Thinking of the future: Effects of episodic future thinking on sexual decision-making

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Abstract

Prevalence and incidence of sexually transmitted infections (STIs) are rising in the United States. The leading cause of STI transmission is engagement in risky sexual behaviors such as unprotected intercourse, which may be conceptualized as an impulsive behavior. Specifically, individuals who engage in unprotected intercourse may do so because they have difficulty waiting for a condom if one is currently unavailable. Studies have viewed decisions about condom use through the behavioral economic framework of delay discounting, in which the subjective value of a delayed outcome decreases as time to its receipt increases. Recent studies have decreased delay discounting in clinical populations using episodic future thinking (EFT); however, no studies have examined the effectiveness of EFT in decreasing delay discounting of condom-protected sex. The present online survey study compared the effects of EFT and control procedures on hypothetical sexual decision-making in the Sexual Delay Discounting Task (SDDT). In Experiment 1, which used a within-subjects design, participants completed the SDDT and a money delay discounting task, which has shown sensitivity to EFT in previous studies. In Experiment 2, which used a between-subjects design, cigarette-smoking participants (≥ 10 cigarettes per day, as in prior studies) completed either the SDDT or the money delay discounting task. Despite predictions that engaging in EFT would reduce discounting of the future rewards compared to control conditions, no significant effects of EFT on delay discounting were observed. Our findings suggest that EFT may not affect either sexual or monetary discounting. Future investigations of EFT should investigate other procedural differences between prior studies and continue to pursue time-based methods of reducing delay discounting and rates of STI transmission in at-risk populations.

Keywords: sexual transmitted infection, delay discounting, condoms, online survey, human

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Sexually transmitted infection (STI) poses a significant threat to public well-being. At any given moment, there are an estimated 110 million individuals in the United States with an STI (CDC, 2018; Satterwhite et al., 2008). Concurrently, there is an increasing trend of new STIs in the United States. Each year 20 million new STIs are reported, of which half (10 million) are contracted by college-aged individuals (i.e., ages 18-24; CDC, 2017). The fiscal, health, and social effects of STIs are multifold. For example, there may arise issues with fertility, social stigma, and in some cases, death (Garolla et al., 2011; Young, Nussbaum, & Monin, 2007; Zhu et al., 2010). There is also a substantial negative impact on the U.S. economy. Annual treatment of STIs costs nearly $16 billion in the United States, a figure which is only projected to rise in the near future.

STIs are especially devastating to the developing individual (e.g., college-aged individuals) and if left untreated may have severe, life-changing effects. For example, human papillomavirus (HPV) can have deleterious effects on not just the individual with the primary infection but it may also affect their sexual partner or partners (Garolla et al., 2011). Contracting an STI such as HPV increases the likelihood of developing genital warts or some forms of cancers that are present in both men and women. Additionally, recent studies have shown that, if left untreated, syphilis may not only lead to the death of a parent but may also increase the mortality rate of the child (Zhu et al., 2010; Gomez et al., 2013). STIs may create social difficulties for the infected individual as well. Social stigmas are prevalent in individuals that contract an STI (Cunningham, Kerrigan, Jennings, & Ellen, 2009; Morris et al., 2014). Individuals that are believed to be infected or are infected with an STI are seen as being less moral (Young, Nussbaum, & Monin, 2007). Moreover, individuals that have an STI believe that

others will see them as less moral. Given the significant physical and social consequences of STIs, preventive measures to decrease STI risk, particularly in college-aged individuals, have become increasingly valuable.

Preventive measures to decrease STI risk by reducing sexual risk behaviors such as unprotected intercourse have focused primarily on education. Education has boosted awareness of STI rates; however, the effects of comprehensive sexual education on sexual risk behavior are mixed. On one hand, in a meta-analysis conducted by Kirby, Laris, and Rolleri (2007), comprehensive sexual education was associated with only a 50% increase in self-reported condom use. Similarly, half of the studies in their meta-analysis showed reduced sexual risk behavior beyond condom use (e.g., high number of sexual partners). On the other hand, many studies in this same meta-analysis showed no significant impact of educational interventions and, at worst, showed negative impacts (i.e., greater sexual risk behavior following education). However, the effectiveness of comprehensive sexual education compared to alternatives such as abstinence-only or abstinence-emphasized sexual education cannot be overlooked (Fonner et al., 2014; Silva, 2002). Overall, sexual education appears to have mixed effects on reducing sexual risk behavior, suggesting that lack of information may be insufficient to explain instances of sexual risk.

Impulsivity

STI knowledge, while helpful in building awareness of the risks associated with sexual risk behavior, may not prevent its occurrence. Paradoxically, in a study by Ajide and Balogun (2018), adolescents with greater HIV knowledge were more willing to engage in risky sexual behavior with familiar people. Why then might individuals engage in unprotected intercourse despite knowing the risks associated with the behavior? One possibility may be related to

impulsivity. Personality theory has traditionally been the lens through which impulsivity has been investigated (Farmer & Golden, 2009). However, recent research has looked at impulsive behavior through an increasingly behavioral lens. Fundamentally, individuals who are considered to be impulsive have difficulty waiting for delayed outcomes (Madden & Johnson, 2010), as observed in behaviors related to pathological gambling (Dixon, Marley, & Jacobs, 2003), obesity (Weller, Cook, Avsar, & Cox, 2008), and drug addiction (Giordano et al., 2002; Kirby, Petry, & Bickel, 1999). Recent investigations of impulsive behaviors such as these have used experimental tasks to measure an individual's likelihood of waiting for delayed rewards, or degree of delay discounting.

Delay discounting is a behavioral framework that describes how individuals choose between "smaller-sooner" (SS) and "larger-later" (LL) outcomes (Mazur, 1987). In a typical delay discounting task, individuals are given a choice between an SS or LL reward (e.g. $50 now or $100 in 1 week). Subsequent trials lead to adjustments in the SS amount, depending on the individual's choice (Richards et al., 1999). Trials continue until the SS and LL reward reach subjective parity, often referred to as the indifference point. Once determined at various LL delays, indifference points are fitted by nonlinear equations to describe the rate of discounting.

Delay discounting procedures such as these have been adapted to examine risky sexual behavior (Johnson & Bruner, 2012; Lawyer, Williams, Prihodova, Rollins, & Lester, 2010; Lawyer & Schoepflin, 2013). Notably, Johnson and Bruner developed the Sexual Delay Discounting Task (SDDT) to measure one's likelihood of condom use during hypothetical sex across various delays to condom access. Prior to completing the SDDT, participants were instructed to choose a hypothetical partner with which they would like to have sexual intercourse based on physical appearance alone. Johnson and Bruner (2012) showed that participants were

less likely to wait for a hypothetical condom as it became increasingly delayed. This finding suggests impulsivity—in this case, the inability to wait for a delayed condom—may be a driving force underlying sexual risk behaviors such as unprotected intercourse.

Beyond the original Johnson and Bruner (2012) study, sexual delay discounting has also been investigated in alcohol users (Johnson, Sweeney, Herrmann, & Johnson, 2016), cocaine users (Johnson, Johnson, Herrmann, & Sweeney, 2015; Johnson, Herrmann, Sweeney, LaComte, & Johnson, 2017; Koffarnus et al., 2016), energy drink users (Meredith, Sweeney, Johnson, Johnson, & Griffiths, 2016), college students and college-aged youth (Collado et al., 2017; Dariotis & Johnson, 2015), men who have sex with men (Herrmann, Johnson, & Johnson, 2015), and opioid-dependent women (Herrmann, Hand, Johnson, Badger, & Heil, 2014). Given that STIs pose significant health risks to individuals that engage in risky sexual behavior, and that delay discounting may explain why individuals fail to use condoms during sexual intercourse, identifying methods to effectively reduce the rate of sexual delay discounting (i.e., increase condom use likelihood) would be especially valuable. One such method with growing support in the delay discounting research literature is episodic future thinking, or EFT.

Episodic Future Thinking

Episodic future thinking involves the production of plausible future events that project the perception of the self into the future (Atance & O'Neill, 2001). The episodic events that are created build upon previously experienced events that create a possible vivid future. Engagement in mental time travel of this sort allows individuals to think about how they will arrive at that future event (Tulving, 1999) and to create a positive narrative of a possibly true future event (e.g., "I am going to go to my friend's wedding in two weeks where I will have delicious cake and dance").

EFT has been shown to positively impact divergent thinking (Madore, Addis, & Schacter, 2015), prospective recollection (Neroni, Gamboz, & Brandimonte, 2013), and snack food intake (Vartanian et al., 2016). Investigations of EFT on delay discounting have also shown promise as an intervention for obese individuals, alcohol users, and cigarette smokers (Daniel et al., 2015; Stein et al., 2016; Stein et al., 2017; Stein et al., 2018; Snider, LaConte, & Bickel, 2016; Bulley & Gullo, 2014). The primary finding of these studies has been that individuals randomly assigned to engage in EFT were more likely to wait for future rewards than those assigned to engage in episodic recent thinking, or ERT, a common control condition in which participants are asked to imagine events that occurred in their recent past (e.g., 1 day ago). In addition, and more importantly, EFT had effects on behavior beyond delay discounting. For example, Stein et al. (2018) observed that individuals consumed fewer cigarettes after engaging in EFT compared to those in the control groups. Likewise, Daniel et al. (2015) found that obese children engaging in EFT consumed fewer calories compared to those who were in the ERT control condition. Collectively, the positive effects of EFT in delay discounting studies suggest that EFT may be an effective method for reducing delay discounting and, in turn, for reducing the likelihood of engaging in impulsive behaviors such as unprotected intercourse.

The Present Study

The present experiments sought to investigate EFT as an intervention to improve sexual decision-making in the Sexual Delay Discounting Task (SDDT; Johnson & Bruner, 2012). Like past studies, participants were randomized to groups differing in the time frame for their episodic cues. In addition to an EFT group, participants were randomly assigned to an ERT group, as well as an episodic past thinking (EPT) group. Based on prior EFT studies involving delay discounting, we predicted that participants in the EFT group would discount condoms less

steeply than those in the ERT or EPT group (i.e., they would be more likely to wait to use a condom in the SDDT). We also predicted that participants in the EFT group would discount hypothetical delayed money less steeply than those in either control group. In essence, we predicted that individuals in the EFT group would exhibit greater self-control than their counterparts. If EFT has a significant positive effect on sexual decision-making in the SDDT (i.e., EFT participants are more likely to wait for a hypothetical condom), then EFT may prove to be a valuable intervention for reducing sexual risk behavior.

Experiment 1

Methods

Participants

Participants were a convenience sample of 180 workers from Amazon's mTurk crowdsourcing platform (www.mturk.com). mTurk is an online crowdsourcing service that provides "Workers" access to Human Intelligence Tasks, or HITs, advertised by "Requesters" (Amazon FAQ, n.d.). Participants were required to be residents of the United States, be 18 years of age or older, and have an mTurk approval rating of at least 90%. mTurk approval ratings are determined by Requesters who approve or reject Worker-submitted HITs. Participants who were not comfortable answering questions about their sexual history, who reported never having had sexual intercourse, or were currently pregnant or trying to become pregnant were not eligible to participate. Participants received $2.00 as compensation for completing the main survey. All study procedures were approved by the Human Subjects Research Committee of California State University, Chico.

Materials

Screening Questionnaire. In a screening questionnaire administered prior to the main online survey, participants responded to questions about their demographic characteristics and sexual history.

Sexual Delay Discounting Task (SDDT) Photograph Selection. Participants were shown 60 images of diverse, clothed individuals. Of the 60 images, 30 depicted men and 30 depicted women. Participants were informed prior to viewing the images that the SDDT involves hypothetical, casual sex scenarios wherein the participant or one's partner cannot become pregnant. Participants were then instructed to view all the images, regardless of gender, and to choose the partners with which they would have sex, based on physical appearance alone. Finally, after participants had selected all their preferred partners, they were asked to select the one partner they most wanted to have sex with. This partner image was used later in the survey in the SDDT.

Episodic Cue Generation. Episodic cue generation procedures were similar to those described by Stein et al. (2018). Briefly, participants were asked to generate positive episodic (i.e., autobiographical) cues relating to future (EFT), past (EPT), or recent (ERT) events. For participants in the EFT group, participants were instructed to think of and write about positive events they would be likely to experience 1 month, 2-6 months, and 7-12 months in the future. The EPT cue generation procedure used identical time frames but in the past. The ERT group was asked to think about recent time frames (e.g. 1 day, 2-6 days, and 7-12 days ago). Participants were instructed to generate 3 positive, non-sexual events for each delay or delay range.

Following episodic cue generation, participants were asked 5 questions about the salience of the generated events (e.g., "How much do you like or enjoy this event?"). Items were rated on

a five-point Likert scale ranging from 1 (Not at all) to 5 (Very). These questions were used to increase the likelihood that participants attended to the event cues. Finally, upon rating the salience of each cue, participants were instructed to select the one event at that delay or delay range that they were able to imagine most clearly. The event cue that was chosen by the participant as most imaginable was subsequently displayed in the SDDT.

Sexual Delay Discounting Task. The Sexual Delay Discounting Task (SDDT; Johnson & Bruner, 2012) assessed condom use likelihood given various delays to condom access. Across 8 trials, the participant was shown the image of the individual he or she most wanted to have sex with and was asked to rate his or her likelihood of using a condom to have sex with their partner. In the present study, the relevant episodic cue was displayed immediately below the partner image. Below the episodic cue were the following instructions:

> *For the next 6* [*sic*] *questions, imagine that you have just met this person. You are getting along great and they are interested in having sex with you now. Imagine you are confident that there is no chance of pregnancy, for example you know that one of you is either on the pill, has their "tubes tied" or had a vasectomy.*
>
> *There is a condom <u>READILY</u> and <u>IMMEDIATELY</u> available. In other words, you do not have to wait for a condom.*
>
> *Please rate how likely you are to use a condom or not.*

Participants then rated their likelihood of using the condom on a visual analog scale from 0 ("I will definitely have sex with this person without a condom") to 100 ("I will definitely have sex with this person with a condom"). On the remaining 7 trials, participants were asked to imagine the same situation, except that they had to wait for the condom. Delays to condom access were 1 hour, 3 hours, 6 hours, 1 day, 1 week, 1 month, and 3 months.

5-Trial Adjusting Discounting Task. The 5-Trial Adjusting Discounting Task (5TADT; Koffarnus & Bickel, 2008) is a monetary delay discounting task that measures the indifference points of a delayed, monetary reward. The indifference point is the point at which a delay is effective at reducing the value of a LL reward by 50% of its undiscounted value. In the 5TADT, the participant is presented with repeated choices between a small amount of money available immediately (e.g., $50 now) and a larger amount available after a delay (e.g., $100 in 3 weeks). While the immediate reward remains constant across trials, the delay to the larger-later reward is adjusted across 5 trials based on the participant's choices to determine the indifference points (for further details, see Koffarnus & Bickel).

Experiment/Experimenter Attitudes Rating Scale. The Experiment/Experimenter Attitudes Rating Scale (EARS; Nichols & Maner, 2008) is used to assess participants' attitudes and beliefs regarding experimental hypotheses. The original EARS contains 10 items; however, 4 items were removed in the present study as they were irrelevant to online experiments. Example questions included, "How happy are you to be here (i.e., taking this survey)?" and, "How much do you care about whether the experimenter's study works?" Items are scored on a 10-point scale ranging from 1 ("Not at all/No way") to 10 ("Very much/definitely"). Higher EARS scores represent higher positive attitudes toward the survey and possible bias. Finally, as in Stein et al. (2018), a question was added assessing whether the participant believed they were assigned to a control or experimental condition.

Post-Task Event Cue Salience Questions. Three questions were administered to assess how much participants attended to the event cues during cue generation, during the SDDT, and during the 5TADT. Items included, "When you were asked to list positive events in your life, how much would you say you thought about the event cues?" (for the given task). Participants

were asked to respond on a visual analog scale ranging from 0 (“I did not think about them”) to 100 (“I definitely thought about them”).

Procedure

Participants were recruited via a Human Intelligence Task (HIT) on mTurk. The HIT was advertised as “Time and Decision-Making (Psychology Research Study)”. The HIT included a brief description of the study including participant compensation. Participants were asked to accept the HIT before completing a screening questionnaire to determine eligibility for the main survey. If participants were ineligible, they were asked to return the HIT. If participants were eligible, they were provided with a password for the main survey.

Once participants accessed the main survey (Qualtrics, Inc.; Provo, UT), they completed the SDDT partner selection; were randomly assigned to either the EFT, ERT, or EPT group; and commenced with event cue generation. Next, either the SDDT or the 5TADT was administered (random order); whichever task was not presented first was presented second. Finally, the EARS and post-task event cue salience questions were administered. Upon completion of the survey (median completion around 17 minutes), participants were shown a debriefing message and provided contact information for the Primary Investigator (AI). Participants were compensated $2.00 via mTurk.

Data Analysis

Demographic characteristics were analyzed using a one-way analysis of variance (ANOVA) for continuous variables (age) and Chi-squares tests for categorical variables (sex, race, ethnicity, and which condition they believe they were in). Means and standard deviations were calculated for the EARS and post-task event cue salience questions to assess group differences in experimenter attitudes and cue salience.

Median condom use likelihoods from the SDDT were fitted using a two-parameter hyperbolic model using Equation 1. In Equation 1, *Y* represents the subjective value of the delayed reward, *A* is the amount of the delayed reward (in this case, A = 100), *D* is the delay, *k* is a free parameter that reflects the discounting rate, and *s* is a free parameter accounting for individual differences in delay sensitivity (McKerchar et al., 2008).

$$Y = \frac{A}{1+(kD)^s} \quad (1)$$

Area-under-the-curve was calculated from SDDT data using GraphPad Prism® (GraphPad Prism version 8.0.1 for Windows, GraphPad Software, La Jolla, CA). AUC values were calculated as AUC_{ord} (Borges et al., 2016), which involves ordinal transformation of delays. In doing so, the analysis allows for an equal distribution of delays. AUC values range from 0 to 1, with smaller values indicating steeper discounting (i.e., lower overall likelihood of using a condom). AUC is often preferred because unlike *k* it is an atheoretical measure of discounting (i.e., it does not assume a particular model; Myerson, Green, & Warasuwitharana, 2001). Analysis of the 5TADT was performed by calculating the *k* value corresponding to the participant's choice on the final trial. Residuals for AUC and *k* were non-normally distributed; group differences were therefore analyzed using Kruskal-Wallis tests (non-parametric, one-way ANOVA).

Results and Discussion

Three hundred and thirty-eight individuals completed the screening questionnaire. Of these individuals, 187 (55.3%) were deemed eligible to participate in the main survey and were randomized into EFT, EPT, and ERT groups. Excluding participants that were not located in the United States (n = 22) resulted in group sizes of n = 61 (EFT), n = 56 (EPT), and n = 48 (ERT).

Table 1 shows the demographic information from each of the groups. Only marital status differed significantly between the groups.

In general, and regardless of cue condition, condom use likelihood decreased as the delay to hypothetical condom access increased (Figure 1). Median likelihood values from all three groups were well-described by the two-parameter discounting model (top panel); R^2 values were 0.88 (EFT), 0.87 (EPT), and 0.94 (ERT). Median likelihood values from all three groups are also represented on the ordinal axis in the bottom panel of Figure 1 for ease of interpretation.

Median AUC values for the SDDT in the EFT, EPT, and ERT groups were 0.43 (interquartile range [IQR] = 0.07-0.82), 0.46 (IQR = 0.10-0.77), and 0.52 (IQR = 0.07-0.84), respectively (Figure 2; top panel). AUC did not differ significantly between the groups (p = 0.93). Median k values from the 5TADT for the EFT, EPT, and ERT groups were -0.01 (IQR = 0.004-0.06), 0.01 (IQR = 0.003-0.04), and 0.01 (IQR = 0.003-0.08), respectively (Figure 2; bottom panel). Discounting rate (k) did not differ significantly between the groups (p = 0.88).

A Kruskal-Wallis test was used to test the group differences for the EARS (Table 2), which also showed no significant difference between groups (p = 0.68). There were no significant differences between participants believing if they were in a control or an experimental condition (p = 0.70). There was no significant difference between event cue attending during cue generation (p = 0.34), during the SDDT (p = 0.12), or during the 5TADT (p = 0.35).

The present experiment sought to examine the effects of EFT on sexual delay discounting while also attempting to reproduce the effects of EFT on delay discounting of money as reported by Stein et al. (2018). In the SDDT, we failed to observe any significant positive effect of EFT. On the contrary, median AUC values were highest in the ERT group, which was opposite our prediction that median AUC values would be highest in the EFT group. In the 5TADT, we were

unable to reproduce the findings by Stein et al. (2018). Interestingly, median *k* values were nearly identical across the three groups and were not significantly different.

There were some noteworthy limitations that could have diminished the effect of EFT on our delay discounting measures. First, the SDDT picture selection took place before the cue generation; this task order may have contaminated the cue generation by increasing arousal and therefore blunting any benefit associated with EFT. Second, due to the within-subjects design of Experiment 1 and in an effort to reduce the likelihood of order effects, we counterbalanced the two tasks. Counterbalancing could have diminished the effect of EFT on the later task which, once averaged, could have weakened the effect compared to prior studies.

Due to these limitations, a second experiment was conducted using a between-subjects design more closely resembling the one used by Stein et al. (2018). In their study, Stein and colleagues also required that participants smoked at least 10 cigarettes a day; we therefore recruited individuals who met this smoking-related criterion. To address the potential limitation associated with SDDT picture selection, participants create their respective episodic cues before image selection (if they were assigned to complete the SDDT). We also eliminated the EPT group because previous research in episodic thinking shows no effect of episodic past thinking on decision-making compared to EFT (Lin & Epstein, 2014). The EPT group was added to the study design because it appeared that one possible reason for differences between ERT and EFT in prior studies could be the drastic differences between time frames selected for cue generation (e.g., 1 month in the future vs 1 hour in the past). If the time frames were responsible for the EFT effect, then we would have observed similarly elevated discounting in the EPT group; however, his was not the case. Therefore, in an effort to focus recruitment into traditionally studied EFT and ERT groups, we decided to eliminate this group from Experiment 2.

Experiment 2

Methods

Participants

Participants who had not participated in Experiment 1 were recruited via mTurk. Two identical but separate HITs were advertised as “Time and Decision-Making (Psychology Research Study)”. One HIT was linked to the SDDT, while the other linked to the 5TADT. Both HITs included a brief description of the study including participant compensation. All other recruitment procedures and ethical approvals were as in Experiment 1, except that participants were now compensated $1.00.

Materials

All materials were identical to those administered in Experiment 1, except for the delays in the SDDT. Specifically, rather than attempting to approximately match the cue-related time frames to the standard set of SDDT delays, we opted to use the exact time frame values from the EFT cue generation (1 day, 2 days, 6 days, 7 days, and 12 days) in the SDDT.

Procedure

Once participants accessed the main survey (Qualtrics, Inc.; Provo, UT), they were randomly assigned to either the EFT or ERT group and commenced immediately with episodic cue generation. Next, if participants were completing the SDDT HIT, they proceeded to partner image selection followed by the SDDT. If participants were completing the 5TADT HIT, they proceeded directly to the 5TADT. The EARS and post-task event cue salience questions were administered at the conclusion of each survey.

Data Analysis

Demographic characteristics, EARS, and post-task event cue salience questions were analyzed similarly to Experiment 1. A Mann-Whitney test (non-parametric independent samples t-test) was used to test for differences between EFT and ERT groups for both the SDDT and 5TADT.

Results and Discussion

Of the individuals that completed the screening questionnaire for the SDDT, 111 were eligible and participated in the survey. Excluding participants not located in the United States (n = 7), participants were randomized into either the EFT (n = 50) or the ERT (n = 54) group. Groups differed significantly by gender (p = 0.03); there were no differences due to ethnicity, age, marital status, and number of cigarettes smoked per day. Table 3 shows the demographic information by survey.

Of the individuals that completed the screening questionnaire for the 5TADT, 125 were eligible and participated in the survey. Excluding participants not located in the United States (n = 10), participants were randomized into either the EFT (n = 59) or the ERT (n = 56) group. There were no significant group differences in any demographic variable.

As in Experiment 1, regardless of condition, condom use likelihood decreased as the delay to the condom access increased (Figure 3). Median likelihood values from all three groups were well-described by the two-parameter discounting model (top panel); R^2 values were 0.86 (EFT) and 0.80 (ERT). Median likelihood values from the two groups are also represented on the ordinal axis in the bottom panel of Figure 3 for ease of interpretation.

Median AUC values for the SDDT in the EFT and ERT groups were 0.35 (IQR = 0.09-0.83) and 0.54 (IQR = 0.16-0.85), respectively (Figure 4; left panel). AUC did not differ significantly between the groups (p = 0.25). Median k values for the 5TADT for the EFT and

ERT groups were 0.01 (IQR = 0.003-0.19) and 0.02 (IQR = 0.01-0.19), respectively (Figure 4; right panel). Discounting rate (*k*) did not differ significantly between the groups ($p = 0.49$).

A Mann-Whitney test was used to test the group differences for the EARS (Table 4), which showed no significant difference between both groups for either the SDDT ($p = 0.36$) or 5TADT money tasks ($p = 0.29$). There were no significant differences between participants believing if they were in an experimental or a control condition in the SDDT ($p = 0.54$) or in the 5TADT ($p = 0.88$). Finally, there were no significant differences between ratings of event cue attending (p's = 0.23-0.83).

Experiment 2 sought to independently assess the effect of EFT on sexual decision-making in the SDDT and to once again reproduce the findings of Stein et al. (2018). As before, we failed to observe any significant effects of EFT on either delay discounting task. In the SDDT, the median AUC values were higher in the ERT group relative to the EFT group, although this difference was not significant. We also were not able to reproduce the effect of EFT on the 5TADT, the monetary delay discounting task used by Stein et al. (2018).

General Discussion

The present study sought to reproduce and extend research on the effects of episodic future thinking on delay discounting to sexual decision-making. In both experiments, we also attempted to reproduce the commonly observed effect of EFT on delay discounting of money. In Experiment 1, participants in all three groups appeared to discounting nearly identically in both the sexual delay discounting and monetary discounting tasks. Moreover, participant data showed nearly identical means and standard deviations for the EARS and ratings of event cue attending within the experiment. In Experiment 2, we sought to address some of the shortcomings of

Experiment 1. Despite our efforts, we once again failed to observe any significant differences between EFT and ERT groups in either discounting task.

One explanation for the lack of significant results in the sexual discounting could be due to participant arousal. Because the sexual discounting task relies on hypothetical sexual rewards, there may be an inherent issue where arousal of the participant may have affected the decisions being made. While arousal is advantageous when assessing sexual delay discounting, it may be problematic when attempting to improve sexual decision-making. Several of the participants, when given the opportunity to reply to an open-ended question of their opinions of the survey, inquired if they could contact their chosen partner (e.g., “Can I have that girl’s number? She’s cute.”). We attempted to reduce sexual arousal during cue generation by instructing the participants to refrain from using sexually explicit or sexual cues of any nature. However, arousal, which we unfortunately did not measure via self-report in the sexual discounting task, may have inadvertently interfered with any effect that EFT may have had on their subsequent decisions.

With respect to monetary discounting, one explanation for the nonsignificant findings of EFT could be the manner in which the episodic cues were matched to the corresponding delays in the monetary discounting task. Although delays for the EFT episodic cue generation task, for instance, are scaled on the order of days (e.g., 1-12 days), delays in the monetary discounting task range from as short as 1 hour to 25 years. In the design of both experiments, care was taken to approximately match the cue time to the monetary delay. However, discrepancies in these delays could have diminished the EFT effect. Interestingly, in a recently published article by O’Donnell, Hollis-Hansen, and Epstein (2018), researchers found that EFT significantly

decreased monetary delay discounting, regardless of whether the cue time frames matched monetary delays or not.

Though not significant between groups, there were some interesting findings from the sexual discounting task when participants were asked about an immediately available condom. In Experiment 1, the median likelihood of using that condom was 84. Similarly, when looking at Experiment 2, the median likelihood of using an immediately available condom was 84. These values suggest that condoms are unlikely to be used in all situations, even when one is immediately available. Thus, efforts to provide immediate access to condoms may not totally prevent STI transmission.

There were several limitations in both experiments. One limitation exclusive to Experiment 1 was that participants were counterbalanced as to whether they completed the sexual discounting or monetary discounting tasks first. Counterbalancing, although a common research design tactic, may have contaminated the results of Experiment 1. Specifically, participants who completed the SDDT first, which may have boosted arousal and subsequently interfered with the monetary discounting task. In contrast, participants who completed the 5TADT first would not have experienced the same increase in arousal. Moreover, as mentioned previously, several participants reported that they were in some form aroused by the partner images in Experiment 1. Arousal may have also confounded our results by priming participants to steeply discount delayed rewards, as has been shown in previous sexual delay discounting studies (Johnson et al., 2017).

Another limitation was that the data in the present study were entirely self-reported. The nature of the study topic may have had an impact on the results as well. Social desirability may have had an effect as well in that it might not be considered socially acceptable to not want to

use a condom for fear of judgement by a group (Rao et al., 2017; Liu et al., 2016). Despite this concern, online data collection was chosen for the present study in an effort to allow for participant anonymity.

These limitations notwithstanding, there is also the possibility that there may be no strong effect of EFT on delay discounting and more specifically sexual delay discounting. Multiple positive aspects can be taken from this research. Primarily, research in this area contributes positively to raise more empirical awareness of the public health threat of sexually transmitted infections. Even though these research findings do not demonstrate that thinking of the future, at least in the form of EFT, is able to improve sexual decision-making, it further underscores the need to investigate why individuals fail to use condoms during sexual intercourse. Future research investigating other interventions should examine the constellation of psychological factors that contribute to one's failure to use condoms in situations likely to encourage sexual risk behavior.

Ethics Statement

All procedures performed involving human participants were in accordance with ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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Figure Captions

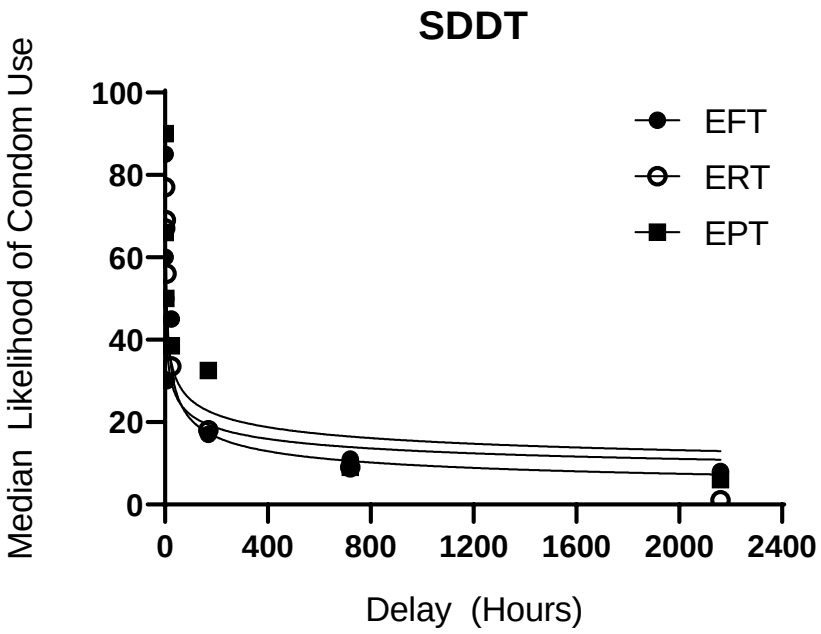
Figure 1. *Best-fitting curves from the two-parameter hyperbolic discounting equation to SDDT data from Experiment 1 (top panel). Data from the same sample are depicted ordinally (bottom panel).*

Figure 2. *Median AUC (left panel) and median k values (right panel) from Experiment 1. Error bars correspond to maximum and minimum values within each group.*

Figure 3. *Best-fitting curves from a two-parameter hyperbolic discounting equation to SDDT data from Experiment 2 (top panel). Data from the same sample are depicted ordinally (bottom panel).*

Figure 4. *Median AUC values (left panel) and median k values (right panel) from Experiment 2. Error bars correspond to maximum and minimum values within each group.*

Fig 1


SDDT
Median Likelihood of Condom Use
100
80
60
40
20
0
0
400
800
1200
1600
2000
2400
Delay (Hours)
EFT
ERT
EPT

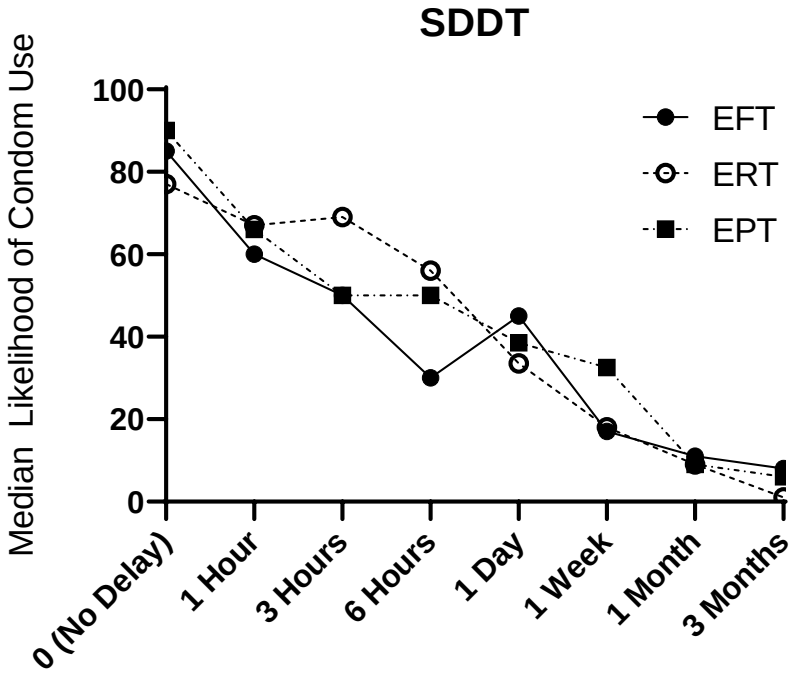

SDDT
Median Likelihood of Condom Use
100
80
60
40
20
0
0 (No Delay)
1 Hour
3 Hours
6 Hours
1 Day
1 Week
1 Month
3 Months
EFT
ERT
EPT

Fig 2

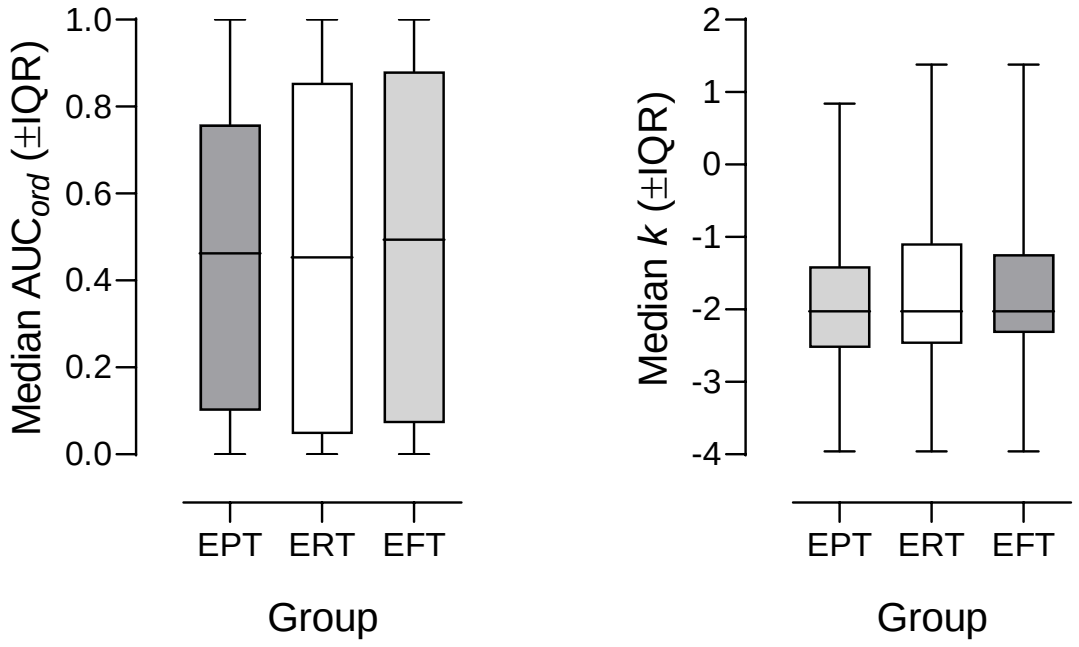
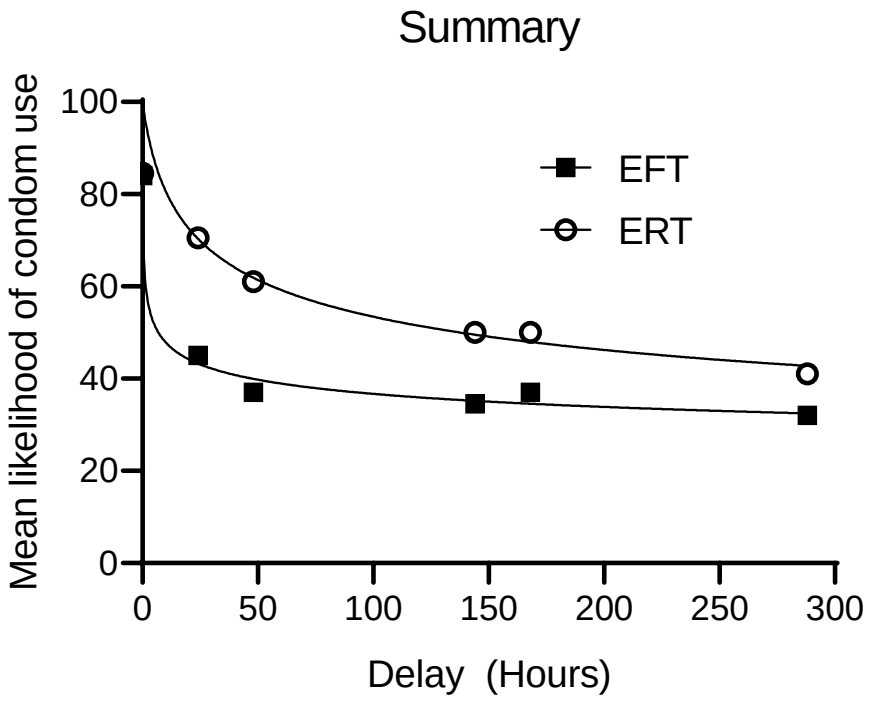

1.0
0.8
0.6
0.4
0.2
0.0
Median AUC$_{ord}$ (±IQR)
EPT
ERT
EFT
Group
2
1
0
-1
-2
-3
-4
Median k (±IQR)
EPT
ERT
EFT
Group

Fig 3


Summary
Mean likelihood of condom use
100
80
60
40
20
0
EFT
ERT
0
50
100
150
200
250
300
Delay (Hours)

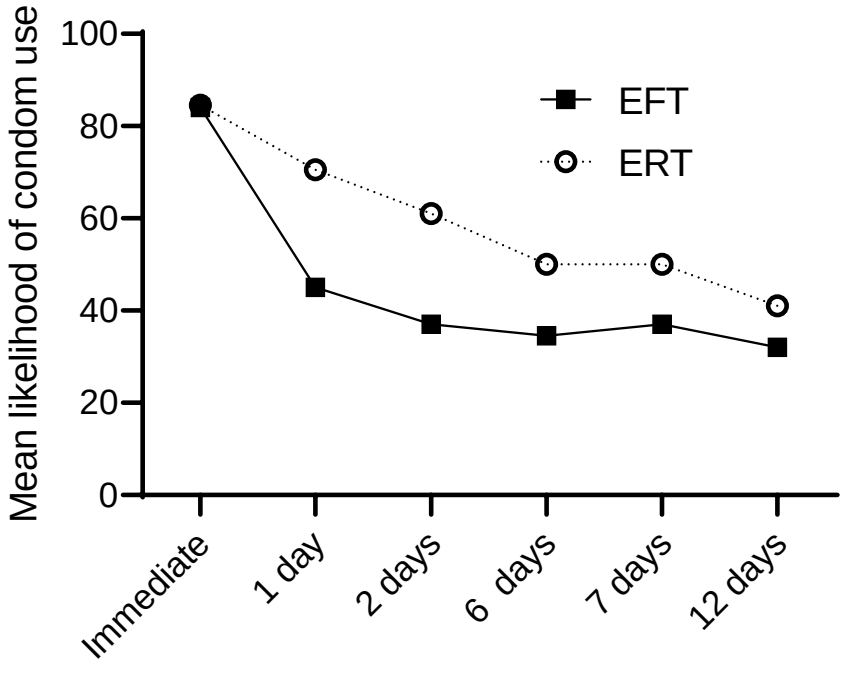

Mean likelihood of condom use
100
80
60
40
20
0
EFT
ERT
Immediate
1 day
2 days
6 days
7 days
12 days

Figure 4

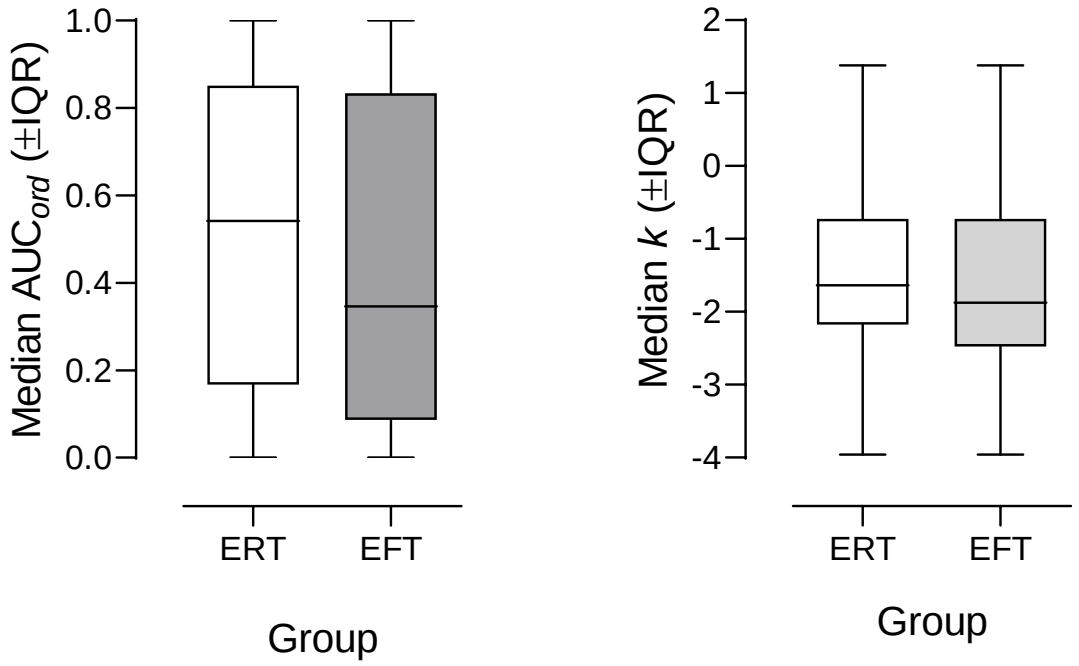

1.0
0.8
0.6
0.4
0.2
0.0
Median AUC$_{ord}$ (±IQR)
ERT
EFT
Group
2
1
0
-1
-2
-3
-4
Median k (±IQR)
ERT
EFT
Group

Table 1

Participant Demographic Information (Experiment 1)

Demographic characteristic	*EFT* (*n* = 61)	*ERT* (*n* = 48)	*EPT* (*n* =56)	*p* value
Age, Years [a]	35.33 (8.54)	34.5 (11.32)	32.43 (7.88)	0.06
Sex				0.29
Male	29 (47.54)	30 (62.50)	29 (51.79)	
Female	32 (52.46)	18 (37.50)	27 (48.21)	
Race				0.87
American Indian or Alaska Native	1 (1.64)	1 (2.08)	2 (3.57)	
Asian	5 (8.20)	2 (4.17)	5 (8.93)	
Black or African American	2 (3.28)	2 (4.17)	5 (8.93)	
White or Caucasian	50 (81.97)	40 (83.33)	41 (73.21)	
Hispanic, Latino/a/x or Spanish origin	3 (4.92)	3 (6.25)	3 (5.36)	
Highest Level of Education Obtained				0.96
High school graduate, diploma or equivalent (GED)	6 (10.71)	2 (4.65)	4 (7.55)	
Some college credit, no degree	10 (17.86)	7 (16.28)	11 (20.75)	
Trade/technical/vocational training	2 (3.57)	1 (2.33)	1 (1.89)	
Associate's degree	6 (10.71)	6 (13.95)	9 (16.98)	
Bachelor's degree	32 (57.14)	27 (62.79)	28 (52.83)	
Master's degree	4 (7.14)	4 (9.30)	3 (5.66)	
Professional/doctorate degree	1 (1.79)	1 (2.33)	0 (0.00)	
Marital Status				0.04*
Single, never married	29 (47.54)	28 (48.28)	27 (48.21)	
Married or domestic partner	30 (49.18)	23 (39.66)	29 (51.79)	
Widowed	0 (0.00)	1 (1.72)	0 (0.00)	
Divorced	1 (1.64)	6 (10.34)	0 (0.00)	
Separated	1 (1.64)	0 (0.00)	0 (0.00)	

[a] Mean (standard deviation); all other data are count (percentage)

*Denotes significance at $p < 0.05$

Table 2

Cue salience ratings and EARS scores (Experiment 1)

Measure	EFT	ERT	EPT	*p* value
Cue generation	84.16 (23.23)	82.13 (23.99)	74.82 (28.83)	0.34
SDDT	77.84 (31.72)	69.54 (32.62)	73.32 (28.96	0.12
5TADT	74.89 (31.69)	67.35 (33.55)	74.43 (28.90)	0.35
EARS	45.74 (12.86)	44.81 (11.06)	45.77 (12.59)	0.68

Note: Values are means. Parenthetical values are standard deviations of the mean

Table 3

Participant Demographic Information (Experiment 2)

Demographic characteristic	SDDT			5TADT		
	EFT (n =50)	ERT (n = 54)	p value	EFT (n = 59)	ERT (n = 56)	p value
Age, Years [a]	32.18 (8.29)	35.69 (10.26)	0.06	36.74 (10.22)	33.46 (8.76)	0.07
Sex			0.03*			0.84
Male	28 (56.00)	30 (55.56)		31 (53.45)	31 (55.36)	
Female	22 (44.00)	24 (44.44)		27 (46.55)	25 (44.64)	
Race			0.25			0.83
American Indian or Alaska Native	1 (2.00)	6 (11.11)		2 (3.45)	1 (1.79)	
Asian	2 (4.00)	2 (4.17)		3 (5.36)	3 (5.45)	
Black or African American	3 (6.00)	3 (6.38)		3 (5.66)	6 (11.54)	
White or Caucasian	43 (86.00)	39 (84.78)		46 (77.97)	42 (80.77)	
Hispanic, Latino/a/x or Spanish origin	1 (2.00)	4 (22.22)		4 (19.05)	4 (18.18)	
Highest Level of Education Obtained			0.55			0.86
High school graduate, diploma or equivalent	0 (0.00)	1 (1.89)		0 (0.00)	0 (0.00)	
Some college credit, no degree	5 (10.00)	2 (3.77)		9 (15.52)	6 (10.71)	
Trade/technical/vocational training	8 (16.00)	11 (20.75)		8 (13.79)	12 (21.43)	
Associate's degree	2 (4.00)	0 (0.00)		1 (1.72)	1 (1.79)	
Bachelor's degree	5 (10.00)	6 (11.32)		6 (10.34)	5 (8.93)	
Master's degree	21 (42.00)	22 (41.51)		22 (37.93)	23 (41.07)	
Professional/doctorate degree	6 (12.00)	10 (18.87)		12 (20.69)	9 (16.07)	
Marital Status			0.74			0.56
Single, never married	18 (36.00)	18 (33.33)		17 (29.31)	19 (33.93)	
Married or domestic partner	28 (56.00)	33 (61.11)		33 (56.90)	33 (58.93)	
Widowed	1 (2.00)	0 (0.00)		0 (0.00)	0 (0.00)	
Divorced	3 (6.00)	3 (5.56)		6 (10.34)	2 (3.57)	
Separated	0	0		2 (3.45)	2 (3.57)	

[a] Mean (standard deviation); all other data are count (percentage)

Table 4

Cue salience ratings and EARS scores (Experiment 2)

	SDDT			5TADT		
Measure	EFT	ERT	*p* value	EFT	ERT	*p* value
Cue generation	77.62 (27.91)	74.61 (28.21)	0.39	75.90 (25.48)	78.86 (20.61)	0.83
SDDT	75.59 (30.95)	68.70 (31.79)	0.26			
5TADT				76.33 (25.83)	73.15 (26.52)	0.38
EARS	46.62 (16.48)	46.48 (12.35)	0.35	46.44 (10.85)	48.50 (10.09)	0.29

Note: Values are means. Parenthetical values are standard deviations of the mean