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Authors

Schuckit, Marc A
Smith, Tom L

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Full length article

Mediation of effects of the level of response to alcohol and impulsivity 15 years later in 36-year-old men: Implications for prevention efforts

Marc A. Schuckit*, Tom L. Smith

Department of Psychiatry, University of California, San Diego 8950 Villa La Jolla Drive, Suite B-218, La Jolla, CA 92037, United States

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ABSTRACT

Background: Although the prevalence of alcohol use disorders (AUDs) has increased in older individuals in the recent decade, there are few programs to mitigate that increase. The current analyses evaluate the feasibility of applying to older drinkers elements of an approach to prevent heavier drinking in young adults by focusing on mediators of effects of two risk factors for alcohol problems, low levels of response to alcohol (low LRs) and higher impulsivity.

Methods: Data were extracted from the San Diego Prospective Study (SDPS). Structural Equation Models evaluated relationships among age 36 low LRs and higher impulsivity; age 46 perceived peer drinking, alcohol expectancies, and drinking to cope; and age 51 alcohol problems, even after controlling for age 36 alcohol problems.

Results: Relationships of age 36 low LRs to later alcohol problems was both direct and linked to age 46 heavy drinking peers. LR also operated indirectly through peer drinking to alcohol expectancies and drinking to cope. Age 36 impulsivity had no direct path to later alcohol problems and operated primarily through mediation by alcohol expectancies and via expectancies to drinking to cope. After controlling for age 36 alcohol problems, the low LR and impulsivity results remained robust.

Conclusions: Programs for mitigating increases in alcohol problems in middle-age drinkers should consider identifying individuals with low LRs and/or higher impulsivity and implementing prevention approaches similar to a program used in young adults. The approach should emphasize some different mediators for older drinkers with low LRs and those with higher impulsivity.

1. Introduction

Historically, risks for heavy drinking and alcohol problems have been thought to decrease with age, although with great variability between individuals (Brennan et al., 2011). Regarding the latter, about 25% of drinkers in their forties drink daily, and a similar proportion consume > five drinks per occasion (Breslow et al., 2003, 2017; Grant et al., 2015; Molander et al., 2010). Even if quantities consumed decreased, with age higher blood alcohol concentrations (BACs) are likely to be observed per drink (Bielefeld et al., 2015).

Over the last decade individuals age 45 and older in the U.S. actually increased their prior-year high-risk drinking by over 50%, and their alcohol use disorders (AUDs) by almost 100% (Grant et al., 2017). Such increases are especially concerning in older individuals as they are more vulnerable to alcohol's psychomotor effects, with increased risks for falls (Boissoneault et al., 2014). They also have chronic medical conditions and take multiple prescription medications that might interact adversely with alcohol (Avendano et al., 2009). Older individuals who drink heavily have at least a 70% increase in their 20-year morbidity, a figure that is even higher for those who previously were more moderate drinkers (Holahan et al., 2010, 2015).

The rapid increase in high-risk drinking and AUDs in individuals in their fifth decade highlights a need to work to prevent future alcohol-related problems in this group. One approach is to identify characteristics that predict future alcohol-related adverse outcomes, establish how they operate over time to enhance alcohol problems (e.g., mediators of the risk), and work to change those mediators (Conrod et al., 2013; Schuckit et al., 2016). This paradigm has had promising results in young adults, especially for those carrying enhanced risks for future alcohol problems through how they react to alcohol (Savage et al., 2015; Schuckit et al., 2016). Prominent among the several alcohol response phenotypes that relate to future alcohol problems (King et al., 2016), is the low level of response (low LR) to alcohol (Quinn and Fromme, 2011; Ray et al., 2010). Low LRs can be seen early in the drinking career and before intersession tolerance and AUDs are likely to have developed, and they predict future heavy drinking (Schuckit et al.,

* Corresponding author.
E-mail addresses: mschuckit@ucsd.edu, mgregg@ucsd.edu (M.A. Schuckit).

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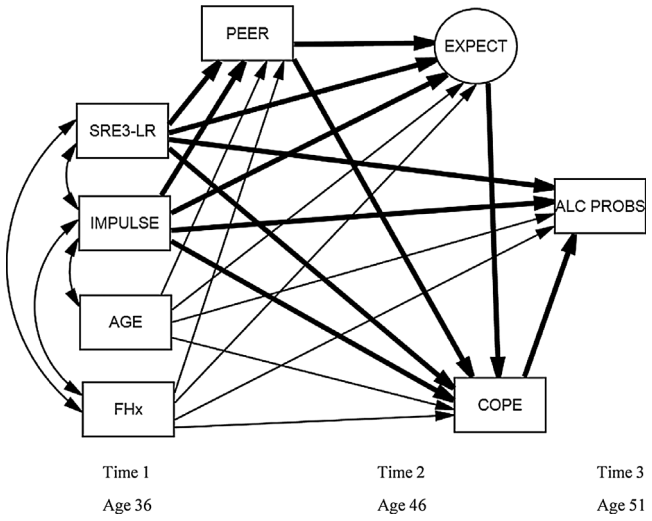

Fig. 1. Hypothesized Model*.
Indicated in bold are the primary hypothesized pathways that potentially impact on prevention efforts in middle age drinkers. Variables include Time 1 SRE3-LR (level of response to alcohol using the prior 3 months of drinking Self-Report of the Effects of Alcohol questionnaire)and impulsivity (IMPLUSE) as they relate directly to Time 3 alcohol problems (ALC PROBS) and via partial mediation by Time 2 perceived peer drinking (PEER), alcohol expectancies (EXPECT), and drinking to cope (COPE). The remaining Time 1 variables, Age and Family History Alcohol Use Disorder (FHx), are baseline covariates in the model. The variables used here are described in Table 2. In the model manifest variables (directly measured values) are represented by rectangles and the latent variable (as generated by confirmatory factor analyses in the SEM measurement model) by a circle.
*Modified from the Hypothesized Model in Schuckit et al. (2017), Alcoholism: Clinical and Experimental Research.

2008, 2007). A second characteristic linked to later problematic drinking is impulsivity, or a tendency to act without appropriate forethought, a phenotype also seen early in life that predicts later alcohol problems (Salvatore et al., 2015; Sher et al., 2005).

As demonstrated in the hypothesized model in Fig. 1, based on prior prospective studies (Schuckit et al., 2012, 2011, 2009, 2004) we predicted that low LRs would contribute to drinkers consuming as much alcohol as needed to achieve the effect they wanted (e.g., feeling drunk or intoxicated). This would have direct effects on later heavy drinking and impact on future excessive alcohol consumption through several mediators of the impact of a low LR. These include: 1) associating with heavier drinking peers who become models of how heavier drinking is a desirable behavior; 2) developing expectations that the most desirable effects of alcohol occur at high BACs with subsequent seeking high alcohol levels to achieve those desired effects; and 3) as alcohol quantities escalate and problems develop, drinkers turn to alcohol to diminish resulting distress. Our group and others have also proposed similar mediators of how impulsivity relates to later heavy drinking and associated problems (e.g., Schuckit et al., in press, 2004; Sher, 1991; Zucker et al., 1995).

We recently reported that teaching young adult drinkers how to determine if they had a low LR to alcohol and working with them to dampen the impact of heavy drinking peers, change their positive expectancies of alcohol's effects, and avoid using alcohol to cope with stress was associated with subsequent decreases in drinking quantities and alcohol-related blackouts (Goncalves et al., 2017; Savage et al., 2015; Schuckit et al., 2016). We also used prospective structural equation models (SEMs) in young adults to compare whether the relationships of low LR and impulsivity to adverse alcohol outcomes were mediated by the same characteristics (Schuckit et al., in press). We found that low LRs had direct links to alcohol problems four years later, with the effect of LR also partially mediated through the perception of heavier peer drinking. However, impulsivity had no direct relationship to later alcohol problems, with the effect on adverse alcohol outcomes mediated primarily through alcohol expectancies. In the SEM, LR was not directly related to expectancies and impulsivity did not relate to peer drinking (Schuckit et al., in press). Similar education-based approaches to decreasing alcohol-related problems in adolescents have also been reported (Conrod et al., 2013)

These results raise the question of whether similar approaches might be useful in preventing alcohol problems in older adults whose vulnerability toward heavy drinking relates to low LRs or impulsivity. The first step in addressing this issue is to ask whether the influence of peers, alcohol expectancies and coping mechanisms might be good targets for change in older drinkers because they remain in flux in middle age and beyond. There are data that indicate that peers do change with age as adult children hold increasingly important roles, marriages end and new relationships begin, and older friends and relatives pass away (e.g., Carstensen, 1992; Steinberg and Monahan, 2007). Alcohol expectancies are also likely to change with increasing age, with potentially less salience on beliefs regarding positive and more emphasis on negative effects of alcohol as people age and are likely to develop higher BACs per drink (Leigh and Stacy, 2004; Pabst et al., 2010). Also, stresses are likely to increase as drinkers grow older, especially regarding chronic rather than episodic stresses along with changes in coping strategies (Aldwin et al., 1996; Martin et al., 2008). In addition, studies support the continuing importance of impulsivity in individuals in middle age and beyond (Lufi et al., 2015).

The second step when considering whether to apply to older drinkers the prevention strategy recently used in young adults is to prospectively evaluate whether older drinkers demonstrate relationships between earlier LRs and levels of impulsivity and later drinking practices, and if those relationships might be at least partially mediated by intermediate time characteristics. For this we turned to prospective data available for 36-year-old men in the San Diego Prospective Study (SDPS) (Schuckit and Gold, 1988; Schuckit et al., 2004). With the earlier youth sample results in mind (Schuckit et al., in press), the analyses use the same hypothesized model that includes similar Time 1 (age 36) LR and impulsivity-related predictors and appropriate covariates, the same Time 2 (age 46) intermediate variables, and the same Time 3 (age 51) alcohol problems. Based on the earlier findings with young adults (Schuckit et al., in press) the analyses tested the following hypotheses: 1) Time 1 LR and impulsivity will correlate with alcohol problems at Time 3, a step necessary to evaluate the additional hypotheses; 2) LR, but not impulsivity, will have a direct path to Time 3 alcohol problems in the SEM; 3) The relationship of Time 1 LR to Time 3 alcohol problems will be partially mediated by Time 2 perceived peer drinking patterns; 4) The relationship of impulsivity to Time 3 alcohol problems will be partially mediated by higher Time 2 alcohol expectancies; and 5) Both LR and impulsivity will contribute significantly to the SEM results.

2. Material and methods

2.1. The sample

Data were generated from average age 36, 46, and 51 follow-ups of SDPS probands. The original protocol, which received approval from the University of California, San Diego (UCSD) Human Subject's Protection Committee at each stage of the work, began in 1978 by selecting drinking but not alcohol dependent 18-to-25-year-old male UCSD students and nonacademic staff. Half of these participants had an alcohol dependent father, with each such subject matched with a family history negative control regarding demography, recent drinking, and drug use histories (Schuckit and Gold, 1988). By June 1988, 453 probands had been identified and evaluated for their LR to alcohol using alcohol challenges (Schuckit and Gold, 1988). These men, and an additional informant for each, were interviewed ten years after study entry and then every five years to determine their drinking quantities,

frequencies and related problems. In the period between average ages of about 20 and 51, 2.2% of the probands had died, 4.8% had dropped from the study before age 36, and 1.3% were excluded for several reasons including key missing data. Of the 437 men appropriate for inclusion in these analyses, 390 (89.2%) participated in all 3 evaluations used here.

2.2. Baseline and follow-up interviews

The face-to-face interviews used items from the Semi-Structured Assessment for the Genetics of Alcoholism (SSAGA) instrument (Bucholz et al., 1994; Hesselbrock et al., 1999). The shortened version of this interview took between 30 and 60 min where probands reported their current demography and alcohol use and related problems that had occurred since the prior evaluation. A parallel interview about the proband was carried out separately with someone likely to know the subjects well, usually a spouse. SSAGA retest reliabilities and validities are ~.75 for alcohol problems as compared to another structured interview (Bucholz et al., 1994; Hesselbrock et al., 1999).

2.3. Age 36 questionnaires

Beginning with age 36 follow-ups (Time 1 for current analyses), subjects completed recently developed Self-Report of the Effects of Alcohol questionnaires (SRE) to estimate numbers of standard drinks (10–12 g ethanol) required for up to four effects actually experienced (Ray et al., 2007; Schuckit et al., 2011, 2008, 2007). SREs retrospectively record drinks needed for effects the first five times of consuming at least an entire drink, heaviest drinking periods, and the three months of drinking prior to filling out the form. Scores for each timeframe (where more drinks needed for effects indicate a lower LR per drink) were generated by summing the drinks required for the up to four effects, and dividing that by the number of effects experienced. As the probands were in their mid-thirties at Time 1 and the goal was to evaluate how that current LR predicted later alcohol problems, analyses used SRE values for the recent three months of drinking (SRE3-LR). SRE Cronbach alphas is in the literature and the current sample are > 0.90 and retest reliabilities in past studies are > .80.

Participants also completed the Impulsiveness Subscale of the Karolinska Scales of Personality (KSP) (Gustavsson et al., 2000). KSP Cronbach alpha is 0.62 in the literature and 0.66 in the current population, and scores correlate 0.36 with Eysenck Personality Questionnaire Extraversion (Ortet et al., 2002). The ten KSP impulsivity questions asked about: acting on the spur of the moment, not thinking about decisions before acting, not considering disadvantages of decisions, hasty actions, not being "particular" about plans, tending to take things as they come, talking before thinking, making decisions quickly, taking life easy, and seeing themselves as impulsive, with each scored on a 1 (not apply) to 4 (applies completely) scale (Gustavsson et al., 2000).

2.4. Age 46 measures

Evaluations of mediation between age 36 LR and impulsivity and later alcohol problems used questionnaires similar to those used in our prior work (e.g., Schuckit et al., in press, 2011, 2009, 2004). These scales were not included in age 41 follow-ups, but were used at age 46. Probands' *perceptions of maximum drinking quantities per occasion in close peers* from the Important People and Activities Scale (Longabaugh et al., 2001) was scored from 0 for abstainers to 4 for > 10 drinks. *Alcohol expectancies* used five subscales of the adult Alcohol Expectancy Questionnaires (AEQ) (Global, Social Behavior, Relaxation, Sex, and Arousal) regarding how subjects believed alcohol usually affects drinkers (Goldman, 2002), with Cronbach alphas across the subscales in this study of 0.79–0.93 The subscale not used was physical/social pleasure, as this score this has the lowest factor loading and has not been used in our prior work with the AEQ. The *Drinking to Cope* Scale asked whether respondents used alcohol to forget worries, relax, cheer up, decrease negative emotions, decrease boredom, or to feel more confident, rated from 1 (almost never) to 4 (almost always), with Cronbach alpha of 0.79 in this sample (Carver et al., 1989; Cooper et al., 1995).

2.5. Age 51 alcohol outcomes

SSAGA-based interviews generated the number of 11 DSM-IV AUD criteria experienced in the five years before Time 1 as a covariate and since age 46 as the outcome measure (American Psychiatric Association, 2000).

2.6. Analyses

Maximum likelihood procedures were used to address missing data, and skew was mitigated with square root transformations for SRE3-LR (z-scores 8.67 before and 3.56 after transformations); logarithmic transformations for age 46 COPE (z-scores 13.73 and 6.51); and inverse-reflected transformations for of alcohol problem outcomes at age 36 (z-scores 23.85 and 9.31) and age 51 (z-scores 20.77 and 10.81). Pearson product moment correlations were evaluated among relevant variables at the three timepoints. To optimize comparisons between the current analyses and SEM results from a younger population (Schuckit et al., in press), the two analyses used the same hypothesized model in Fig. 1. SEMs used AMOS software (Arbuckle, 2014) involving maximum likelihood estimations, while Mplus (Muthén and Muthén, 2012) evaluated direct associations and indirect mediation within the SEM based on 1000 resamples with 95% confidence intervals. In the current analyses, when the measurement models are evaluated outside the SEM at least four indices are required, a criterion that only fit EXPECT. Table 3 lists acceptable fit statistics for the SEMS (Hu and Bentler, 1999), the fit indices for the measurement model for EXPECT, and for the full model in Figs. 2 and 3. Hierarchical regression analyses tested Hypothesis 5 where effect sizes (f^2) were 0.02 = small, 0.15 = medium, and 0.35 = large effects (Cohen, 1992).

3. Results

Table 1 describes the 390 predominantly European American (EA) men from the SDPS used in these analyses. These probands were relatively highly educated; reflecting the original selection criteria, half had a parent with an AUD; and they reported requiring an average of 4.2 drinks for effects during the prior 3 months of drinking (SRE3-LR). Average drinking patterns over the three timepoints included modest decreases from Times 1–3 for usual ($F(1389) = 13.43$, $p < 0.001$) and maximum drinks ($F(1389) = 72.35$, $p < 0.001$), and increases in drinking frequency ($F(1389) = 3.89$, $p < 0.05$), but no significant changes in drinking problems ($F(1389) = 1.84$, $p = 0.18$). Table 1 also presents values for the Time 2 measures where, using the scale described in Methods, the average peers were perceived as light to moderate drinkers who consumed alcohol once or twice a week, with a maximum of 3 drinks/occasion.

Table 2 presents the Pearson product moment correlations among key variables in Table 1, including the factor score for the latent variable of EXPECT. Consistent with Hypothesis 1, Time 1 SRE3-LR and impulsivity each correlated significantly with Time 3 ALC PROBS. Relating to part of Hypotheses 3 and 4, SRE3-LR correlated significantly with all three Time 2 variables (including PEER), but Time 1 impulsivity did not correlate with Time 2 PEER. In addition, all three Time 2 variables correlated positively with each other and with Time 3 ALC PROBS; Time 1 age correlated negatively with all other variables except EXPECT; ethnicity did not correlate with any other variable except PEER; and at age 36 parental AUDs (FHx) correlated positively with ALC PROBS and EXPECT.

Fig. 2 presents the SEM results where all variables in Table 1 were

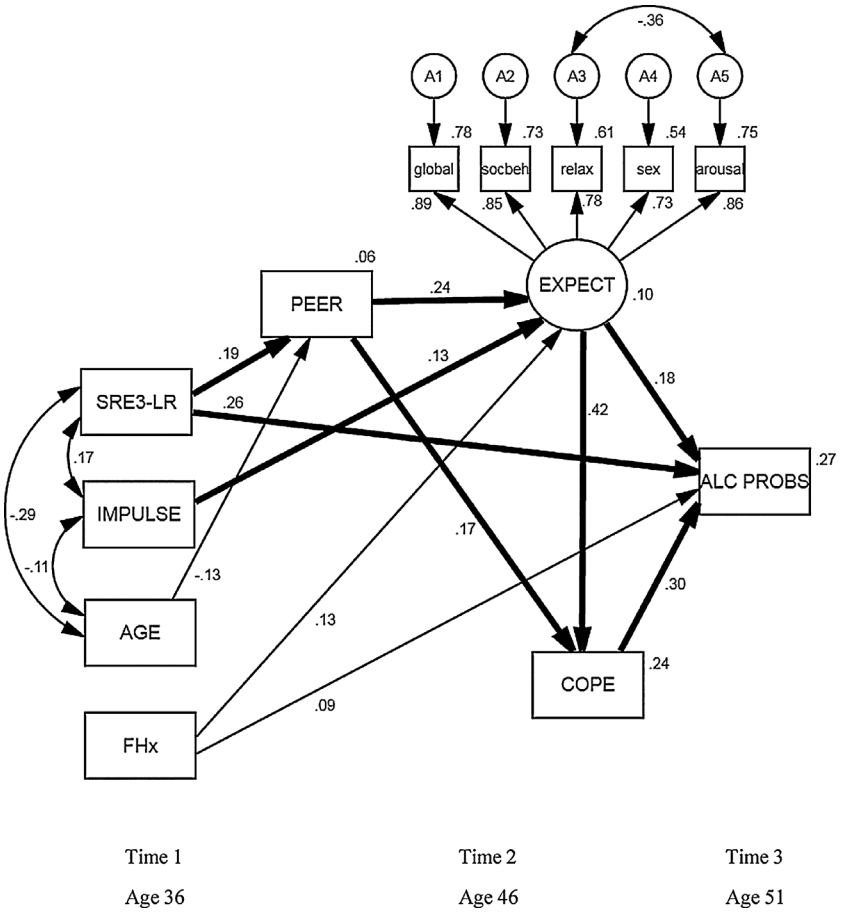

Fig. 2. Structural Equation Model (SEM) Results.
This full SEM model is the result of testing the Hypothesized Model (Fig. 1). The bolded pathways relate to the hypotheses that guided the analyses and that potentially impact on prevention efforts in middle age drinkers. The measurement model is incorporated into the SEM. Significant paths (beta weights) and correlations are shown here. Manifest variables are represented as rectangles and the latent variable as a circle (definitions are provided in Fig. 1). SEM model fit indices were CFI = 0.96; NNFI = 0.94; RMSEA = 0.063 [0.049–0.077]; Standardized RMR = 0.042.

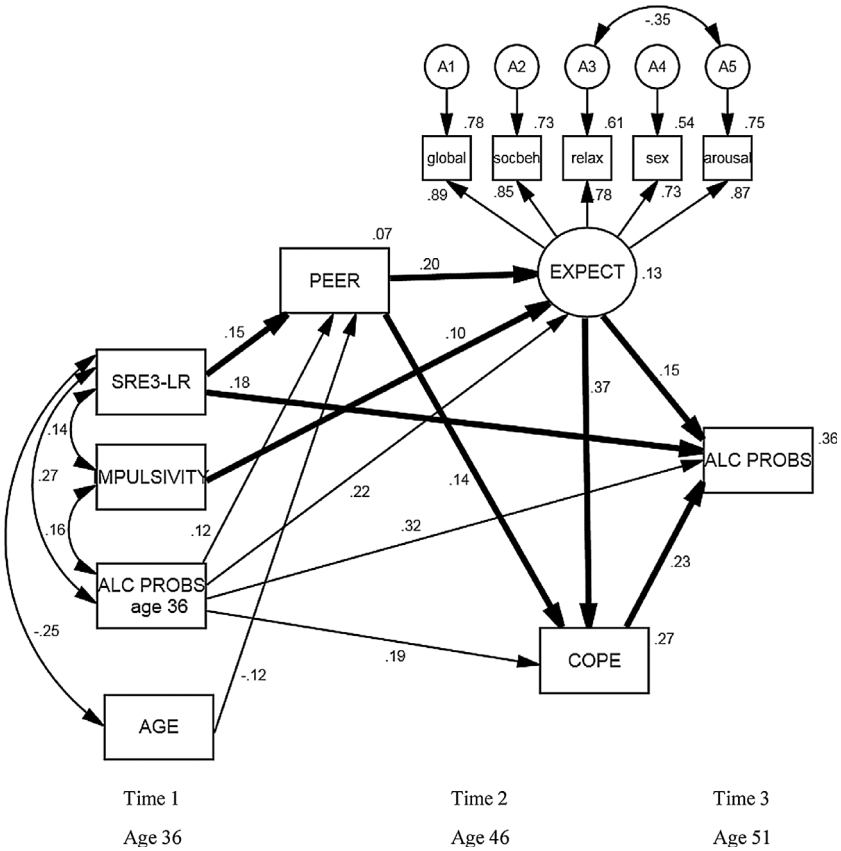

Fig. 3. Structural Equation Model (SEM) Results with Alcohol Problems Age 36.
This full SEM model is the result of testing the Hypothesized Model (Fig. 1) while also including alcohol problems at age 36. The measurement model is incorporated into the SEM. Significant paths (beta weights) and correlations are shown here. The bolded pathways relate to the hypotheses that guided the analyses and that potentially impact on prevention efforts in middle age drinkers. Manifest variables are represented as rectangles and the latent variable as a circle (definitions are provided in Fig. 1). SEM model fit indices were CFI = 0.95; NNFI = 0.93; RMSEA = 0.072 [0.058–0.087]; Standardized RMR = 0.045.

Table 1
Descriptions of 390 Men from the San Diego Prospective Study at Time 1, Time 2, and Time 3 (mean and standard deviation or %).

Variables	Value
Time 1 (Baseline at age 36.8 [3.09])	
Ethnicity (% EA)	98.2
Years of Education	17.6 (2.17)
SRE3-LR	4.2 (2.05)
1 or both parents lifetime AUD (%)	50.0
Karolinska Impulsiveness Score	22.7 (3.43)
Alcohol past 5 years	
Usual Quantity/occasion	2.3 (1.56)
Max Quantity/occasion	7.3 (4.77)
Usual Frequency/month	12.3 (9.35)
Number of DSM-IV Problems	0.7 (1.54)
Variables	**Value**
Time 2 (25-year follow-up at age 46.6 [3.27])	
Peer Maximum Drinks/occasion	2.6 (1.85)
AEQ Scores for Latent Variable EXPECT	
Global	55.3 (14.13)
Social Behavior	29.9 (7.86)
Relaxation	28.0 (5.81)
Sex	16.9 (5.08)
Arousal	24.0 (5.62)
DTC COPE Score Total	10.2 (3.00)
Alcohol past 5 years	
Usual Quantity/occasion	2.2 (1.56)
Max Quantity/occasion	6.3 (4.25)
Usual Frequency/month	13.7 (10.52)
Number of DSM-IV Problems	0.6 (1.39)
Variables	**Value**
Time 3 (30-year follow-up at age 50.9 [3.78])	
Alcohol past 5 years	
Usual Quantity/occasion	2.0 (1.55)
Max Quantity/occasion	5.4 (3.79)
Usual Frequency/month	13.3 (10.55)
Number of DSM-IV Problems	0.6 (1.35)

EA = European American Ethnicity; ***SRE3-LR*** = Level of Response to alcohol as measured by the Self Report of the Effects of Alcohol questionnaire for prior 3 months; ***AUD*** = Alcohol Use Disorder; ***Karolinska Impulsiveness Score*** is the Impulsiveness subscale of the Karolinksa Scales of Personality; ***PEER Maximum Drinks/occasion*** = maximum drinks scored on a 5-point scale ranging from 0 (doesn't drink) to 4(≥10per occasion) [converted to number of drinks]; ***AEQ*** = Alcohol Expectancy Questionnaire adult subscale scores (1 = disagree strongly to 5 = agree strongly) for Global, Social Behavior, Relaxation, Sex and Arousal used to generate EXPECT, which is the latent variable generated in the SEM shown in Figs. 2 and 3; ***DTC*** = ***Drinking to Cope*** scores (each item scaled from 1 = almost never to 4 = almost always) used to generate COPE; ***Number of DSM-IV Alcohol Problems*** = the number of 11 diagnostic items experienced in the prior 5 years from the Diagnostic and Statistical Manual of Mental Disorders, 4th Edition. EXPECT is the latent variable generated in the SEM shown in Figs. 2 and 3.

entered in the model, although, as seen in the figure, ethnicity did not contribute. The paths related to the original hypotheses are presented in bold. As predicted by Hypothesis 2, in these middle-age adults SRE3-LR had a direct path to ALC PROBS, but impulsivity did not. Consistent with Hypotheses 3 and 4, SRE3-LR related directly to Time 2 PEER and impulsivity related directly to Time 2 EXPECT, but not vice versa. In addition, both PEER and EXPECT related to Time 2 COPE, and both EXPECT and COPE related to Time 3 ALC PROBS. In this model, age related negatively to PEER (older subjects reported lower perceived peer maximum drinks) and to both SRE3-LR and impulsivity (older age correlated with fewer drinks needed for effects and to lower impulsivity). Family histories of AUDs (FHx) related to higher alcohol expectancies and to later alcohol problems. As shown in Table 3, the key fit statistics for full model were all similar to or better than the recommended range, and the fit values for the measurement model were all good.

Formal mediation testing for Fig. 2 indicated significance for SRE3-LR to PEER to COPE to ALC PROBS (0.002, 0.020), SRE3-LR to PEER to EXPECT to ALC PROBS (> 0.002, 0.014), and SRE3-LR to PEER to EXPECT to COPE to ALC PROBS (0.002, 0.011). Mediation was also found for impulsivity to EXPECT to COPE to ALC PROBS (0.002, 0.033), and for impulsivity to EXPECT to ALC PROBS (0.003, 0.051).

Fig. 3 evaluates if the model in Fig. 2 was altered once age 36 ALC PROBS was added. This step resulted in few changes from Fig. 2 regarding the bolded key pathways related to testing hypotheses. In this alternate model, SRE3-LR maintained a significant direct path to later ALC PROBS, although with a lower beta weight than seen in Fig. 2. Also similar to Fig. 2, SRE3-LR remained directly linked to PEER. In Fig. 3 impulsivity remained related to ALC PROBS through EXPECT and COPE. Additional elements of Fig. 3 included relationships of age to PEER, SRE3-LR, and impulsivity that were similar to Fig. 2, but family histories of AUDs no longer contributed to the model. If family history is forced into the model it is interesting to note that IMPULSIVITY develops a direct path ($p < 0.05$) to ALC PROBS. TOM?? Age 36 ALC PROBS related directly to age 51 ALC PROBS, to all three Time 2 variables, and to both Time 1 SRE3-LR and impulsivity. The resulting fit indices for the full model, as shown in Table 3, were similar to those in Fig. 2 except for a higher than desired RMSEA. Significant mediation in Fig. 3 included SRE3-LR to PEER to COPE to ALC PROBS (0.001, 0.010), SRE3-LR to PEER to EXPECT to ALC PROBS (0.001, 0.008) and SRE3-LR to PEER to EXPECT to COPE to ALC PROBS (0.001, 0.005). Mediation from impulsivity to ALC PROBS included impulsivity to EXPECT to ALC PROBS (< 0.001, 0.003) and impulsivity to EXPECT to COPE to ALC PROBS (< 0.001, 0.002).

The final step in these analyses was to test Hypothesis 5 using two hierarchical regression analyses predicting Time 3 ALC PROBS. For the first hierarchical regression, in step 1, when SRE3-LR was entered first $R^2 = 0.11$ ($p < 0.001$, $f^2 = 0.12$). In step 2, adding impulsivity produced a significant change in $R^2 = 0.02$ ($p = 0.007$, $f^2 = 0.02$). In a separate hierarchical regression analysis, when impulsivity was entered first, $R^2 = 0.033$ ($p < 0.001$, $f^2 = 0.034$), and in step 2 the addition of SRE3-LR resulted in a significant change in $R^2 = 0.093$, ($p < 0.001$,$f^2 = 0.10$). When both SRE3-LR and impulsivity were entered simultaneously, $R^2 = 0.13$ ($p < 0.001$, $f^2 = 0.149$).

4. Discussion

These analyses used prospective data from 390 men to evaluate a hypothesized model of how a low LR and impulsivity predict alcohol-related problems from ages 36–51. The results might have implications regarding the feasibility of applying to an older population an education program associated with decreases in heavy drinking in young adults with low LRs (Savage et al., 2015; Schuckit et al., 2016). Few previous studies have evaluated both LR and impulsivity in the same model of vulnerability to later alcohol problems. Such studies are important because mediators of the impact of LR and impulsivity might operate differently in the development of alcohol problems, which might indicate that different potential mediators should be emphasized in prevention protocols.

In the current results, low SRE3-LR at age 36 performed well and in a manner similar to what was seen in young adults (Schuckit et al., in press). As predicted in Hypotheses 1 and 5, SRE3-LR and impulsivity correlated significantly with later alcohol problems, even when considered in the same analyses. Regarding Hypothesis 2, in Figs. 2 and 3 only SRE3-LR had a direct path to alcohol problems, a relationship that remained significant after controlling for age 36 alcohol problems. As predicted in Hypotheses 3 and 4, SRE3-LR's link to later drinking problems was partially mediated by peer drinking, and impulsivity's effect operated in part through expectancy. Results supported Hypothesis 5 as

Table 2
Correlations among Relevant Time 1 Variables and the Manifest and Latent Variables from the SEM as Assessed at 3 Time Points.

	SRE3-LR[1]	Impulsivity	ALC PROBS	PEER	EXPECT	COPE	Age	Ethnic (EA)
Impulsivity[1]	0.17[c]							
ALC PROBS[3]	0.33[c]	0.18[c]						
PEER[2]	0.22[c]	0.07	0.21[c]					
EXPECT[2]	0.14[b]	0.15[b]	0.37[c]	0.25[c]				
COPE[2]	0.16[b]	0.12[a]	0.43[c]	0.27[c]	0.46[c]			
Age[1]	-0.29[c]	-0.11[a]	-0.15[b]	-0.18[c]	−0.10	-0.15[b]		
Ethnic (EA)[1]	−0.01	0.04	−0.01	0.13[a]	−0.03	0.04	−0.09	
Parent AUD[1]	0.01	0.08	0.13[b]	0.01	0.15[b]	0.06	−0.01	−0.06

Superscript 1 = Time 1, 2 = Time 2, and 3 = Time 3.
SRE3-LR[1] = Time 1 LR value for the prior 3 months from the Self-Report of the Effects of Alcohol questionnaire (higher values = lower LR/drink); Impulsivity[1] = Time 1 Karolinska Impulsivity Scale score; ALC PROBS[3] = Time 3 number of DSM-IV alcohol problems endorsed in the prior 5 years; PEER[2] = Time 2 peer maximum quantity/occasion; EXPECT[2] = Time 2 alcohol expectancy latent variable; COPE[2] = Time 2 Drinking to Cope score; Age[1] = Time 1 age in years; Ethnic (EA)[1] = European American ethnicity; Parent AUD[1] = one or both biological parents with an alcohol use disorder;
Superscript a = $p < 0.05$, b = $p < 0.01$, c = $p < 0.001$.

Table 3
Model Fit Indices for the EXPECT Measurement Model and each of the Full Models.

	CFI	NNFI	RMSEA	SRMR
Fit Standards[a]	≥0.95	≥0.95	≤0.06	≤0.08
Expect Measurement Model	1.00	1.00	0.000 (0.000–0.073)	0.0075
Fig. 2 Full Model	0.96	0.94	0.063 (0.049–0.077)	0.042
Fig. 3 Full Model	0.95	0.93	0.072 (0.058–0.087)	0.045

CFI = comparative fit index, NNFI = Bentler-Bonett non-normed fit index.
RMSEA = root mean square error of approximation, SRMR = standardized.
root mean square residual.

[a] Fit standards are from Hu and Bentler, 1999. Note that we do not list χ^2 fit statistics because those values are almost always significant in modest sized samples such as ours, thus, are likely to add little information beyond the fit statistics listed here (Kenny, 2015).

both impulsivity and SRE3-LR added to prediction of later problems.

The similarity of the current results to what was observed regarding how low LRs related to later alcohol problems in young adults has a practical implication. The direct and indirect pathways from earlier low LRs to later alcohol problems was the impetus for an education-based prevention program that was associated with decreases in future heavier drinking and alcohol problems in the young adults (Schuckit et al., 2016). Those findings support the possibility that a similar prevention approach might also work in middle-age adults. Based on the results reported here, attempts to moderate future alcohol problems in middle-age drinkers with low LRs should emphasize that their high risk operates directly on later alcohol problems and that they must always monitor their alcohol quantities when they drink. Individuals with low LRs should also work to avoid being influenced by heavy drinking peers and avoid using alcohol to cope with stress.

The current results regarding impulsivity were also similar to the prior results regarding how impulsivity related to later alcohol problems in young adults (Schuckit et al., in press). The take- home message for impulsivity is that, consistent with Hypotheses 1 and 5, impulsivity relates to later alcohol problems in middle-age drinkers. Related to Hypothesis 4, education programs developed to decrease risks for future heavy alcohol intake in older drinkers should place a special emphasis on alcohol expectancies and less on the effect of peer drinking. Thus, the results are also consistent with the prior report that LR and impulsivity are likely to operate differently over time regarding how mediators for future alcohol problems operate.

It is worth noting that the current analyses with older drinkers and the recent report using young adults (Schuckit et al., in press) indicated that, compared to impulsivity, SRE-LR accounted for higher proportions of the variance for predicting alcohol problems. This was demonstrated by higher zero-order correlations with ALC PROBS for SRE3-LR in Table 2, as well as the higher R^2s and effect sizes for SRE3-LR in hierarchical regression analyses predicting alcohol problems 15 years later.

In viewing the current results, it is important to keep the several caveats in mind. First, the SDPS probands were relatively highly educated, 36-year-old, mostly European-American males, and that future studies need to include women and members of minority groups. However, as noted above, the results in Table 2 and Fig. 2 were similar to findings in the young adult sample of less well-educated males and females, and that included African-Americans and Hispanic individuals (Schuckit et al., in press). Second, the SDPS probands used in these analyses evidenced lower levels of impulsivity than are likely to be seen in other groups of subjects, and the results may be different in individuals who did not attend college or who had more conduct problems in childhood. Third, only two Time 1 predictors and three potential mediators were evaluated, and no potential moderators were tested, so more work is needed to more fully test how LR and impulsivity relate to later alcohol problems during middle age. Fourth, the key variables at the three timepoints were each evaluated with only one measure, and results might be different if different questionnaires had been used. Fifth, a single SEM only tests a specific model and does not indicate whether another model is better. Sixth, although the SEM fit statistics for Fig. 2 are all within or close to acceptable values, the higher than desired RMSEA for Fig. 3 should be noted as this suggests that Fig. 2 might be the better model.

5. Conclusion

These results support the feasibility of evaluating in middle-age drinkers a prevention approach for alcohol-related problems associated with low LRs and impulsivity modeled after a successful program in college freshmen.

Contributors

Each author materially participated in the research, article preparation, and approved of the manuscript before submission. Dr. Schuckit was principal investigator for the research project and prepared the original draft of the manuscript, while Dr. Smith provided the statistical analyses and results.

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Conflict of interest

Neither Marc Schuckit nor Tom Smith have any financial interest or personal relationships that could inappropriately influence our work.

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