Experimental and Clinical Psychopharmacology

Initial Evaluation of Domain-Specific Episodic Future Thinking on Delay Discounting and Cannabis Use

Michael J. Sofis, Shea M. Lemley, Nicholas C. Jacobson, and Alan J. Budney

Online First Publication, June 7, 2021. http://dx.doi.org/10.1037/pha0000501

AMERICAN PSYCHOLOGICAL ASSOCIATION

Experimental and Clinical Psychopharmacology

ISSN: 1064-1297

https://doi.org/10.1037/pha0000501

Initial Evaluation of Domain-Specific Episodic Future Thinking on Delay Discounting and Cannabis Use

Michael J. Sofis[1, 2], Shea M. Lemley[1], Nicholas C. Jacobson[1], and Alan J. Budney[1]
[1] Geisel School of Medicine, Dartmouth College, Center for Technology and Behavioral Health
[2] Advocates for Human Potential, Inc., Sudbury, Massachusetts, United States

Episodic Future Thinking (EFT), mental simulation of personally relevant and positive future events, may modulate delay discounting (DD) in cannabis users. Whether EFT impacts cannabis use, whether DD mediates this effect, and whether EFT can be enhanced by prompting future events across specific life domains is unknown. Active, adult cannabis users (n = 90) recruited from Amazon mTurk and Qualtrics Panels were administered an Episodic Specificity Induction (ESI) to enhance quality of imagined events before being randomized to EFT, domain-specific-EFT (DS-EFT), or Episodic Recent Thinking (ERT). All participants created four, positive life events; DS-EFT participants imagined social, leisure, health, and financial events. Event-quality ratings were assessed (e.g., enjoyment). DD was assessed at baseline (Day 1), post-intervention (Days 2–4), and follow-up (Days 9–12). Cannabis use was assessed at baseline and follow-up. Differences in change in days and grams of cannabis use between conditions and mediation of changes in use by DD were examined. No differences in DD were observed between conditions. DS-EFT, but not EFT, showed significantly greater reductions in grams (d = .54) and days of cannabis use (d = .50) than ERT. DS-EFT and EFT demonstrated significantly greater event-quality ratings than ERT (ds > .55). EFT-based interventions showed potential for reducing cannabis use. Unexpectedly, effects on DD did not mediate this effect. Further testing with larger samples of cannabis users is needed to better understand EFT's mechanisms of action and determine optimal implementation strategies.

Public Significance Statement
Participation in a brief online intervention that prompts the creation and imagination of positive future events across life domains may help reduce frequent cannabis use.

Keywords: Episodic Future Thinking, cannabis use, digital intervention, Episodic Specificity Induction, delay discounting

Between 2010 and 2019, past-month cannabis use increased from 6.9% to 11.5% among those 12 and older in the U.S (Substance Abuse and Mental Health Services Administration [SAMHSA], 2020). This rise in the prevalence of cannabis use is concerning given that frequent cannabis use is associated with deficits in cognitive functioning and decision-making, and that between 12% and 30% of past-year cannabis users meet criteria for cannabis use disorder (CUD; Grucza et al., 2016; Hasin et al., 2015; Volkow et al., 2014). As with other substances, delay discounting (DD), which is defined as the devaluation of future rewards (Bickel et al., 2019), is associated with more frequent and problematic cannabis use (Sofis, Budney, et al., 2020; Sofis, Lemley, et al., 2020; Strickland et al., 2020). Specifically, DD demonstrates a small but direct relationship with more frequent and problematic cannabis use, even when accounting for other influences such as other measures of impulsivity or nicotine use, cognitive functioning, and reinforcing efficacy of cannabis use (Aston et al., 2016; Lopez-Vergara et al., 2019; Sofis, Budney, et al., 2020). Generally, excessive DD is often associated with more frequent substance use, and increased risk for developing a substance use disorder (SUD), and

Michael J. Sofis https://orcid.org/0000-0001-6249-5836
Shea M. Lemley https://orcid.org/0000-0003-1705-8199
Nicholas C. Jacobson https://orcid.org/0000-0002-8832-4741
Alan J. Budney https://orcid.org/0000-0001-6308-6823

The data from this manuscript were presented at the 2020 College on Problems of Drug Dependence and the 2021 Collaborative Perspectives on Addiction Conference.

This work was supported by the National Institutes on Drug Abuse [grant numbers T32-DA037202, P30-DA029926, & R01DA050032].

Michael J. Sofis: Conceptualization, formal analysis, funding acquisition, methodology, writing—original draft, writing—review & editing. Shea M. Lemley: Writing—original draft, methodology, software. Nicholas C. Jacobson: Writing—original draft, formal analyses. Alan J. Budney: Funding acquisition, methodology, writing—original draft. All authors contributed in a significant way to the manuscript and that all authors have read and approved the final manuscript.

We have no conflicts of interest to declare.

Correspondence concerning this article should be addressed to Michael J. Sofis, Advocates for Human Potential, Inc., 490-B Boston Post Road, Sudbury, MA 01776, United States. Email: msofis@ahpnet.com

tends to decrease with effective treatment (Amlung et al., 2017; Bickel et al., 2019; Rung & Madden, 2018). Hence, DD has become an important potential target of interventions seeking to reduce substance use (Bickel et al., 2019). Several clinical studies demonstrated that DD was reduced following treatment for cocaine use (Black & Rosen, 2011), opioid use (Landes et al., 2012), and nicotine use (Weidberg et al., 2015; Yi et al., 2008).

To date, there has been little attention to DD as a target of interventions to reduce cannabis use and no studies to our knowledge have directly tested whether reductions in DD contribute to reductions in cannabis use. Post-hoc evaluations of the relationship between DD and reduced cannabis use have revealed mixed findings, with secondary analyses of intervention studies showing both positive (Lee et al., 2015) and null findings (Peters et al., 2013). Testing interventions that directly target DD is needed to better examine its potential role as a mediating influence on reductions in cannabis use.

One such candidate intervention is Episodic Future Thinking (EFT), which is a brief intervention that prompts mental simulation of personally relevant, positive future events (Atance & O'Neill, 2001; O'Neill et al., 2016; Rung & Madden, 2019; Snider et al., 2016). Traditional EFT procedures iteratively prompt participants to construct and imagine positive events that take place in the future (e.g., 1 week, 1 month, 3 months, 1 year). Growing evidence suggests that EFT may engender reduction in DD among those who use substances in studies that compare EFT to Episodic Recent Thinking (ERT), a control condition that prompts participants to recollect events from the previous day (Snider et al., 2016; Stein et al., 2016; Sze et al., 2017). Such positive effects on DD have been observed in EFT studies targeting nicotine and alcohol use, and in one of these studies, the magnitude of reduction in DD was shown to mediate the relationship between EFT and reductions in cigarette use (Bulley & Gullo, 2017; Chiou & Wu, 2017; Stein et al., 2016). EFT may reduce DD by increasing the capacity to focus on the future via improvement in the ability to construct mental scenes of an event in a given time and place (Benoit & Schacter, 2019; Madore, Jing, et al., 2019; Madore, Thakral, et al., 2019; Peters & Büchel, 2010).

Mental event construction based on past events or imagined future events is thought to be driven by episodic memory, that is, the retrieval of contextual details related to past events (Jing et al., 2017). Episodic memory processes support the construction of mental scenes regarding future events by flexibly recombining details from past events to create novel mental scenes (Schacter & Addis, 2007). Notably, the specificity and salience (i.e., quality) of imagined future events during EFT has been shown to relate to the positivity and perceived value of future events, which tends to correspond to greater reductions in DD (Rung & Madden, 2019; Sofis, Budney, et al., 2020). Such findings support the assertion that the interaction of event specificity, future focus, and reward valuation may serve as a mechanism by which EFT changes DD. That is, the quality of event details during EFT (i.e., sometimes referred to as episodic specificity) may be important to the process of reducing DD and substance use.

Those who use cannabis regularly often demonstrate episodic memory deficits (Duperrouzel et al., 2019; Petker et al., 2019; Smith et al., 2015; Solowij & Battisti, 2008), and thus cannabis users may have difficulty engaging or benefiting from EFT. They may be less likely to generate a range of novel and personally important future events without being prompted because of episodic memory deficits that support this ability (Jing et al., 2017). Hence, prompting creation of future events across life domains (e.g., social, leisure, financial/career, health) during EFT may enhance engagement in important elements of the future event creation process and potentially increase impact on target health behaviors. For the present study, we developed a "domain-specific" EFT (DS-EFT) prompted participants to create and imagine personally relevant and positive future events across social, leisure, financial/career, and health domains.

Episodic memory deficits may also impede the ability to construct detailed mental future scenes related to cannabis use (Duperrouzel et al., 2019; Petker et al., 2019; Pillersdorf & Scoboria, 2019). Interestingly, Episodic Specificity Induction (ESI), a brief procedure which involves prompting the recollection of episodic details derived from a brief video, has been shown to enhance the ability to generate alternative future events and to improve the salience of mentally constructed events (Madore & Schacter, 2016). ESI, therefore, may be an effective method of priming EFT in persons with episodic memory deficits, including regular cannabis users. Indeed, in a study of frequent cannabis users, those who received ESI prior to EFT exhibited lower rates of DD and rated their created events during EFT or ERT as more vivid, enjoyable, important, and exciting than the group that received a control ESI training (Sofis, Lemley, et al., 2020).

The present study provided an initial direct test of the effects of EFT on change in cannabis consumption, compared the impact of a novel domain-specific EFT to traditional EFT on DD and cannabis use, and tested whether DD mediated the effects of the interventions on cannabis use. We anticipated that the DS-EFT training would produce greater reductions in both DD and cannabis use relative to the EFT and ERT conditions and that the magnitude of reduction in DD would mediate reductions in cannabis use.

Materials and Method

Participants and Recruitment

The Institutional Review Board from Dartmouth College approved all procedures of the present study (STUDY00029652, "Episodic Future Thinking in Cannabis Users"). Participants completed the informed consent prior to beginning the baseline session (Day 1). All study activities, including the training session (Day 2–3) and the follow-up session (Day 9–11) occurred remotely using Qualtrics survey software. Participants were recruited from Amazon Mechanical Turk (mTurk), an online crowdsourcing marketplace, and from Qualtrics Research Panels. A sample size of 90 was targeted because the only published study that has tested the impact of EFT on substance use (cigarettes) included 90 participants randomized to three independent conditions and reported moderate between-condition effect sizes and a significant mediation effect of DD (Chiou & Wu, 2017). These exclusions resulted in a final sample of $n = 90$. The current exploratory study was not preregistered as a randomized clinical trial.

Procedures

Participants were randomized to receive ESI + ERT ($n = 35$), ESI + EFT ($n = 26$), or ESI + DS-EFT ($n = 29$). Of the 90 participants, 38 (42%) were recruited from mTurk and 52 (58%) from Qualtrics Research Panels. After informed consent, participants completed a brief screening that assessed lifetime cannabis use, and past 30-day use of cannabis, illicit prescription opioids, other illicit opioids (e.g., fentanyl, heroin), alcohol, and tobacco. Participants averaged 45 min total to complete all three sessions (screening, intervention, follow-up). mTurk participants who completed the study earned up to $7.50. Qualtrics Research Panel participants were compensated via standard procedures for the panels (exact amount varied and was unknown to us), however, Qualtrics representatives indicated were similar in magnitude to that of our mTurk participants.

Episodic Specificity Induction

ESI involved watching a 2-min video of a woman giving a tour of her tiny house, and participants could not move to the next step in the training until the entire 2-min had passed. They then typed in answers to each of seven questions about episodic details from the tiny house video (e.g., "What did the people in the video look like?," "What happened in the video, in order?"). Participants typed short answers to six questions about the episodic details of each event (e.g., "What will you be doing?," "What will you be tasting and smelling?").

Episodic Future Thinking

Those assigned to traditional EFT were prompted to create four, iterative positive future events (1 week, 1 month, 3 months, 1 year). Moreover, participants who received EFT were prompted to create future events that were progressively more distant in the future (e.g., 1 week, 1 month, 3 months, 1 year) whereas all DS-EFT future events were in 1 year.

Domain-Specific Episodic Future Thinking

The DS-EFT, adapted from Sofis, Budney, et al. (2020) and Sofis, Lemley, et al. (2020), prompted participants to imagine an event 1 year in the future within each of the following life domains; social, leisure, financial/professional, and health. In contrast to EFT, all future events were imagined 1 year in the future to provide a sufficiently broad timeframe in which participants could realistically envision the occurrence of the domain-specific events. For example, it may be difficult to imagine an especially positive future work or financial life-event that occurs in a week because the perceived likelihood that such an event could occur would be low. Participants typed short answers to six questions about the episodic details of each event similar to the EFT condition.

Episodic Recent Thinking

ERT, which served as the control condition, prompted episodic thinking of recent positive events from yesterday during 3-hr intervals (4–7 p.m., 1–4 p.m., 10–1 p.m., 7–10 a.m.). Like for DS-EFT and EFT, participants in the ERT group answered the same six questions about each event.

Event Cues

All participants were required to create a short contextual cue summarizing each imagined event (Rung & Madden, 2019; Snider et al., 2016; Stein et al., 2016). For DS-EFT and EFT, participants completed the phrase "In *X time* from now, I will be . . . ," where *X* was the future time point. Participants in the ERT group completed the phrase, "Yesterday between *Y*, I was . . . ," where *Y* was the time interval (e.g., 7–10 a.m.) from the day before. These textual cues were then presented during corresponding timepoint choices in the DD task.

Event Ratings

Participants rated the excitement, enjoyment, importance, and vividness of each event on separate 100-point Visual Analogue Scales (VASs) as a measure of quality of episodic event creation to compare the quality of the events created by those who received ERT, EFT, and DS-EFT (Snider et al., 2016).

Measures

Demographics and Substance Use

Table 1 shows distributions and descriptive statistics for demographic variables and substance use measures. Participants ranged from age 19 to 75 ($M = 41.0$ years, $SD = 13.1$), and 61% were female. Most participants were *not* college educated (62%), and over half of the sample reported full-time employment (59%). All substance use measures regarding use during the 30 days before the baseline session were ordinal in nature. Median number of days of cannabis use was 26–29 days per month (IQR; Inter Quartile Range = 10–19, all 30 days) and the median number of times cannabis was used per day was 2 (IQR = 1, 3 times). Median number of days of alcohol use was 3–5 days (IQR 1–2, 10–19 days) and median number of alcoholic drinks was two drinks (IQR = 1, 5 drinks). Median number of days of tobacco use was all 30 days (IQR = 6–9 days, all 30 days) and median number of times using tobacco was five times per day (IQR = 1 times, 6–10 times per day).

The Timeline Followback procedure (Sobell & Sobell, 1992) was used to obtain reports of cannabis, alcohol, nicotine, and any other illicit substance use during the 7 days prior to the baseline session (see Table 1). Participants averaged 5.4 days of cannabis use ($SD = 2.1$), 17.6 g of cannabis ($SD = 15$), 2.1 days of alcohol use ($SD = 2.1$), 6.7 alcoholic drinks (9.0), 5 days of tobacco use (3.0), and 27.6 instances of tobacco use ($SD = 20$). Eighty percent of the sample used tobacco during the week prior to baseline ($n = 72$) and 73% used alcohol ($n = 66$).

Delay Discounting

Participants completed the five-trial DD task as a part of the screening process, given the brevity of the task (Koffarnus & Bickel, 2014), and completed the adjusting amount DD task (Estle et al., 2006) during the intervention and follow-up sessions to facilitate presentation of episodic cues during DD choices. A well-accepted index of DD rate, k, was obtained for both DD tasks.

For the five-trial task, participants made a series of five choices regarding whether to receive $500 now or $1,000 after a delay. The delay for the first choice was 3 weeks. For each trial, the delay was adjusted based on the participant's previous choice (i.e., choosing the immediate reward shortened the delay experienced during the subsequent trial and choosing the delayed reward lengthened the delay). The combination of choices made on the five trials resulted in

Table 1
Sample and Group Characteristics

Demographic and behavioral economic variables	Overall	ERT	EFT	DS-EFT	*p*
Age (*M, SD*)	41.0 (13)	42.7 (14)	40.7 (12)	39.2 (14)	.58
Ready to change Cann (1–10; *M, SD*)	2.4 (1.8)	2.5 (1.7)	2.3 (1.9)	2.2 (2.0)	.84
Delay discounting (ln(*k*); *M, SD*)	−4.4 (1.5)	−4.4 (1.8)	−4.1 (1.4)	−4.6 (1.2)	.58
Cann demand elasticity (α; *M, SD*)	.07 (.10)	.06 (.09)	.06 (.10)	.08 (.11)	.78
Cann demand intensity (Q_0; *M, SD*)	24 (27)	18.9 (20)	34.9 (35)	18.8 (25)	.04
Gender (*n*, %)					.56
Female	35 (39)	14 (40)	8 (31)	13 (45)	
Level of education (*n*, %)					.33
No college degree	62 (69)	21 (60)	20 (77)	21 (72)	
Employment (*n*, %)					.61
Full-time	53 (59)	18 (51)	17 (65)	18 (62)	
Part-time	11 (12)	3 (9)	4 (15)	4 (14)	
Retired/disabled	16 (18)	8 (23)	4 (15)	4 (14)	
Unemployed	10 (11)	6 (17)	1 (4)	3 (10)	
Substance-related variables					
Cannabis					
Readiness to change (1–10; *M, SD*)	2.4 (1.8)	2.5 (1.7)	2.3 (1.9)	2.2 (2.0)	.84
CUD (*no/yes*)	40 (44)	18 (51)	11 (42)	11 (38)	.54
Past week *(M, SD)*					
Days of use	5.4 (2.1)	5.2 (2.2)	5.5 (2.0)	5.6 (2.1)	.75
Cannabis grams	17.6 (15)	16.3 (14)	17.2 (14)	19.7 (17)	.66
Past 30 days (*Mdn*)					
Days of use	26–29	26–29	20–25	All 30	.84
Times/day	2	3	2	2	.75
Alcohol					
Past week *(M, SD)*					
Alcohol days	2.1 (2.1)	1.7 (1.8)	2.0 (1.9)	2.7 (2.4)	.18
Alcoholic drinks	6.7 (9.0)	6.5 (10)	5.9 (6.7)	7.8 (9.4)	.74
Past 30 days (*Mdn*)					
Days of use	3–5	3–5	3–5	6–9	.07
Drinks/day	2	1	2	3	.64
Nicotine					
Past week *(M, SD)*					
Tobacco days	5.0 (3.0)	4.9 (3.0)	5.2 (2.9)	4.9 (3.1)	.90
Tobacco times	27.6 (20)	27.6 (21)	27.5 (20)	27.5 (21)	1.0
Past month (*Mdn*)					
Days of use	All 30	All 30	All 30	All 30	.99
Times/day	5	5	5	5	.95

Note. ERT = Episodic Recent Thinking; EFT = Episodic Future Thinking; DS-EFT = domain-specific-EFT; CUD = cannabis use disorder; Cann = cannabis; *Mdn* = median; *M* = mean; *SD* = standard deviation.

one of 32 possible outcomes, each of which was assigned a predetermined *k* value (Koffarnus & Bickel, 2014).

For the adjusting amount DD task, participants' first choices at each delay were between receiving $500 now or $1,000 after a delay (i.e., ascending delays of 1 day, 1 week, 1 month, 3 months, 1 year); the smaller, sooner amount was titrated after each choice for six trials at each delay (Estle et al., 2006). The raw *k* values were positively skewed; thus ln(*k*) values were used for analyses.

CUDIT-R

Participants completed the Cannabis Use Disorder Identification Test-Short Form (CUDIT-SF), a tool used to screen for CUD and as an index of problematic cannabis use (Bonn-Miller et al., 2016). Response options range from *never* (0) to *daily or almost daily* (4) for the three-item tool. In the present study, 44% screened positive for potentially having CUD (score > 1).

Readiness to Change Cannabis Use

Participants reported their readiness to change using a tool adapted from the Readiness Ruler (LaBrie et al., 2005). Participants reported an average readiness to reduce cannabis use of 2.4 (*SD* = 1.8) on a 10-point visual analog scale (VAS; 1 = *Not important*, 10 = *Very important*).

Marijuana Purchase Task

After completing ERT, EFT, or DS-EFT sessions, participants completed a Marijuana Purchase Task (MPT; Aston et al., 2015) to examine state-like reinforcing efficacy of cannabis. Demand *intensity* (Q_0), which represents the maximum amount of cannabis participants are willing to consume at free price, and demand *elasticity* (α), which characterizes sensitivity of cannabis consumption amidst rising prices, were calculated for each participant using the exponential demand model (Hursh & Silberberg, 2008).

The same instructions employed in Aston et al. (2015) were used in the present study wherein participants are instructed to imagine that they are consuming average quality cannabis on a typical day in the last month, that they did not use cannabis beforehand, that they cannot save the cannabis, and that they must consume all the cannabis requested in the purchase task.

Analysis Plan

To be eligible for mTurk recruitment, participants had to have a 95% or higher approval rating on all previously submitted mTurk HITs, and have completed at least 100 Human Intelligence Tasks (HITs). Inclusion criteria for mTurk and Qualtrics Panels recruitment included: reside in the U.S., age 18 or older, at least 100 lifetime days of cannabis use, at least 10 days of cannabis use in the last month, and DD rates that were not in the bottom 25% of those observed in a prior study that involved regular cannabis users (Sofis, Budney, et al., 2020; Sofis, Lemley, et al., 2020; $\ln(k) = -7.35$). Participants were eligible for the follow-up session if they completed the first ($n = 671$) and second session ($n = 210$) and did not miss more than one attention check out of the three presented in the first session and the two presented in the second session. Participants were excluded if their DD rates were too low ($n = 41$) because of previous research suggesting that EFT-induced reductions in DD may be more likely to occur in those with higher rates of baseline DD (Snider et al., 2018). Participants were also excluded if their responses on the DD tasks were too inconsistent, based on criteria delineated by Johnson and Bickel (2008) or were so inconsistent that valid k value could not be derived ($n = 10$). Participants were excluded for inconsistent or nonsensical responding on the hypothetical cannabis purchase task which was informed by Stein et al. (2015; $n = 24$). Specifically, 10 participants were excluded for not meeting the Stein et al. (2015) bounce criteria, one was excluded for not meeting the Stein et al. (2015) trend criteria, and the remaining 13 were excluded for study specific unrealistic consumption criteria (i.e., no consumption at free price at baseline, consumption >100, or consumption at free price that was equal to consumption at the maximum price assessed ($20/unit).

Cannabis demand *elasticity* and *intensity* were included in the present study but the indices of $O_{\max}$, $P_{\max}$, and *breakpoint* were not included. Specifically, when examining baseline correlations between all five demand indices and measures of recent cannabis use, the cannabis use measures were significantly correlated with *elasticity*, *intensity*, and *breakpoint*, but $P_{\max}$ and $O_{\max}$ were not. Although *elasticity*, *intensity*, and *breakpoint* were each correlated with the cannabis use measures, *elasticity* and *breakpoint* were correlated at $r = .85$, which suggests that very little variance would be accounted for by adding either *breakpoint*, $P_{\max}$, or $O_{\max}$ as separate covariates or together with *elasticity* to form the persistence factor (Aston et al., 2017). Further, when replicating the methods of the Principal Component Analysis for demand indices from Aston et al. (2017) using the current data (e.g., including the oblim rotation and using the eigenvalue >1 and scree plot methods for determining the number of factors), a one-factor solution was the best solution. We were therefore not confident in using the two-factor solution for this study.

To test for baseline differences between the three groups, Chi-squared tests and one-way Analysis of Variance; ANOVAs (Lempert et al., 2020) were performed on demographics, substance use (cannabis, alcohol, tobacco), DD, cannabis demand *elasticity* and *intensity*, and readiness to reduce cannabis use (Table 1). The only statistically significant difference between groups was for demand *intensity* ($p = .04$), such that the EFT group reported that they would smoke more cannabis joints if they were free than the ERT ($p = .02$) and DS-EFT ($p = .03$) groups. Further, demand *intensity* and *elasticity* demonstrated moderate strength correlations with correlated demonstrated a strong negative correlation with cannabis use both demand *intensity* and *elasticity* were used as covariates for comparative analyses between groups on event ratings, DD, and cannabis use.

Age and gender were used as covariates because men and older individuals often demonstrate deficits in episodic memory relative to women and younger individuals (Addis et al., 2008; Asperholm et al., 2019). Both demand indices were included as covariates given the significant group differences found in demand *intensity* at baseline ($p = .04$). Further, *elasticity* demonstrated moderate strength correlations with both cannabis use grams ($r = -.37$, $p < .001$) and days ($r = .31$, $p < .01$) and *intensity* was significantly correlated at a similar strength to grams of cannabis use ($r = .37$, $p < .001$). The sum of CUDIT-SF items was also used as a covariate to control for initial level of problematic cannabis use.

Five one-way analyses of covariances (ANCOVAs) were used to examine between-group differences in quality ratings for enjoyment, vividness, excitement, importance, and realism, respectively. Age and gender were entered into each model as covariates because men and older individuals are more likely to demonstrate deficits in episodic memory processes important to quality of event construction (Addis et al., 2008; Asperholm et al., 2019; Fuentes & Desrocher, 2013). Subsequent pairwise comparisons of groups were planned to test for specific between intervention differences for each quality of event rating.

Latent Change Score Models (LCSMs), a subset of Structural Equation Modeling (SEM) was used to: (a) test whether DS-EFT engendered greater latent reductions in cannabis use than the EFT and ERT while controlling for covariates, (b) examine whether change in DD mediated the relationship between interventions and change in total cannabis grams and total cannabis days, and (c) test whether DS-EFT engendered greater latent reductions in cannabis use than the EFT and ERT while controlling for covariates. Notably, LCSMs allow for the flexibility and benefits associated with SEM, including a reduction in measurement error (Hamaker et al., 2015; Kievit et al., 2018). This test allows for the incorporation of an examination of reliable change within intervention condition on change in these outcomes, while incorporating subject specific differences by explicitly modeling the variation in the latent change factor. LCSMs also allow one to control for initial starting conditions (Kievit et al., 2018). Model fit was assessed based on the observed χ^2, Root Mean Square Error of Approximation (RMSEA), Comparative Fit Index (CFI), and the Tucker–Lewis Index (TLI). Good fit was determined based on commonly accepted indicators for fit indices with RMSEA ≤ 0.05, CFI ≥ 0.95, and TLI ≥ 0.95, and acceptable fit is indicated when RMSEA ≤ 0.08, CFI ≥ 0.90, and TLI ≥ 0.90 (Brown, 2015; Marsh et al., 2004; Sharma et al., 2005). The robust maximum likelihood was utilized to account for the non-normal structure of the data.

Results

Event Ratings

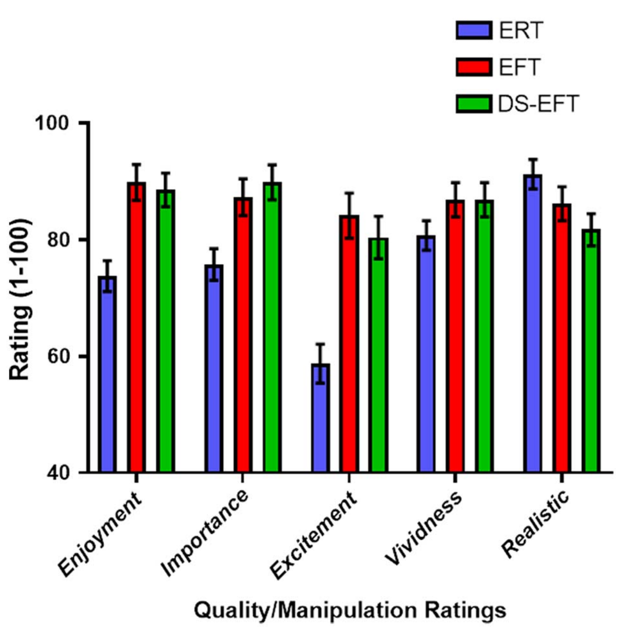
Figure 1 shows the adjusted mean ratings for each type of quality rating and each intervention after controlling for gender and age. Significant between-group differences emerged for enjoyment, $F(2, 85) = 10.35$, $p < .001$, $d = .99$, importance, $F(2, 85) = 6.90$, $p < .01$, $d = .81$, excitement, $F(2, 85) = 15.30$, $p < .001$, $d = 1.20$, and realism, $F(2, 85) = 3.25$, $p = .04$, $d = .55$, but not for vividness, $F(2, 85) = 1.60$, $p = .21$, $d = .39$. For enjoyment, importance, and excitement ratings, both EFT and DS-EFT engendered significantly greater quality ratings than ERT (*p*s < .01), but no differences were observed between EFT and DS-EFT (*p*s > .48). For realism, those who received ERT perceived their events as more realistic than those who received DS-EFT ($p < .05$). No other significant pairwise differences were observed.

Change in Cannabis Use

Grams

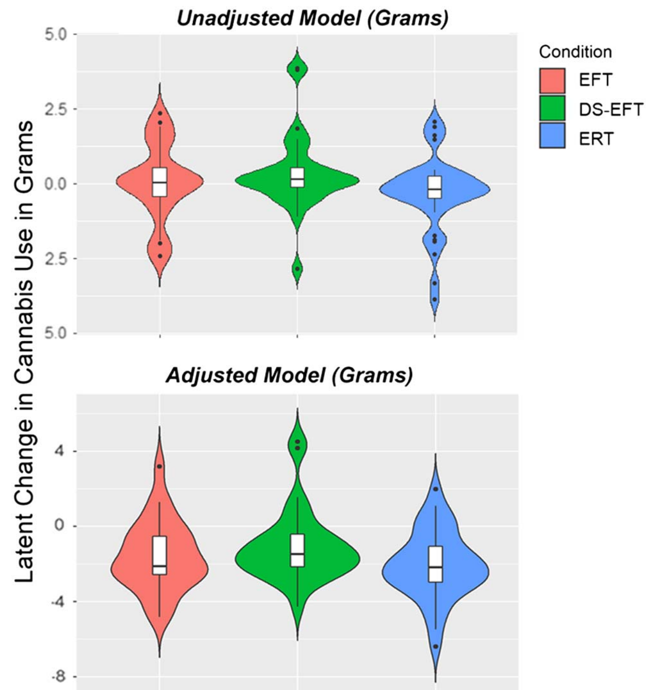
Figure 2 shows the Violin plots of latent change in total cannabis use grams such that without controlled for any covariates (i.e., unadjusted model) and when controlling for age, gender, cannabis demand *intensity* and *elasticity*, and the CUDIT-SF score (i.e., adjusted model). Values greater than 0 on the *y*-axis indicate reductions in cannabis use and negative values indicate increase in use. The LCSM analyses showed that DS-EFT showed a greater reduction in grams of cannabis use than ERT for the unadjusted

Figure 1
Event-Quality Manipulations



Note. This figure shows the event quality ratings of, importance, excitement, vividness, and realistic (*x*-axis) on a scale of 1–100 that were assessed following creation and imagination of each event. Error bars denote standard error of the mean. Green bars correspond to DS-EFT (right), red to EFT (middle), and blue to ERT (left). See the online article for the color version of this figure.

Figure 2
Violin Plot of Change in Cannabis Grams for Each Condition



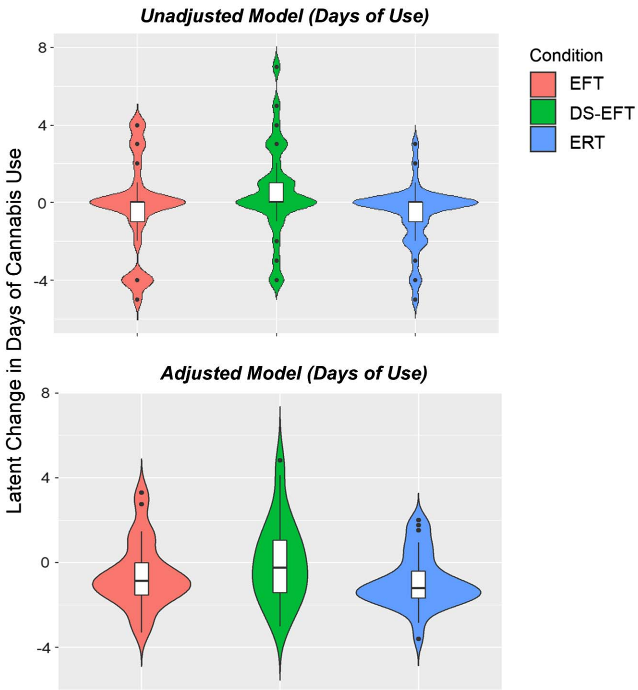
Note. The width (*x*-axis) of each plot represents the density of the data as a function of the latent change in grams (amount) of cannabis use (*y*-axis). The *y*-axis is reverse scored such that positive scores reflect reductions in grams. Median values for each condition are denoted with a horizontal line across each rectangular for each plot, the first and third quartiles are characterized by the end of each rectangle, and the end of each vertical black line for each plot represents the first quartile subtracted by 1.5 IQR, and the third quartile subtracted by 1.5 IQR. The DS-EFT condition is denoted by green (middle), EFT by red (left), and ERT by blue (right). See the online article for the color version of this figure.

($d = .47$, $p = .03$) and the adjusted model ($d = .55$, $p = .009$). No significant differences in reductions in grams were found between EFT and ERT for the unadjusted ($d = .27$, $p = .21$) or the adjusted model ($d = .28$, $p = .18$), or between DS-EFT and EFT for the unadjusted ($d = .15$, $p = .47$). or the adjusted model ($d = .19$, $p = .36$).

Days

Figure 3 shows the Violin plots of latent change in total cannabis use days without controlled for any covariates (i.e., unadjusted model) and when controlling for age, gender, cannabis demand *intensity* and *elasticity*, and the CUDIT-SF score (i.e., adjusted model). Values greater than 0 on the *y*-axis indicate reductions in cannabis use and negative values indicate increase in use. For days of use, DS-EFT also showed a greater reduction in days of cannabis use for both unadjusted ($d = .49$, $p = .02$) and adjusted models ($d = .50$, $p = .019$) than ERT. Like for grams of use, no significant differences in reductions in days of use were found between EFT and ERT for unadjusted ($d = .07$ $p = .73$) or adjusted models ($d = .18$, $p = .39$) or between DS-EFT and EFT for unadjusted ($d = .36$, $p = .09$) and adjusted models ($d = .26$, $p = .22$).

Figure 3
Violin Plot of Change in Cannabis Days for Each Condition



Note. The width (*x*-axis) of each plot represents the density of the data as a function of the latent change in days of cannabis use (*y*-axis). The *y*-axis is reverse scored such that positive scores reflect reductions in grams. Median values for each condition are denoted with a horizontal line across each rectangular for each plot, the first and third quartiles are characterized by the end of each rectangle, and the end of each vertical black line for each plot represents the first quartile subtracted by 1.5 IQR, and the third quartile subtracted by 1.5 IQR. The DS-EFT condition is denoted by green (middle), EFT by red (left), and ERT by blue (right). See the online article for the color version of this figure.

The statistical significance of the LCSM analyses comparing reductions in cannabis use grams and days between conditions did not differ when contrasting the unadjusted and adjusted models.

Testing of DD as a Mediator

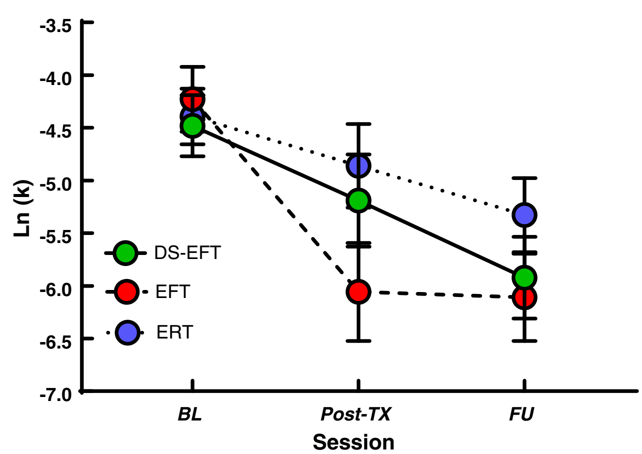
The LCSM models testing whether DD change mediated the relationship between condition and reduction in total cannabis grams and days of cannabis were unable to run because DD exhibited too much unexplained variance between groups and across sessions. Given the inability to directly examine DD as a mediator using the LCSM models, a repeated measures ANCOVA was performed to directly test whether there were group differences in the relative reduction of DD across sessions. Figure 4 depicts the adjusted mean DD rates after controlling for age, gender, demand *elasticity* and *intensity*, and CUDIT-SF score at the baseline, training, and follow-up. As seen in Figure 4, DD decreased across sessions for all groups ($p = .003$) but No session × Intervention interaction effect on DD was found ($p = .11$), suggesting that change (reduction) in DD across conditions did not differ. A second repeated measures ANCOVA was performed to compare the EFT and DS-EFT conditions to the ERT condition, and did not reveal a Significant session × Group interaction effect on DD ($p = .33$).

Discussion

The present study was designed to compare an initial test of a novel DS-EFT intervention on cannabis use and DD with that of a traditional EFT and an ERT control condition. We anticipated that DS-EFT would enhance the potency of the positive future thinking intervention by prompting imagined events across a wider range of life situations, and that greater reductions in DD would mediate such effects. However, no differences across conditions in DD were observed. DS-EFT did however engender greater reductions in both grams and days of cannabis use relative to ERT, but not EFT. When comparing change in cannabis use grams and days within each condition, DS-EFT participants averaged a 35% reduction in grams and a 13% reduction in days of cannabis use, whereas those in the EFT and ERT conditions averaged small increases for both grams and days. The effect size of the comparisons in cannabis use between DS-EFT and EFT for cannabis grams and days was $d = .19$ and $d = .26$, respectively, but these effects were not statistically significant. Replication with larger samples and greater statistical power are needed to provide more stringent comparisons of the effects of DS-EFT and EFT on cannabis use.

The failure to observe a clear effect of either EFT condition on reductions in DD relative to the ERT condition, and hence a mediation effect, was unexpected based on prior studies suggesting that EFT produces moderate effect-size reductions in DD in both clinical and healthy samples (Jun-yan et al., 2020). In the present study, participants in all three conditions showed *reduced* DD across sessions. Several possible explanations for this finding merit discussion. We used different DD tasks for the baseline and intervention sessions to present EFT cues during the DD task as is typical in

Figure 4
Changes in DD Observed Across Sessions and Conditions



Note. Delay discounting (ln(*k*)) is plotted on the *y*-axis as a function of session on the *x*-axis and each condition [DS-EFT condition is denoted by green (solid line), EFT by red (thick dashed line), and ERT by blue (thin dashed line)]. The baseline session is abbreviated as "BL," the Post-treatment session is abbreviated as "Post-Tx," and the follow-up session is abbreviated by "FU." DD (ln(*k*)) scores closer to zero correspond to greater, or more maladaptive rates of DD. See the online article for the color version of this figure.

prior tests of EFT effects on DD (Snider et al., 2016). The two types of DD tasks used here, the adjusting amount procedure and the five-trial DD task, may evoke different discounting levels on average, thus potentially obscuring relative changes in DD between conditions. However, the type and order of DD tasks administered were identical across conditions and the 5-trial, the adjusting amount tasks tend to demonstrate strong within-subject correlations, (Cox & Dallery, 2016; Koffarnus & Bickel, 2014), and no differences in DD were observed at baseline ($p = .52$), which together suggest it is unlikely that the varied DD procedure was responsible for the similar DD rates observed between conditions throughout the study.

The lack of differences in DD observed between conditions in the present study could have also been impacted by a loss of sensitivity of DD due to repeated assessments across a relatively short period of time (Mellis et al., 2019; Reynolds et al., 2006), however, the use of the different DD tasks during baseline and intervention sessions should have decreased this concern. Alternatively, those with particularly low rates of DD (i.e., <-7.35) were not included in the study, which may have contributed to a regression to the mean (Snider et al., 2018). Another explanation is that, as observed, the ESI training received by participants in all conditions produced comparable reductions in DD, and the three experimental conditions were not sufficient to add to this effect. Of note, the only study to our knowledge to demonstrate that DD mediated the relationship between EFT and reductions in substance use did not deliver an ESI prior to EFT (Chiou & Wu, 2017). ESI engendered reductions in DD would be congruent with evidence demonstrating that episodic memory processes contribute to individual differences in DD (Lempert et al., 2020). Further, episodic memory processes that underlie the quality of event construction for imagined future or present events have both been shown to correspond with reductions in DD (Ciaramelli et al., 2019) potentially by reducing the salience of smaller sooner rewards such as immediate cannabis use (Sellitto, 2020). Additional research is needed to isolate the effects of ESI and EFT on event quality ratings and DD.

The current findings provided mixed support for the hypothesis that DS-EFT would engender greater reductions in cannabis use through enhancing the quality and generality of mental event construction. Prior studies suggest that future focus and quality of personally relevant event-construction during EFT both impact DD and health behaviors (Rung & Madden, 2019; Thakral et al., 2020). In the present study, it was not possible to identify whether the domain-specific characteristics or the more distant timeframes imagined during the DS-EFT condition compared with traditional EFT contributed to the observed reductions on cannabis use. DS-EFT prompted participants to create more temporally distant time-frames than EFT because of concerns that prompting positive thinking related to health or work/financial events only 1 week into the future (as done in traditional EFT) would be perceived as unrealistic and challenging, thereby limiting the impact of the DS-EFT condition. Future studies are needed to examine the relative contributions of time, domain-specific characteristics, and their interaction to better understand the potential mechanism of the current effects of DS-EFT on cannabis use.

Additional limitations and considerations of this initial exploration of the impact of DS-EFT on reductions in DD and cannabis use warrant brief mention. First, the present study employed a relatively small sample size ($n = 90$) for the use of latent change score models, and participants that were not seeking clinical treatment, which may limit the generality of the current findings. Second, a relatively large number of inclusion and exclusion criteria were used, which also may affect the likelihood the current findings generalize to studies that do not use the same exclusion and inclusion criteria. Third, change in cannabis use was assessed after only 1-week follow-up. Longer duration studies are needed to assess potential clinical importance and to provide enough time to observe clinical change. Fourth, most participants in the present study used cannabis and tobacco daily. The effects of DS-EFT on cannabis use may differ based on whether samples include patterns of mono or polysubstance use. Fifth, the study was not designed to test whether the ESI component significantly interacts with DS-EFT training to enhance the effect on reductions in cannabis use or whether the DS-EFT produces these effects independently of the ESI training. Lastly, if the observed reductions in cannabis use engendered by DS-EFT observed here are replicated in larger samples, future research might explore whether a facilitator-guided approach strengthens the impact of the intervention on cannabis use. Such an investigation could provide initial insights into the contexts or mode of delivery wherein DS-EFT provides clinical utility.

Conclusions

Accessible, more potent interventions for those with problematic cannabis use or CUD or are sorely needed. Our findings suggest remotely delivered EFT interventions may hold promise. Future research that identifies the relative contributions of ESI and various EFT implementation procedures components, and that betters our understanding of their mechanisms of action may lead to more potent adaptations and applications.

References

Addis, D. R., Wong, A. T., & Schacter, D. L. (2008). Age-related changes in the episodic simulation of future events. *Psychological Science*, *19*(1), 33–41. https://doi.org/10.1111/j.1467-9280.2008.02043.x

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*(1), 51–62. https://doi.org/10.1111/add.13535

Asperholm, M., Nagar, S., Dekhtyar, S., & Herlitz, A. (2019). The magnitude of sex differences in verbal episodic memory increases with social progress: Data from 54 countries across 40 years. *PLOS ONE*, *14*(4), Article e0214945. https://doi.org/10.1371/journal.pone.0214945

Aston, E. R., Farris, S. G., MacKillop, J., & Metrik, J. (2017). Latent factor structure of a behavioral economic marijuana demand curve. *Psychopharmacology*, *234*(16), 2421–2429. https://doi.org/10.1007/s00213-017-4633-6

Aston, E. R., Metrik, J., Amlung, M., Kahler, C. W., & MacKillop, J. (2016). Interrelationships between marijuana demand and discounting of delayed rewards: Convergence in behavioral economic methods. *Drug and Alcohol Dependence*, *169*, 141–147. https://doi.org/10.1016/j.drugalcdep.2016.10.014

Aston, E. R., Metrik, J., & MacKillop, J. (2015). Further validation of a marijuana purchase task. *Drug and Alcohol Dependence*, *152*, 32–38. https://doi.org/10.1016/j.drugalcdep.2015.04.025

Atance, C. M., & O'Neill, D. K. (2001). Episodic future thinking. *Trends in Cognitive Sciences*, *5*(12), 533–539. https://doi.org/10.1016/S1364-6613(00)01804-0

Benoit, R. G., & Schacter, D. L. (2019). Episodic simulations nudge future-oriented choices by conveying prospective affect [Paper presentation]. International Convention of Psychological Science, Paris, France.

Bickel, W. K., Athamneh, L. N., Basso, J. C., Mellis, A. M., DeHart, W. B., Craft, W. H., & Pope, D. (2019). Excessive discounting of delayed reinforcers as a trans-disease process: Update on the state of the science. *Current Opinion in Psychology*, *30*, 59–64. https://doi.org/10.1016/j.copsyc.2019.01.005

Black, A. C., & Rosen, M. I. (2011). A money management-based substance use treatment increases valuation of future rewards. *Addictive Behaviors*, *36*(1–2), 125–128. https://doi.org/10.1016/j.addbeh.2010.08.014

Bonn-Miller, M. O., Heinz, A. J., Smith, E. V., Bruno, R., & Adamson, S. (2016). Preliminary development of a brief cannabis use disorder screening tool: The cannabis use disorder identification test short-form. *Cannabis and Cannabinoid Research*, *1*(1), 252–261. https://doi.org/10.1089/can.2016.0022

Brown, T. A. (2015). *Confirmatory factor analysis for applied research* (2nd ed.). Guilford Press.

Bulley, A., & Gullo, M. J. (2017). The influence of episodic foresight on delay discounting and demand for alcohol. *Addictive Behaviors*, *66*, 1–6. https://doi.org/10.1016/j.addbeh.2016.11.003

Chiou, W.-B., & Wu, W.-H. (2017). Episodic future thinking involving the nonsmoking self can induce lower discounting and cigarette consumption. *Journal of Studies on Alcohol and Drugs*, *78*(1), 106–112. https://doi.org/10.15288/jsad.2017.78.106

Ciaramelli, E., Sellitto, M., Tosarelli, G., & di Pellegrino, G. (2019). Imagining events alternative to the present can attenuate delay discounting. *Frontiers in Behavioral Neuroscience*, *13*, Article 269. https://doi.org/10.3389/fnbeh.2019.00269

Cox, D. J., & Dallery, J. (2016). Effects of delay and probability combinations on discounting in humans. *Behavioural Processes*, *131*, 15–23. https://doi.org/10.1016/j.beproc.2016.08.002

Duperrouzel, J. C., Hawes, S. W., Lopez-Quintero, C., Pacheco-Colón, I., Coxe, S., Hayes, T., & Gonzalez, R. (2019). Adolescent cannabis use and its associations with decision-making and episodic memory: Preliminary results from a longitudinal study. *Neuropsychology*, *33*(5), 701–710. https://doi.org/10.1037/neu0000538

Estle, S. J., Green, L., Myerson, J., & Holt, D. D. (2006). Differential effects of amount on temporal and probability discounting of gains and losses. *Memory & Cognition*, *34*(4), 914–928. https://doi.org/10.3758/BF03193437

Fuentes, A., & Desrocher, M. (2013). The effects of gender on the retrieval of episodic and semantic components of autobiographical memory. *Memory*, *21*(6), 619–632. https://doi.org/10.1080/09658211.2012.744423

Grucza, R. A., Agrawal, A., & Bierut, L. J. (2016). NESARC findings on increased prevalence of marijuana use disorders-reply: Consistent with other sources of information. *JAMA Psychiatry*, *73*(5), 532–533. https://doi.org/10.1001/jamapsychiatry.2016.0244

Hamaker, E. L., Kuiper, R. M., & Grasman, R. P. (2015). A critique of the cross-lagged panel model. *Psychological Methods*, *20*(1), 102–116. https://doi.org/10.1037/a0038889

Hasin, D. S., Saha, T. D., Kerridge, B. T., Goldstein, R. B., Chou, S. P., Zhang, H., Jung, J., Pickering, R. P., Ruan, W. J., Smith, S. M., Huang, B., & Grant, B. F. (2015). Prevalence of marijuana use disorders in the United States between 2001–2002 and 2012–2013. *JAMA Psychiatry*, *72*(12), 1235–1242. https://doi.org/10.1001/jamapsychiatry.2015.1858

Hursh, S. R., & Silberberg, A. (2008). Economic demand and essential value. *Psychological Review*, *115*(1), 186–198. https://doi.org/10.1037/0033-295X.115.1.186

Jing, H. G., Madore, K. P., & Schacter, D. L. (2017). Preparing for what might happen: An episodic specificity induction impacts the generation of alternative future events. *Cognition*, *169*, 118–128. https://doi.org/10.1016/j.cognition.2017.08.010

Johnson, M. W., & Bickel, W. K. (2008). An algorithm for identifying nonsystematic delay-discounting data. *Experimental Clinical Psychopharmacology*, *16*(3), 264–274. https://doi.org/10.1037/1064-1297.16.3.264

Jun-yan, Y., Qing-yu, D., Ji-fang, C., Zhe, L., Lu-xia, J., Xiao-jing, Q., Xu, H., & Wang, Y. (2020). *A meta-analysis of the effect of episodic future thinking on delay discounting*. psych.chinaxiv.org

Kievit, R. A., Brandmaier, A. M., Ziegler, G., van Harmelen, A.-L., de Mooij, S. M. M., Moutoussis, M., Goodyer, I. M., Bullmore, E., Jones, P. B., Fonagy, P., the NSPN Consortium, Lindenberger, U., & Dolan, R. J. (2018). Developmental cognitive neuroscience using latent change score models: A tutorial and applications. *Developmental Cognitive Neuroscience*, *33*, 99–117. https://doi.org/10.1016/j.dcn.2017.11.007

Koffarnus, M. N., & Bickel, W. K. (2014). A 5-trial adjusting delay discounting task: Accurate discount rates in less than one minute. *Experimental and Clinical Psychopharmacology*, *22*(3), 222–228. https://doi.org/10.1037/a0035973

LaBrie, J. W., Quinlan, T., Schiffman, J. E., & Earleywine, M. E. (2005). Performance of alcohol and safer sex change rulers compared with readiness to change questionnaires. *Psychology of Addictive Behaviors*, *19*(1), 112–115. https://doi.org/10.1037/0893-164X.19.1.112

Landes, R. D., Christensen, D. R., & Bickel, W. K. (2012). Delay discounting decreases in those completing treatment for opioid dependence. *Experimental and Clinical Psychopharmacology*, *20*(4), 302–309. https://doi.org/10.1037/a0027391

Lee, D. C., Stanger, C., & Budney, A. J. (2015). A comparison of delay discounting in adolescents and adults in treatment for cannabis use disorders. *Experimental and Clinical Psychopharmacology*, *23*(2), 130–137. https://doi.org/10.1037/a0038792

Lempert, K. M., Mechanic-Hamilton, D. J., Xie, L., Wisse, L. E. M., de Flores, R., Wang, J., Das, S. R., Yushkevich, P. A., Wolk, D. A., & Kable, J. W. (2020). Neural and behavioral correlates of episodic memory are associated with temporal discounting in older adults. *Neuropsychologia*, *146*, 107549. https://doi.org/10.1016/j.neuropsychologia.2020.107549

Lopez-Vergara, H. I., Jackson, K. M., Meshesha, L. Z., & Metrik, J. (2019). Dysregulation as a correlate of cannabis use and problem use. *Addictive Behaviors*, *95*, 138–144. https://doi.org/10.1016/j.addbeh.2019.03.010

Madore, K. P., Jing, H. G., & Schacter, D. L. (2019). Selective effects of specificity inductions on episodic details: Evidence for an event construction account. *Memory*, *27*(2), 250–260. https://doi.org/10.1080/09658211.2018.1502322

Madore, K. P., & Schacter, D. L. (2016). Remembering the past and imagining the future: Selective effects of an episodic specificity induction on detail generation. *Quarterly Journal of Experimental Psychology: Human Experimental Psychology*, *69*(2), 285–298. https://doi.org/10.1080/17470218.2014.999097

Madore, K. P., Thakral, P. P., Beaty, R. E., Addis, D. R., & Schacter, D. L. (2019). Neural mechanisms of episodic retrieval support divergent creative thinking. *Cerebral Cortex (New York, N.Y.)*, *29*(1), 150–166. https://doi.org/10.1093/cercor/bhx312

Marsh, H. W., Wen, Z., & Hau, K.-T. (2004). Structural equation models of latent interactions: Evaluation of alternative estimation strategies and indicator construction. *Psychological Methods*, *9*(3), 275–300. https://doi.org/10.1037/1082-989X.9.3.275

Mellis, A. M., Snider, S. E., Deshpande, H. U., LaConte, S. M., & Bickel, W. K. (2019). Practicing prospection promotes patience: Repeated episodic future thinking cumulatively reduces delay discounting. *Drug and Alcohol Dependence*, *204*, Article 107507. https://doi.org/10.1016/j.drugalcdep.2019.06.010

O'Neill, J., Daniel, T. O., & Epstein, L. H. (2016). Episodic future thinking reduces eating in a food court. *Eating Behaviors*, *20*, 9–13. https://doi.org/10.1016/j.eatbeh.2015.10.002

Peters, E. N., Petry, N. M., Lapaglia, D. M., Reynolds, B., & Carroll, K. M. (2013). Delay discounting in adults receiving treatment for marijuana dependence. *Experimental and Clinical Psychopharmacology*, *21*(1), 46–54. https://doi.org/10.1037/a0030943

Peters, J., & Büchel, C. (2010). Episodic future thinking reduces reward delay discounting through an enhancement of prefrontal-mediotemporal interactions. *Neuron*, *66*(1), 138–148. https://doi.org/10.1016/j.neuron.2010.03.026

Petker, T., Owens, M. M., Amlung, M. T., Oshri, A., Sweet, L. H., & MacKillop, J. (2019). Cannabis involvement and neuropsychological performance: Findings from the Human Connectome Project. *Journal of Psychiatry & Neuroscience*, *44*(6), 414–422. https://doi.org/10.1503/jpn.180115

Pillersdorf, D., & Scoboria, A. (2019). Cannabis-associated impairments in the fading affect bias and autobiographical memory specificity. *Consciousness and Cognition*, *74*, Article 102792. https://doi.org/10.1016/j.concog.2019.102792

Reynolds, B., Richards, J. B., & de Wit, H. (2006). Acute-alcohol effects on the Experiential Discounting Task (EDT) and a question-based measure of delay discounting. *Pharmacology, Biochemistry, and Behavior*, *83*(2), 194–202. https://doi.org/10.1016/j.pbb.2006.01.007

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*(9), 1349–1381. https://doi.org/10.1037/xge0000462

Rung, J. M., & Madden, G. J. (2019). Demand characteristics in episodic future thinking II: The role of cues and cue content in changing delay discounting. *Experimental and Clinical Psychopharmacology*, *27*(5), 482–495. https://doi.org/10.1037/pha0000260

Schacter, D. L., & Addis, D. R. (2007). The cognitive neuroscience of constructive memory: remembering the past and imagining the future. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, *362*(1481), 773–786. https://doi.org/10.1098/rstb.2007.2087

Sellitto, M. (2020). Commentary: Episodic future thinking about the ideal self induces lower discounting, leading to a decreased tendency toward cheating. *Frontiers in Psychology*, *11*(1027), Article 1027. https://doi.org/10.3389/fpsyg.2020.01027

Sharma, S., Mukherjee, S., Kumar, A., & Dillon, W. R. (2005). A simulation study to investigate the use of cutoff values for assessing model fit in covariance structure models. *Journal of Business Research*, *58*(7), 935–943. https://doi.org/10.1016/j.jbusres.2003.10.007

Smith, M. J., Cobia, D. J., Reilly, J. L., Gilman, J. M., Roberts, A. G., Alpert, K. I., Wang, L., Breiter, H. C., & Csernansky, J. G. (2015). Cannabis-related episodic memory deficits and hippocampal morphological differences in healthy individuals and schizophrenia subjects. *Hippocampus*, *25*(9), 1042–1051. https://doi.org/10.1002/hipo.22427

Snider, S. E., Deshpande, H. U., Lisinski, J. M., Koffarnus, M. N., LaConte, S. M., & Bickel, W. K. (2018). Working memory training improves alcohol users' episodic future thinking: A rate-dependent analysis. *Biological Psychiatry: Cognitive Neuroscience and Neuroimaging*, *3*(2), 160–167. https://doi.org/10.1016/j.bpsc.2017.11.002

Snider, S. E., LaConte, S. M., & Bickel, W. K. (2016). Episodic future thinking: Expansion of the temporal window in individuals with alcohol dependence. *Alcoholism, Clinical and Experimental Research*, *40*(7), 1558–1566. https://doi.org/10.1111/acer.13112

Sobell, L. C., & Sobell, M. B. (1992). Timeline follow-back: A technique for assessing self-reported alcohol consumption. In R. Litten & J. Allen (Eds.), *Measuring alcohol consumption* (pp. 41–72). Humana Press. https://doi.org/10.1007/978-1-4612-0357-5_3

Sofis, M. J., Budney, A. J., Stanger, C., Knapp, A. A., & Borodovsky, J. T. (2020). Greater delay discounting and cannabis coping motives are associated with more frequent cannabis use in a large sample of adult cannabis users. *Drug and Alcohol Dependence*, *207*, Article 107820. https://doi.org/10.1016/j.drugalcdep.2019.107820

Sofis, M. J., Lemley, S. M., Lee, D. C., & Budney, A. J. (2020). A web-based episodic specificity and future thinking session modulates delay discounting in cannabis users. *Psychology of Addictive Behaviors*, *34*(4), 532–540. https://doi.org/10.1037/adb0000557

Solowij, N., & Battisti, R. (2008). The chronic effects of cannabis on memory in humans: A review. *Current Drug Abuse Reviews*, *1*(1), 81–98. https://doi.org/10.2174/1874473710801010081

Stein, J. S., Koffarnus, M. N., Snider, S. E., Quisenberry, A. J., & Bickel, W. K. (2015). Identification and management of nonsystematic purchase task data: Toward best practice. *Experimental and Clinical Psychopharmacology*, *23*(5), 377–386. https://doi.org/10.1037/pha0000020

Stein, J. S., Wilson, A. G., Koffarnus, M. N., Daniel, T. O., Epstein, L. H., & Bickel, W. K. (2016). Unstuck in time: Episodic future thinking reduces delay discounting and cigarette smoking. *Psychopharmacology*, *233*(21–22), 3771–3778. https://doi.org/10.1007/s00213-016-4410-y

Strickland, J. C., Lee, D. C., Vandrey, R., & Johnson, M. W. (2020). A systematic review and meta-analysis of delay discounting and cannabis use. *Experimental and Clinical Psychopharmacology*. Advance online publication. https://doi.org/10.1037/pha0000378

Substance Abuse and Mental Health Services Administration (SAMHSA) (2020). *Results from the 2019 National Survey on Drug Use and Health: Detailed tables*.

Sze, Y. Y., Stein, J. S., Bickel, W. K., Paluch, R. A., & Epstein, L. H. (2017). Bleak present, bright future: Online episodic future thinking, scarcity, delay discounting, and food demand. *Clinical Psychological Science*, *5*(4), 683–697. https://doi.org/10.1177/2167702617696511

Thakral, P. P., Madore, K. P., & Schacter, D. L. (2020). The core episodic simulation network dissociates as a function of subjective experience and objective content. *Neuropsychologia*, *136*, Article 107263. https://doi.org/10.1016/j.neuropsychologia.2019.107263

Volkow, N. D., Baler, R. D., Compton, W. M., & Weiss, S. R. (2014). Adverse health effects of marijuana use. *New England Journal of Medicine*, *370*(23), 2219–2227. https://doi.org/10.1056/NEJMra1402309

Weidberg, S., Landes, R. D., López-Núñez, C., Pericot-Valverde, I., González-Roz, A., Yoon, J. H., & Secades-Villa, R. (2015). Contingency management effects on delay discounting among patients receiving smoking cessation treatment. *Psicothema*, *27*(4), 309–316. https://doi.org/10.7334/psicothema2015.184

Yi, R., Johnson, M. W., Giordano, L. A., Landes, R. D., Badger, G. J., & Bickel, W. K. (2008). The effects of reduced cigarette smoking on discounting future rewards: An initial evaluation. *The Psychological Record*, *58*(2), 163–174. https://doi.org/10.1007/BF03395609

Received January 13, 2021
Revision received May 1, 2021
Accepted May 4, 2021 ■