consequence, they cannot always “afford” to delay food consumption so as to obtain more food later, or to choose a larger, risky alternative that has a higher expected value over a more certain, albeit smaller alternative with a lower expected value.

Human choice behavior has also been shown to be sensitive to changes in budget constraints (e.g., Pietras, Locey, & Hackenberg, 2003). When money is abundant, for example, basic expenses are handled easily as they arise, but when it is scarce, such expenses create immediate problems that necessarily lead to the neglect of other problems, including those concerned with meeting long-term goals (Shah, Mullainathan, & Shafir, 2012). It is important to note that Shah et al. stressed that the effects of scarcity do not necessarily reflect the personality characteristics of the poor (e.g., that they are impulsive). In a series of studies involving hypothetical budgets, Shah et al. found that individuals randomly assigned to tight budgets made decisions indicating that they were focused on those commodities that were scarce, to the exclusion of other goods and benefits. Time, of course, is another resource that may be scarce. Just as the poor may need to focus on immediate expenses, the busy may need to borrow time from other tasks in order to meet immediate goals.

Like both the small bird in winter and the drug-dependent individual, most of us occasionally make choices that others, who may not consider the larger “economic” context in which those decisions are being made, consider to be impulsive and indicative of a lack of self-control. In contrast, consideration of the context does not require making judgments about the personal “psychological” characteristics of the individuals involved, but rather involves taking into account the fact that when people are poor, busy, or are experiencing scarcity of some other critical resource, they make choices that appear to reflect a lack of self-control. Considering such contextual factors may lead to more accurate diagnosis of specific behavioral problems and shifts the focus from how to change an individual to how best to modify the environmental context within which their behavior occurs.

Implications for Treatment

Previous discounting research conducted with the goal of developing behavioral treatments has focused on choices involving delayed rewards. Indeed, this focus seems appropriate given that drug-dependent individuals, on average, appear less likely to differ from controls in their discounting of probabilistic rewards or delayed or probabilistic losses. However, individual-level analyses of the results of several of our recent studies suggest potential limitations of focusing on just those who steeply discount delayed rewards. Consider the data from cocaine-dependent and control participants in the Mejía-Cruz et al. (2016) study, as presented in box plots of distributions of individual measures of the Area-under-the-Discounting curve (AuC; Myerson, Green, & Warusawitharana, 2001; see Figure 1). The bottom of each box represents the 25th percentile and the top represents the 75th percentile, and the horizontal line across the

box represents the median AuC for the group, with lower AuC values representing steeper discounting. (The bottom and top “whiskers” extend to the 10th and 90th percentiles, and the solid circles represent the data from individuals with AuCs below or above those percentiles, respectively.)

Comparing the position of the top of the box plot for the cocaine-dependent individuals, which marks the 75th percentile for that group, with the horizontal line within the rectangular box for the control group, which represents their median AuC, reveals that approximately one-fourth of the cocaine-dependent individuals showed shallower than average discounting. As may be seen in Figure 1, this was observed with both the smaller and larger delayed monetary rewards. With both delayed amounts, moreover, approximately one-fourth of the controls actually discounted more steeply than the average cocaine-dependent participant. This may be seen by comparing the positions of the bottoms of the box plots for the control group with the horizontal lines (medians) in the box plots for the cocaine-dependent group.

The same phenomenon (i.e., many drug-dependent individuals who show shallower discounting than the average person in the control group and many controls who show steeper discounting than the average person in the drug-dependent group) may be seen in Figure 2, which depicts the data from low-income African American alcohol-dependent individuals and controls (Myerson, Green, van den Berk-Clark, & Grucza, 2015; for another example, see Bernhardt et al. 2017). Note that the figure depicts only the data from the male participants, and in particular, only from those male participants in the original study who had not experienced severe psychological trauma. This is because although male alcoholics discounted delayed monetary gains significantly more steeply than male controls, female alcoholics from the same population did not discount more steeply than female controls. Moreover, the figure depicts the data of only those participants who did not experience severe psychological trauma, which was common in this inner-city population (van den Berk-Clark, Myerson, Green, & Grucza,

Fig. 1 Box plots of individual discounting measures (AuCs) for cocaine-dependent individuals and controls in the delayed monetary conditions of Mejia-Cruz et al. (2016). *** Group differences at both reward amounts were significant at $p < .001$

2018), although the same degree of overlap in the AuC distributions of male alcoholics and controls was observed in the sample as a whole. It is important to note that, as in the Mejía-Cruz et al. (2016) study, approximately one-fourth of these alcohol-dependent men discounted less steeply than the average individual in the control group, and approximately one-fourth of the controls discounted more steeply than the average alcoholic.

It is clear that discounting is not the Rosetta Stone for identifying individual addicts. As we have shown, a substantial proportion of shallow discounters may take drugs and many steep discounters may not. Moreover, as already noted, female alcoholics in the Myerson et al. (2015) study did not discount more steeply than female controls (who, it should be noted, did not differ from male controls). Thus, if steep discounting is involved in problem drinking, this may be more of an issue for males than for females, and thus one-size-fits-all treatments may be inappropriate. Even within the male participants in that study, we found that approximately one-fourth of the alcoholics discounted a delayed monetary reward less steeply than the average nonalcoholic, raising the question of whether treatments focused on decreasing the steepness with which individuals discount delayed rewards would benefit individuals who already show such shallow discounting. It is certainly possible that they would benefit, but if so, it would raise questions as to why they benefit, questions that are not easily answerable within the discounting framework.

Moreover, as Killeen (2015) pointed out, a number of behavioral mechanisms (e.g., differences in weighting of amount and delay, differences in the curvature of the value function relating amount to subjective value) can give rise to steep discounting that some would term “impulsive.” The potential existence of different mechanisms is both

Fig. 2 Box plots of individual discounting measures (AuCs) for low-income African American men (alcoholics and controls) in the delayed monetary reward condition of Myerson et al. (2015). *** The difference between the groups was significant at $p < .001$

good and bad news from a treatment perspective. It may be bad news from the perspective of a one-size-fits-all treatment approach, but at the same time, it suggests that there could be multiple treatment approaches that could be successful in different cases. This would not only be advantageous for treatment providers, but also might explain the fact that a number of different manipulations appear to be at least somewhat successful in reducing delay discounting (Rung & Madden, 2018).

Further Complications

There is another important issue to be considered, and that is the fact that most everyday choice situations are more complicated than those typically studied in the laboratory, which are reasonably selected based on their apparent analytic tractability. Although the hope is usually that understanding such simple situations will provide insight into the more complicated ones, this is an assumption that needs to be empirically tested, and then tested again, because the nature of the complications varies from one everyday choice situation to the next.

For example, many situations involve choosing between outcomes that differ in both likelihood and immediacy. Although delay and probability discounting have both been studied extensively, previous research has not clarified the way in which they combine. For example, delay and probability could combine either additively or multiplicatively. Both are reasonable possibilities, and there is support for the idea that the subjective value of an outcome may represent the sum of the values of at least some of its attributes (Estle, Green, & Myerson, 2019; Killeen, 2009). However, this does not appear to be the case for the combination of the delay until and the likelihood of an outcome, at least when that outcome is a hypothetical monetary reward. In that case, the effects of delay and probability (i.e., the odds against receiving a reward) combine multiplicatively (Vanderveldt, Green, & Myerson, 2015). That is, the subjective value, or present, certain equivalent, of an outcome that is both delayed and probabilistic is predicted by the product of a delay discounting function and a probability discounting function.

Although the results of the Vanderveldt et al. (2015) study strongly support the assumption that the subjective value of a combination follows from what is known about the values of its components, this is not the only result that would have supported this assumption, because an additive combination of delay and probability also would have been consistent with this assumption. Both additive and multiplicative models build on our understanding of discounting in simple situations. However, the fact that one type of model may apply in some more complicated situations and the other type of model may apply in other situations exemplifies the need to actually study different complicated situations to determine what provides the best account in each case.

Another example of an everyday choice situation that is more complicated than that in simple delay discounting experiments is the choice between qualitatively different outcomes. Even if one knows how steeply a large delayed reward is discounted when the alternative is a smaller, immediate amount of the same reward, it does not necessarily follow that one knows how steeply it will be discounted when the alternative is a different kind of reward. Two recent studies by Huskinson et al. (2016; Huskinson, Woolverton, Green, Myerson, & Freeman, 2015) exemplify the problem.

They found that monkeys, when given a choice between a delayed food reward and an immediate cocaine injection, steeply discounted the value of the delayed food reward. However, they showed shallow discounting of the same delayed food reward when the immediate alternative was a smaller amount of food. In contrast, when the delayed reward was an injection of cocaine, the monkeys showed virtually the same shallow rate of discounting regardless of whether the immediate alternative was food or a weaker dose of cocaine.

Although these results are consistent with the idea that cocaine is a powerful reinforcer for monkeys, they are inconsistent with the view that cocaine-addicted monkeys cannot wait to get it or to get a higher, albeit delayed, dose. In general, the present findings raise the possibility that although human drug abusers also may choose impulsively when immediate drug reinforcement is available, like the monkeys choosing between immediate cocaine and delayed food, nevertheless, drug abusers may exercise what some might refer to as “self-control” in the acquisition of delayed drug reinforcers. This, perhaps, should come as no surprise. After all, as William S. Burroughs (writing under the pseudonym of “William Lee”; Lee, 1953) wrote, “A junkie spends half his life waiting.”

Finally, many everyday choice situations also differ from those studied in most discounting experiments in that they involve both gains and losses. Moreover, the choice situations faced by drug abusers often involve not only gains and losses, but qualitatively different outcomes that may be both delayed and probabilistic. As already noted, drug use may have a variety of delayed and/or probabilistic negative consequences, and drug rewards themselves may be both delayed and probabilistic. In brief, everyday choice situations, both those that involve drugs and those that do not, can be quite complicated, and ultimately it is an empirical question how the results of typical discounting experiments apply to these more complicated everyday choice situations.

In some cases, subsequent findings regarding such situations may reveal that the application of what is known from the study of simpler situations is straightforward. In other cases, however, things may not be so straightforward, and further theoretical work will be needed to understand the interactions among the processes revealed by the study of simpler choice situations. Past research on discounting examining simple choices has provided a solid foundation for future research. It is clear, however, further efforts will be required to understand choice and decision making in complicated situations and to determine how the principles revealed by these efforts can inform our choices both as treatment providers and as individuals who are ourselves faced with complicated everyday situations.

Conclusions

Understanding how and why people differ in the degree to which they discount delayed and probabilistic outcomes is clearly important, as is the fact that it is associated with the incidence of a number of serious behavioral problems. Moreover, emerging research on the discounting of effort, both physical and cognitive, may reveal further associations. For example, discounting more cognitively effortful outcomes may lead to neglecting informational resources, resulting in poorer medical and financial decisions and subsequent problems in those areas.

Moreover, research on group differences in discounting is critically important from a public health perspective, where the goal is to develop and implement interventions that have positive results at the population level. However, such research may not represent the best approach to understanding individual decision making in general or individual decision-making problems in particular. For one thing, it may cause us to mischaracterize many individuals who are unlike those who appear to be typical members of their group, such as the many drug addicts whose discounting is relatively shallow, as revealed by the present analyses, or the “negative discounters” observed when examining choices involving delayed losses, who prefer not to delay negative outcomes. Such mischaracterization not only may be an obstacle to successful treatment of the mischaracterized individuals, it also may mislead us in our quest to understand the kind of decision making involved.

Acknowledgements Preparation of this manuscript was supported in part by the National Institute on Aging of the National Institutes of Health under Award Number R01AG058885.

References

- Bernhardt, N., Nebe, S., Pooeh, S., Sebold, M., Sommer, C., Birkenstock, J., et al. (2017). Impulsive decision making in young adult social drinkers and detoxified alcohol-dependent patients: A cross-sectional and longitudinal study. *Alcoholism: Clinical & Experimental Research*, 41, 1794–1807.
- Coffey, S. F., Gudleski, G. D., Saladin, M. E., & Brady, K. T. (2003). Impulsivity and rapid discounting of delayed hypothetical rewards in cocaine-dependent individuals. *Experimental & Clinical Psychopharmacology*, 11, 18–25.
- Estle, S. J., Green, L., & Myerson, J. (2019). When immediate losses are followed by delayed gains: Additive hyperboloid discounting models. *Psychonomic Bulletin & Review*.
- Green, L., & Myerson, J. (2010). Experimental and correlational analyses of delay and probability discounting. In G. J. Madden & W. K. Bickel (Eds.), *Impulsivity: The behavioral and neurological science of discounting* (pp. 67–92). Washington, DC: American Psychological Association.
- Green, L., & Myerson, J. (2013). How many impulsivities? A discounting perspective. *Journal of the Experimental Analysis of Behavior*, 99, 3–13.
- Green, L., & Myerson, J. (2018). Preference reversals, delay discounting, rational choice, and the brain. In J. L. Bermúdez (Ed.), *Self-control, decision theory, and rationality: New essays* (pp. 121–146). Cambridge: Cambridge University Press.
- Heil, S. H., Johnson, M. W., Higgins, S. T., & Bickel, W. K. (2006). Delay discounting in currently using and currently abstinent cocaine-dependent outpatients and non-drug-using matched controls. *Addictive Behaviors*, 31, 1290–1294.
- Hofmann, W., Baumeister, R. F., Förster, G., & Vohs, K. D. (2012). Everyday temptations: an experience sampling study of desire, conflict, and self-control. *Journal of Personality & Social Psychology*, 102, 1318–1335.
- Huskinson, S. L., Myerson, J., Green, L., Rowlett, J. K., Woolverton, W. L., & Freeman, K. B. (2016). Shallow discounting of delayed cocaine by male rhesus monkeys when immediate food is the choice alternative. *Experimental & Clinical Psychopharmacology*, 24, 456–463.
- Huskinson, S. L., Woolverton, W. L., Green, L., Myerson, J., & Freeman, K. B. (2015). Delay discounting of food by rhesus monkeys: Cocaine and food choice in isomorphic and allomorphic situations. *Experimental & Clinical Psychopharmacology*, 23, 184–193.
- Johnson, M. W., Bickel, W. K., Baker, F., Moore, B. A., Badger, G. J., & Budney, A. J. (2010). Delay discounting in current and former marijuana-dependent individuals. *Experimental & Clinical Psychopharmacology*, 18, 99–107.
- Killeen, P. R. (2009). An additive-utility model of delay discounting. *Psychological Review*, 116, 602–619.
- Killeen, P. R. (2015). Models of ADHD: Five ways smaller sooner is better. *Journal of Neuroscience Methods*, 252, 2–13.

- Lee, W. (1953). *Junkie: Confessions of an unredeemed drug addict*. New York: Ace Books.
- MacKillop, J., Amlung, M. T., Few, L. R., Ray, L. A., Sweet, L. H., & Munafò, M. R. (2011). Delayed reward discounting and addictive behavior: a meta-analysis. *Psychopharmacology*, 216(3), 305–321.
- MacKillop, J., Weafer, J., Gray, J. C., Oshri, A., Palmer, A., & de Wit, H. (2016). The latent structure of impulsivity: impulsive choice, impulsive action, and impulsive personality traits. *Psychopharmacology*, 233, 3361–3370.
- Madden, G. J., & Bickel, W. K. (2010). *Impulsivity: The behavioral and neurological science of discounting*. Washington, DC: American Psychological Association.
- McKeon, R. (Ed.). (1941). *The basic works of Aristotle*. New York: Random House.
- Mejia-Cruz, D., Green, L., Myerson, J., Morales-Chainé, S., & Nieto, J. (2016). Delay and probability discounting by drug-dependent cocaine and marijuana users. *Psychopharmacology*, 233, 2705–2714.
- Milyavskaya, M., & Inzlicht, M. (2017). What's so great about self-control? Examining the importance of effortful self-control and temptation in predicting real-life depletion and goal attainment. *Social Psychological & Personality Science*, 8, 603–611.
- Mischel, W. (1973). Toward a cognitive social learning reconceptualization of personality. *Psychological Review*, 80, 252–283.
- Moeller, F. G., Barratt, E. S., Dougherty, D. M., Schmitz, J. M., & Swann, A. C. (2001). Psychiatric aspects of impulsivity. *American Journal of Psychiatry*, 158, 1783–1793.
- Muraven, M., & Baumeister, R. F. (2000). Self-regulation and depletion of limited resources: Does self-control resemble a muscle? *Psychological Bulletin*, 126, 247–259.
- Myerson, J., Green, L., Hanson, J. S., Holt, D. D., & Estle, S. J. (2003). Discounting of delayed and probabilistic rewards: Processes and traits. *Journal of Economic Psychology*, 24, 619–635.
- Myerson, J., Green, L., & Warusawitharana, M. (2001). Area-under-the-curve as a measure of discounting. *Journal of the Experimental Analysis of Behavior*, 76, 235–243.
- Myerson, J., Green, van den Berk-Clark, C., & Grucza, R. A. (2015). Male, but not female, alcohol-dependent African Americans discount delayed gains more steeply than propensity-score matched controls. *Psychopharmacology*, 232, 4493–4503.
- Pietras, C. J., Locey, M. L., & Hackenberg, T. D. (2003). Human risky choice under temporal constraints: Tests of an energy-budget model. *Journal of the Experimental Analysis of Behavior*, 80, 59–75.
- Rung, J. M., & Madden, G. J. (2018). Experimental reductions of delay discounting and impulsive choice: A systematic review and meta-analysis. *Journal of Experimental Psychology: General*, 147, 1349–1381.
- Shah, A. K., Mullainathan, S., & Shafir, E. (2012). Some consequences of having too little. *Science*, 338, 682–685.
- van den Berk-Clark, C., Myerson, J., Green, L., & Grucza, R. A. (2018). Past trauma and future choices: Differences in discounting in low-income, urban African Americans. *Psychological Medicine*, 48, 2702–2709.
- Vanderveldt, A., Green, L., & Myerson, J. (2015). Discounting of monetary rewards that are both delayed and probabilistic: Delay and probability combine multiplicatively, not additively. *Journal of Experimental Psychology: Learning, Memory, & Cognition*, 41, 148–162.