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Do genetic and individual risk factors moderate the efficacy of motivational enhancement therapy? Drinking outcomes with an emerging adult sample

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Abstract

Research indicates that motivational enhancement therapy (MET) helps catalyze reductions in problem drinking among emerging adults. However, moderators of this intervention remain relatively unknown. Therefore, the objectives of this study were: (1) to test whether a single session of MET increased motivation to reduce drinking and drinking outcomes; and (2) to examine whether genetic dopamine D₄ receptor L (*DRD4 L*) and individual personality risk factors (impulsivity and novelty seeking) moderated the effects of the MET. These hypotheses were evaluated by randomly assigning a sample of emerging adult problem drinkers ($n = 67$) to receive a single session of MET or alcohol education. Follow-up data indicated that only individuals who were low in impulsivity, novelty seeking and/or who had the short *DRD4* variable number of tandem repeats genotype evidenced differentially increased behavior change (taking steps toward reducing drinking) following the MET.

Keywords

Alcohol; emerging adults; genetics; impulsivity; motivation enhancement therapy; novelty seeking

INTRODUCTION

Many emerging adults increase their alcohol use during their college years (O'Malley & Johnston 2002). Specifically, studies throughout the past five decades have consistently found that approximately 40–47% of college students engage in binge drinking (O'Malley & Johnston 2002; Schulenberg & Maggs 2002; Chen, Dufour & Yi 2004–2005). This is concerning, as binge drinking has been significantly associated with an increase in accidents and injuries among this age group (Hingson *et al.* 2005). Many of these accidents and injuries stem from 'dumb drinking', single occasions of excessive consumption that lead to poor choices resulting in sadly irrevocable outcomes, such as those that result from drinking and driving or alcohol-related sexual risk behaviors (Miller & Munoz 2005).

Within the last decade, the cost-effectiveness, transportability and flexibility of motivational enhancement therapy (MET; Miller *et al.* 1999) has resulted in its surging popularity across adolescent and emerging adult settings (e.g. Stewart *et al.* 2005; Baer *et al.* 2007). Although details of this intervention vary between sites and studies (Burke, Arkowitz & Menchola 2003), MET interventions for problem drinking consistently incorporate both the

fundamental motivational interviewing (MI) principles (Miller & Rollnick 2002), including rolling with resistance, accurate empathy, developing discrepancy, supporting self-efficacy as well as the provision of personalized feedback about drinking behaviors (Baer *et al.* 1992, 2001; Marlatt *et al.* 1998; Monti *et al.* 1999, 2007; Borsari & Carey 2000, 2005). When examining the efficacy of MET interventions in reducing late adolescent and emerging adult alcohol use, MET has gained support for catalyzing sustained, significant reductions in quantity of drinking (Baer *et al.* 1992; Borsari & Carey 2000; Monti *et al.* 2007), frequency of drinking (Borsari & Carey 2000; Monti *et al.* 2007), frequency of heavy drinking (Borsari & Carey 2000; Monti *et al.* 2007), alcohol-related problems (Marlatt *et al.* 1998; Borsari & Carey 2005), negative alcohol-related consequences (Baer *et al.* 2001), risk behaviors (Monti *et al.* 1999) and alcohol dependence (Marlatt *et al.* 1998) in follow-ups spanning from 6 weeks to 4 years.

Despite these robust results, research is needed to investigate the variables that may moderate the effectiveness of MET, particularly with high-risk drinking groups such as emerging adults. Recent research has started to support the clear role of genetic polymorphisms in biological, personality and behavioral phenotypes related to the progression of alcohol dependence. One promising genetic polymorphism is the dopamine D₄ receptor (*DRD4*). Located in exon III, this gene has a 48-base pair (bp) variable number of tandem repeats (*DRD4* VNTR). Three common variants (D4.2, D4.4 and D4.7) indicate the length of the VNTR, which has been found to have functional effects on the receptor, with lower response to dopamine corresponding with the longest (D4.7) variant (for a review, see Ray *et al.* 2009). As some of the key brain regions involved with alcohol dependence include the mesocorticolimbic dopamine pathway (e.g. Kalivas & Volkow 2005), this dopamine receptor is likely to play a critical role in the development and expression of incentive salience, meaning this receptor may modulate the strength and perception of alcohol, subsequently affecting the experience of craving (e.g. Hutchison *et al.* 2006).

In terms of previous studies, recent research has found that with adults, the *DRD4* VNTR polymorphism has been linked to alcohol use disorders, novelty seeking and impulsivity (Benjamin *et al.* 1996; Ebstein *et al.* 1996; Noble *et al.* 1998; Hutchison *et al.* 2006; Eisenberg *et al.* 2007; MacKillop *et al.* 2007; Congdon, Lesch & Canli 2008; Ray *et al.* 2009). However, the relationship between *DRD4* and alcohol use disorders appears to be developmentally sensitive. Specifically, evidence for the role of *DRD4* in alcohol abuse symptomatology (i.e. frequency of drinking) has been less robust with adolescents and emerging adults, with several studies finding no relationship (Hopfer *et al.* 2005; Guo, Wilhelmsen & Hamilton 2007; McGeary *et al.* 2007) and other studies only finding support for this relationship among adolescent males (Skowronek *et al.* 2006; Laucht *et al.* 2007).

In addition to the important relationship between genetic variables and the development of alcohol dependence, the association between genetic factors and individual personality risk factors is also quite salient, as studies have repeatedly demonstrated that impulsivity and novelty seeking can lead to excessive alcohol consumption levels, alcohol-related problems and consequences (e.g. Lukasiewicz *et al.* 2008; Verdejo-Garcia, Lawrence & Clark 2008; Vermont *et al.* 2008). Moreover, Although some adult studies have found that personality factors may not predict who best responds to which type of behavioral treatment (Project MATCH Research Group 1997, 1998), this relationship may also vary by developmental level, as adolescent studies have found preliminary evidence that impulsivity affects the efficacy of MET (e.g. Helstrom, Hutchison & Bryan 2007).

Recent studies have also indicated that genetic factors may influence treatment response. This is an area of rapidly growing interest, with several studies finding that genetic factors

may moderate the effectiveness of both pharmacological and behavioral interventions, including MET (Hutchison *et al.* 2006, 2008; Bauer *et al.* 2007; Anton *et al.* 2008). Within the MET/pharmacological studies (Hutchison *et al.* 2006, 2008), two different genetic variants (e.g. CNR1, *DRD4*) have predicted who responded to MET combined with either placebo or pharmacotherapy. Notably, as examined in Hutchison *et al.*'s (2006) study, individuals with the genetic risk factors reduced their drinking only after receiving the active medication. However, individuals 'without' the genetic risk factors demonstrated reduction in the MET/placebo condition. Although preliminary, these findings suggest the integral role of genetic risk in predicting who responds to MET or other psychosocial interventions. Understanding the genetic and individual risk factors that may moderate the effectiveness of MET is an important step toward improving the efficacy of alcohol interventions for emerging adults; it may help identify who may respond to psychosocial interventions, and who may need different, perhaps more pharmacologically based, approaches to initiate and sustain reductions in alcohol use.

The objective of the present study was to examine the effects of an empirically validated alcohol intervention, MET, with the high-risk drinking group of emerging adults. The *a priori* aims were: (1) to determine the effect of a MET on emerging adults motivation to change their drinking behaviors and their drinking outcomes; and (2) to examine potential moderators of the efficacy of the MET, specifically evaluating the role of genetic (*DRD4*) and individual risk factors (impulsivity and novelty seeking). It was hypothesized that the MET, compared with an alcohol education (AE) control condition, would increase motivation to change drinking behaviors and drinking reductions 30 days post-intervention. It was further hypothesized that the *DRD4* VNTR and the individual personality risk factors of impulsivity and novelty seeking would moderate the effectiveness of the MET.

MATERIALS AND METHODS

Participants

This study was conducted with approval from the participating university's Institutional Review Board. Potential participants were recruited via fliers that invited interested students to participate in an 'Alcohol Study'. Inclusion criteria included self-reported moderate to heavy drinking, as defined by drinking twice per week with a minimum of four to five drinks per drinking occasion (women, men, respectively).

Seventy-five emerging adults (*M* age = 21 years; 68% male, 87% Caucasian) participated in this study. Each was paid \$150 for their participation. Participants were randomly assigned to receive either a single 45-minute session of a MET or an AE control condition. Notably, because of practical constraints (e.g. the need to randomize before genotyping could occur), individuals were randomized to condition prior to genotyping. Eight participants did not complete the study, resulting in a final sample of 67 participants.

Measures

Demographic data are shown in Table 1 for the MET and AE groups, along with personality and drinking data. In addition to demographics, there were three classes of variables assessed: motivation to change, personality and alcohol history, and outcome measures.

Motivation—The *Contemplation Ladder* (Biener & Abrams 1991) was adapted for use with alcohol and was used to assess the level of motivation to change drinking behaviors prior to the intervention and assess the level of motivation 30 days after the intervention. The Ladder is a single-item, continuous measure of motivation to change with good reliability and validity (Biener & Abrams 1991). Baseline motivation to change drinking

behavior, as determined by this measure, served as a covariate in analyses of intervention effects to statistically control baseline motivation across treatment groups.

Moderators—Levels of all moderating variables were assessed at baseline.

The Novelty-Seeking (NS) subscale of the Tridimensional Personality Questionnaire (Cloninger 1987) was utilized as a putative moderator of intervention effectiveness. NS is described as the tendency to be excitable, exploratory, enthusiastic and impulsive. Reliability in the sample was adequate (coefficient alpha $\alpha = 0.75$).

Individuals high in the Impulsivity/Sensation-seeking Scale (IMPSS; Zuckerman & Kuhlman 2000) have been found to have the tendency to take risks for novel, varied and intense experiences (e.g. Zuckerman 1994). Reliability in this sample was adequate ($\alpha = 0.80$).

The Rutgers Alcohol Problem Index (RAPI; White & Labouvie 1989) was used to assess alcohol-related problems. The RAPI uses 23 items to investigate the impact of alcohol on social and health functioning. This scale has reported high reliability and validity in previous studies (Jessor *et al.* 1995). Reliability of this measure was high for this sample ($\alpha = 0.88$).

Genotyping—Genomic DNA was isolated from buccal cells using published procedures (Lench, Stanier & Williamson 1988; Freeman *et al.* 1997), and the average yield of DNA was $40 \pm 2 \mu\text{g}$. The 48 bp VNTR in the third exon of the *DRD4* receptor polymorphism was assayed using previously reported methods (Sander *et al.* 1997). The primer sequences were forward, 5'-AGGACCCTCATGGCCTTG-3' (fluorescently labeled), and reverse, 5'-GCGACTACGTGG TCTACTCG-3' (Lichter *et al.* 1993). Consistent with previous reports (Lerman *et al.* 1998), participants who carried at least one copy of a seven-repeat or longer allele were classified as *DRD4 L*, although participants with alleles of fewer than seven-repeats were classified as *DRD4 S*; similar to frequencies found in other studies (e.g. Hutchison *et al.* 2006), 42% of sample was classified as *DRD4 L* and 58% was classified as *DRD4 S* (see Table 2). The majority of subjects are typically genotyped two times. Any disparities that emerged were resolved with a third genotyping.

Changes in drinking behavior—Four outcome measures were used to assess changes in drinking behavior at the 30-day follow-up.

The first three were alcohol consumption items derived from the Timeline Follow Back (Sobell & Sobell 1992): the average number of drinks during each drinking occasion (calculated as total drinks/total drinking days), the total number of drinking days and the total number of heavy drinking days.

The fourth measure was the Taking Steps (TS) subscale of the Stages of Change Readiness and Treatment Eagerness Scale (SOCRATES; Miller & Tonigan 1996). Of the three scales of the SOCRATES [i.e. contemplation, readiness for change and taking steps (TS) in changing drinking behavior], TS is the only one that assesses whether or not an individual has engaged in behaviors designed to reduce drinking. The abbreviated version of the TS scale has eight items with response options on a 5-point Likert scale ranging from 1 = 'Strongly Disagree' to 5 = 'Strongly Agree', and has been shown to have good reliability and validity (Isenhart 1994). Reliability of the TS measure in this sample was high ($\alpha = 0.93$). Items in this scale include the following (Miller & Tonigan 1996, p. 85):

1. I have already started making some changes in my drinking.
2. I was drinking too much at one time, but I've managed to change my drinking.

3. I'm not just thinking about changing my drinking, I'm already doing something about it.
4. I have already changed my drinking, and I am looking for ways to keep from slipping back to my old pattern.
5. I am actively doing things now to cut down or stop drinking.
6. I want help to keep from going back to the drinking problems that I had before.
7. I am working hard to change my drinking.
8. I have made some changes in my drinking, and I want some help to keep from going back to the way I used to drink.

Procedures

Screening—Participants contacted the study coordinator from advertisements to participate in an 'Alcohol Study posted on college campus bulletin boards. A comprehensive phone screen provided study procedures, and included general health questions, consumption rates and the alcohol use disorders identification test (AUDIT; Babor *et al.* 2006) screen, to see if participants appeared to meet inclusion criterion. If participants appeared eligible and interested, they were scheduled for the baseline appointment.

Baseline—All participants completed the informed consent procedures and an assessment battery of paper and pencil measures, as well as DNA collection procedures.

Intervention—Upon completion of baseline measures, participants were randomly assigned to receive either a 45-minute, individually delivered MET or an AE control condition. Interventionists included a clinical psychologist of doctoral level and therapist of master's level. Interviewers were trained using a manual, live-observation and ongoing supervision (provided by the fourth author).

Control: AE—Currently, the standard treatment for college students seeking (or mandated to) alcohol treatment is AE (Barnett & Read 2005). Similar to many other studies of alcohol interventions with college youth (e.g. Barnett *et al.* 2007; Lau-Barraco & Dunn 2008), we therefore selected a comparison condition which would provide the most accurate comparison between what youth would be most likely to receive in the real-world (AE). During the AE session, the interviewer provided participants with information and handouts on the social, behavioral and biological effects of alcohol abuse. This included information on campus and state drinking policies, physical effects of alcohol (stimulant/depressant), blood alcohol concentration information and long-term risks of alcohol abuse. The interviewer did not elicit individualized information from participants, nor utilized open-ended questioning. However, the interviewer did answer the participants direct questions about alcohol abuse.

MET—The MET condition followed the fundamental principles of MI and the procedures outlined in the MET manual (Miller *et al.* 1999). The MET session consisted of a 45-minute session, focused on participants ambivalence around their drinking behaviors. Personalized feedback regarding drinking behaviors and related risk factors (i.e. family history of drinking, current drinking rates) was provided in the form of an individualized feedback report based on their responses to baseline measures and as compared with national averages. MET providers were trained to utilize reflections, accurate empathy and open questions to explore ambivalence, to elicit and support change talk, and to assist participants in developing behavioral strategies to reduce their drinking and related negative

consequences. At the end of the MET session, all participants in this condition were provided with the same informational handouts as those in the AE session.

Follow-up—Participants completed an immediate post-intervention 11-item manipulation check of the intervention. A follow-up assessment battery was given 30 days after the conditions, to assess changes in motivation to reduce drinking and drinking outcomes.

RESULTS

Pretest differences

Pretest differences were assessed on demographic variables, putative moderators of intervention effectiveness and baseline behavior. There were no pretest differences between the MET and AE participants on demographic variables of gender and culture (Table 1). There was a significant difference in age such that the MET participants were slightly older than the AE participants. However, all analyses reported herein were conducted again with age as a covariate, and all results remained the same. There were no differences between the MET and AE participants on the measure of alcohol problems (RAPI), NS, IMPSS or on the presence of the short or long DRD4 polymorphism. Finally, although there were no differences in the quantity and frequency of alcohol consumption variables, the two groups were significantly different on the TS variable, such that the MET participants reported having taken more steps to reduce their drinking. Given these differences, baseline TS was controlled for in every analysis.

Effects on 30-day follow-up motivation

An analysis of covariance (ANCOVA) was conducted to test for differences in the 30-day follow-up motivation as measured by the Contemplation Ladder. Intervention condition was the independent variable, and baseline Ladder scores and TS served as covariates. There were significant intervention effects, $F(1,60) = 5.62$, $P < 0.05$. The pattern of the adjusted means (i.e. controlling for baseline motivation) showed that the MET participants had higher motivation, $M_{adj} = 5.97$ [standard error of the mean (SE) = 0.50] than AE participants, $M_{adj} = 4.18$ (SE = 0.55) at follow-up. There was no moderation of these effects by NS, RAPI or the DRD4 VNTR polymorphism. However, there was a significant intervention $\times$ IMPSS interaction, $F(1,58) = 4.18$, $P = 0.05$. Controlling for pretest motivation, the pattern suggests that the highest motivation to change was exhibited by low IMPSS participants in the MET condition, $M_{adj} = 6.06$, and the lowest motivation to change was exhibited by low IMPSS participants in the AE condition, $M_{adj} = 3.01$, as anticipated. Levels of motivation among those high on IMPSS did not differ between condition however: MET – $M_{adj} = 5.89$, AE – $M_{adj} = 5.80$. *Post hoc* pair-wise comparisons on the adjusted means confirmed that low IMPSS participants in the AE intervention had significantly lower motivation to change than all three other groups (P -values for comparisons ranged from 0.001 to 0.009), but those three other groups did not significantly differ from one another.

Effects on 30-day follow-up drinking behavior

The ANCOVAs on the drinking measures (average drinks per drinking day, total number of drinking days and total number of heavy drinking days), controlling for baseline values and baseline TS, showed changes in the expected direction, though none were statistically significant. Those in the MET condition decreased their average number of drinks per drinking day from 5.38 to 5.04, as compared with AE participants who went from 5.45 to 5.15 average drinks per session, $F(1,60) < 1$, not significant (ns). Similarly, the MET participants decreased their drinking days slightly from 11.71 to 11.50 over a 1-month follow-up, although AE participants also decreased slightly from 11.07 to 10.99 days, $F(1,60) < 1$, ns. Participants in the MET condition decreased their largest number of heavy

drinking days from 8.36 drinks to 7.43 drinks, as compared with 7.80 drinks to 6.99 drinks in the AE condition, $F(1,60) < 1$, ns.

An ANCOVA on the Taking Steps to Reduce Drinking measure (TS), controlling for baseline TS and for baseline motivation, showed a marginal main effect of the intervention [$F(1,59) = 3.70$, $P = 0.06$], such that controlling for baseline TS, those in the MET condition were more likely to rate themselves as having taken action to reduce their drinking and had a desire not to 'go back' to previous drinking patterns. As this measure seemed to show the largest response to the intervention, we chose to examine moderation of drinking reductions in the context of the TS measure.

Moderation of effects on drinking reductions

The next step in our analysis was to test our putative moderators of intervention effects on behavior change (taking steps to reduce drinking; TS). In each of the following analyses, the main effect of the moderator (median split for continuous moderators) and the intervention $\times$ moderator interaction were included in the ANCOVA on the TS measure, controlling for baseline TS and for baseline motivation.

DRD4 genotype—The intervention $\times$ *DRD4* interaction was significant, $F(1,57) = 6.44$, $P = 0.01$. As can be seen in Fig. 1, *DRD4 S* individuals responded more favorably to the MET condition, although *DRD4 L* individuals actually responded slightly more favorably to the AE condition. *Post hoc* pair-wise comparisons between conditions at posttest (controlling for baseline TS) confirmed that *DRD4 S* participants in the MET condition had taken more steps toward changing their drinking than *DRD4 L* individuals in the MET condition ($P = 0.001$). None of the other comparisons were significant.

Impulsivity (IMPSS)—The intervention $\times$ IMPSS interaction was significant, $F(1,57) = 8.22$, $P < 0.01$. As can be seen in Fig. 2a, in the AE condition there was no change from pretest to posttest among low IMPSS participants, although those in the MET condition increased behavior change. In contrast (see Fig. 2b), high IMPSS participants actually increased behavior change in the direction of reductions in drinking in the AE condition, but did not show any noticeable change in the MET condition. *Post hoc* pair-wise comparisons between conditions at posttest (controlling for base-line TS) confirmed that low IMPSS participants in the MET condition had taken more steps toward changing their drinking than any other group (P -values for comparisons ranged from 0.04 to 0.001), but that the three other groups did not significantly differ from one another. In other words, high impulsivity participants—regardless of intervention—and low impulsivity participants in the AE control had all taken fewer steps to change their drinking.

Novelty seeking (NS)—The intervention $\times$ NS interaction was significant, $F(1,57) = 4.01$, $P = 0.05$. The pattern of means was identical to the effects for IMPSS, such that high NS participants responded positively to the AE condition and not to the MET, although low NS participants responded to the MET but not the AE condition [1].

[1] Please note that no significant correlation emerged between the *DRD4* VNTR and impulsivity ($r = 0.10$, $P = 0.42$) and between the *DRD4* VNTR and novelty-seeking ($r = 0.01$, $P = 0.96$). However, unsurprisingly, there was a substantial correlation between impulsivity and novelty-seeking ($r = 0.54$, $P < 0.001$). Because of multi-collinearity, both variables could not be included in one model. We therefore ran two models, one with impulsivity as a covariate in addition to gender and race, and one with novelty-seeking as a covariate in addition to gender and race. As 86% of our sample was Caucasian, to include race as a covariate, we had to re-categorize race as Caucasian versus non-Caucasian. In the

analysis including impulsivity, race, and gender as covariates, the gene $\times$ treatment interaction was still significant, $F(1,54) = 7.09$, $P = 0.01$. In the analysis including novelty-seeking, race, and gender as covariates, the gene $\times$ treatment interaction was also still significant, $F(1,54) = 7.66$, $P < 0.01$. Notably, inclusion of these covariates did not alter the presented findings.

Manipulation checks

Immediately following the intervention, participants were asked for their feedback on the intervention. There were two classes of manipulation checks in this feedback section. As accurate empathy is one of the main tenets of MET, one set of four questions measured the participant's evaluation of the interventionist's empathy (e.g. 'The person I spoke with today was easy to talk to'), rated on five-point scales ranging from 1 'Strongly Disagree' to 5 'Strongly Agree'. The evaluation score was the mean of the four items comprising this measure. Participants in the MET condition perceived the interventionist to be significantly more empathic [$M = 4.50$, standard deviation (SD) = 0.81] than participants did in the AE condition [$M = 3.69$, SD = 0.88, $t(62) = -3.82$, $P < 0.001$]. The second class of manipulation checks involved assessing whether participants perceived the presence of the MET components. Participants were given seven components of the MET (e.g. receiving a personal feedback report, developing goals to make some changes), and were asked to answer the question 'How useful was each of the following topics' on a 0–5 scale, where 0 = 'topic was not introduced', 1 = topic was 'not useful' and 5 = topic was 'very useful', for each of the seven components. Because we were interested in whether the components had been introduced and noticed during the MET compared with the AE condition, answers were re-coded such that 0 = 'not introduced' and answers ranging from 1 to 5 = 'introduced'. The dependent variable was thus the number of the MET components noticed by the participants. As expected, the MET participants reported that a significantly higher number of the MET components were introduced ($M = 6.51$, SD = 0.80) than AE participants ($M = 2.33$, SD = 2.04), $t(62) = -11.35$, $P < 0.001$.

DISCUSSION

This study is one of the first investigations of genetic and individual risk moderators of MET with an emerging adult sample. Notably, although the MET sample had slightly larger decreases in the number of heavy drinking days, drinking outcomes were not significantly different between the MET and the AE control condition. Despite similar drinking outcomes, the MET group reported themselves as being significantly more likely than the AE group to have taken action to reduce their drinking (TS). This differential movement on the TS variable is notable, as a strong clinical predictor of sustained abstinence is the endorsement of actions to reduce drinking (e.g. Carbonari & DiClemente 2000).

With respect to the investigated moderators, the proposed genetic and individual risk factors indicated that, although the MET increased behavior change during the first 30 days after the intervention, these effects were stronger among individuals who were low in impulsivity/sensation seeking, low in novelty seeking, or had the S genotype of the *DRD4* VNTR polymorphism. The MET was not effective in influencing behavior change to reduce drinking among individuals who were high on impulsivity/sensation seeking, high on novelty seeking or for *DRD4* L individuals.

In order to maximize the effectiveness of MET, it is critical to understand who is most likely to benefit from this intervention. In the present study, the MET only resulted in drinking reductions among emerging adults who demonstrated lower impulsivity, lower novelty seeking or had the *DRD4* S genotype. High impulsivity and novelty seeking have previously been related to more severe, chronic levels of alcohol problems and it is therefore not

surprising that these traits were associated with a poor response to the MET in the current study. In addition, the *DRD4* L genotype has been associated with higher craving for alcohol after exposure to alcohol cues and appears to predict the effectiveness of medications that target mesocorticolimbic circuits (Hutchison *et al.* 2002, 2003, 2006). The present findings are also consistent with data suggesting that MET combined with placebo effectively reduces alcohol consumption in treatment-seeking adults with the S genotype (Hutchison *et al.* 2006). Thus, together, these factors may represent a neurobiological vulnerability that predicts a poor response to a psychosocial intervention like MET. The clinical implication of these findings is that emerging adults, who demonstrate a personality or genetic profile associated with a more chronic, potentially biologically-driven drinking pattern, may require a more pharmacologically focused intervention in order to effectively initiate and sustain drinking reductions. Although many challenges are likely to come along with using genetic factors in tailoring substance abuse treatment (Shields & Lerman 2008), this study provides important data indicating that emerging adults with specific genetic and individual personality risk factors respond better to one type of intervention over another.

Limitations

The objective of this investigation was to determine the effects of a MET on the motivation to reduce drinking and drinking outcomes in an emerging adult sample. Notably, this was a relatively homogenous, college-attending sample, and additional research is necessary to support these findings across a more diverse demographic. Moreover, the current sample size may have underpowered our genetic analyses; replication with a larger sample size would provide greater support for our findings. In addition, although reductions in quantity and frequency of drinking were in the expected direction at the 1-month follow-up, these changes were not significantly different from those of the AE control sample. Obviously, future research utilizing larger samples and longer follow-ups is necessary to replicate and extend our preliminary results.

Summary and future directions

The current work provides support for the notion that MET increases the motivation to change risky drinking behavior in an emerging adult sample. Further, we have shown that, for at least a subset of individuals, these changes in motivation appear to be translated into drinking reductions. From a larger perspective, the current work demonstrates the importance of tailoring treatment to genetic and individual personality risk factors. Although these findings arguably make designing broadly successful interventions more difficult, the more sophisticated our knowledge of individual differences in response to treatment becomes, the more likely our chances of success at developing effective treatments for the widest range of at-risk individuals.

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Figure 1. Intervention effects by DRD4 VNTR genotype in the alcohol education (AE) control and motivational enhancement therapy (MET) conditions. (a) DRD4 S individuals. (b) DRD4 L individuals

Figure 2. Intervention effects by level of impulsivity/sensation-seeking in the alcohol education (AE) control and motivational enhancement therapy (MET) conditions. (a) Low impulsivity/sensation seeking. (b) High impulsivity/sensation seeking

Table 1

Pretest differences in motivational enhancement therapy (MET) versus alcohol education (AE) participants.

Variable ^a	MET(n = 38)	AE (n = 29)	Test for difference
Gender (% male)	67.57%	68.97%	$\chi^2(1) < 1$, ns
Age	22.09 (2.54)	21.24(1.01)	$t(59) = -2.66$, $P = 0.01$
Culture (% Caucasian)	81.08%	93.10%	$\chi^2(1) = 1.99$, ns
Alcohol problems (RAPI)	21.76(13.58)	22.50(18.09)	$t(64) < 1$, ns
Novelty seeking	19.84(4.81)	17.72 (5.82)	$t(65) = -1.63$, ns
Impulsivity/Sensation seeking	10.21 (3.76)	9.24 (4.15)	$t(65) < 1$, ns
<i>DRD4</i> L genotype (% with version)	34.21%	51.72%	$\chi^2(1) = 2.07$, ns
Number of drinking days past 30 days	11.40(5.28)	11.28(3.47)	$t(65) < 1$, ns
Average number of drinks per session past 30 days	5.26 (2.01)	5.39 (2.50)	$t(65) < 1$, ns
Number of heavy drinking days past 30 days	8.08 (4.15)	7.86 (3.35)	$t(65) < 1$, ns
Taking steps to reduce drinking	2.23 (1.11)	1.70 0.93	$t(65) = -2.02$, $P = 0.05$

^a Standard deviations appear in parentheses next to the means; *DRD4* L = *DRD4* long alleles; ns = not significant.

Table 2

Evaluation of differences of genetic variables by demographics.

Variable	DRD4 L (n = 28)	DRD4 S (n = 38)	Test for difference
Gender (% male)	57.14%	73.68%	$\chi^2(1) = 1.98$, $P = 0.15$
Culture (% Caucasian)	78.57%	92.11%	$\chi^2(1) = 2.51$, $P = 0.11$

DRD4 L = DRD4 long alleles; DRD4 S = DRD4 short alleles.s