Spring 2-22-2023

Precision Medicine Approaches to Alcohol Use Disorder for American Indians: Assessment and Phenotypic Differentiation of Reward and Relief Drinking

Hanna M. Hebden
University of New Mexico

Hanna Hebden
Candidate

Psychology
Department

This thesis is approved, and it is acceptable in quality and form for publication:

Approved by the Thesis Committee:

Kamilla Venner, Ph.D., Chairperson

Katie Witkiewitz, Ph.D.

Margo Hurlocker, Ph.D.

PRECISION MEDICINE APPROACHES TO ALCOHOL USE DISORDERS FOR AMERICAN INDIANS: ASSESSMENT AND PHENOTYPIC DIFFERENTIATION OF REWARD AND RELIEF DRINKING

by

HANNA M. HEBDEN

B.A., PSYCHOLOGY, UNIVERSITY OF CALIFORNIA, LOS ANGELES, 2020

THESIS

Submitted in Partial Fulfillment of the
Requirements for the Degree of

Master of Science
Psychology

The University of New Mexico
Albuquerque, New Mexico

May 2023

PRECISION MEDICINE APPROACHES TO ALCOHOL USE DISORDER FOR AMERICAN INDIANS: ASSESSMENT AND PHENOTYPIC DIFFERENTIATION OF REWARD AND RELIEF DRINKING

by

Hanna M. Hebden

B.A., Psychology, University of California, Los Angeles, 2020
M.S., Psychology, University of New Mexico, 2023

ABSTRACT

American Indians (AI) endorse high rates of abstinence from alcohol and substance use, yet experience disparate rates of alcohol and substance-related consequences. Alcohol and substance use is conceptualized as interwoven with unique AI contextual factors, which are often not incorporated into examination of related constructs. Current knowledge gaps exist in study of precision medicine approaches to treatment for reward and relief drinking in AI. This study aimed to understand reward and relief substance use phenotypes in AI. We described a contextually-informed model of relief assessment and to compare this assessment to the original reward and relief models using latent profile analysis. We expected 4 profile solutions to be best fit to the data for both models, and that the contextually-informed would be better than the original at distinguishing profiles. Our sample consisted of n=79 AI people seeking treatment at an outpatient Southwest Tribal SUD treatment facility. Our results indicated that a two-profile solution best fit the data for both the original (LMR (p)=0.195, entropy=0.884) and CI models (LMR (p)=0.003, entropy=0.908), and in contrast to our hypotheses both models fit approximately equally well. Due to theoretical fit, the culturally informed model was selected. We conducted a Monte Carlo simulation study to examine the effects of our small sample size on our profile solutions, which indicated that a four-profile solution that more closely resembled hypothesized phenotypes may have been best fit to the data had the sample size approached 1,000. These findings indicate that in AI people, incorporating context improves understanding of these constructs, and might help inform precision medicine approaches to behavioral and medication treatments for alcohol use disorder.

TABLE OF CONTENTS

INTRODUCTION

Despite being more likely to report complete abstinence or light to moderate use of alcohol than Non-Hispanic White individuals (NHW), American Indian (AI) communities experience higher rates of negative consequences from substance use (Greenfield & Venner, 2012; Chartier & Caetano, 2010; Cunningham et al., 2015; Whitesell et al., 2012; Landen et al., 2014; Substance Abuse and Mental Health Administration, 2018). Specifically, AI people who do use substances report higher rates of alcohol-attributable mortality, illicit substance use, binge drinking and heavy drinking, fetal alcohol spectrum disorder, and alcohol-related motor-vehicle deaths (Center for Disease Control, 2008; Cunningham et al., 2015; Landen et al., 2014; Russo et al., 2004; Substance Abuse and Mental Health Administration, 2018; Oluwoye et al., 2020). As of 2008 and according to data gleaned from death certificates, nearly 12% of AI deaths were determined to be alcohol-related, although this figure is likely underreported given racial misclassification of data gathered from death certificates (Center for Disease Control, 2008; Epsey et al., 2014). These disparate rates of diagnosed substance use disorders and substance-related consequences exemplify the influences of unique contextual factors and resulting health inequalities that harm AI communities. Research on how to best ameliorate them is vital to improving the wellness of AI communities.

Substance Use in AI Populations

Contexts surrounding substance use problems within AI communities are important to integrate into assessment when aiming to improve substance-related health inequities, as measures and constructs are often tested within majoritized populations and fail to consider sociodemographic contextual factors, such as historical trauma (Skewes et al., 2021). Substance use related health disparities in American Indian communities are attenuated when adjusted for income, education, geographical area, and health insurance coverage, indicating that these sociodemographic inequities contribute to health disparities (Brave Heart et al., 2016; Akins et al., 2013).

Historical trauma and discrimination are two notable influences on substance use in AI communities. Over the last several centuries, AI communities have experienced traumatic group-level assaults, including genocidal policies, forced removal, forced relocation, and violence (Brave Heart & DeBruyn, 1998; Evans-Campbell, 2008). In AI communities, this historical and racial trauma is often cited as a main mechanism by which substance use materializes within communities, made continuously salient by ongoing experiences of discrimination and structural racism which likely contribute to health disparities (Skewes et al., 2021; Mohatt et al., 2014; Brave Heart, 2003; Whitbeck et al., 2004). Individual level factors, such as chronic stress, unemployment, and lack of social support have been shown to increase relapse risk after attending SUD treatment in majoritized and AI samples (Witkiewitz & Marlatt, 2007; Chong & Lopez, 2008). The interaction of present-day risk factors for substance use and relapse, such as those mentioned by Marlatt and Witkiewitz, likely interact with historical trauma, health inequities, and discrimination at individual and community levels in AI communities (Skewes et al., 2021).

Reward and Relief Craving

Translational research on the addiction cycle has led to the derivation of reward and relief craving phenotypes to explain clinical presentation of individuals with alcohol use disorder. The addiction cycle is a commonly researched theory of alcohol and substance use disorder based on a neurobiologically-informed mechanistic framework (Koob and Volkow, 2010, 2016; Koob & LeMoal, 1997). The addiction cycle has been operationalized for the study of alcohol use disorders as the Alcohol Addiction Research Domain Criteria (AARDoC), and Addictions Neuroclinical Assessment (ANA) (Kwako et al., 2016; Sher et al., 2015; Litten at al., 2015).

The addiction cycle begins with the binge/intoxication stage, which is underpinned by the associated functional domains of reward and incentive salience by way of positive reinforcement. Incentive salience is the process by which substances become more wanted or liked by way of associated cues. The incentive-sensitization theory, originally described by Robinson & Berridge (1993, 2001, 2017), posits that habit-forming substances dysregulate the brain's dopaminergic neural circuitry, which is implicated in the attribution of reward to stimuli. The withdrawal/negative affect stage involves substance use to relieve negative emotionality. In the withdrawal/negative affect phase, substances act as a negative reinforcer by reducing negative affect or stress (Blume, 2001; Koob and Volkow, 2010). There is some conceptual conflict regarding whether negative emotionality is primarily a result of continued substance use (e.g. using to relieve distress related to continued negative effects of substance use) or a precursor to substance use (Boness et al., 2021; Koob & Volkow, 2010; Hussong et al., 2011). Hypothesized neurobiological mechanisms underlying relief drinking include dysregulation of corticotropin-releasing factor in the area of the amygdala. The third stage is the preoccupation-anticipation stage, which is theorized to be motivated by loss of control over use later in the stages of the addiction cycle, influenced by dysregulation in GABA and glutamate release in amydgala and basal ganglia. Functional domains that characterize the preoccupation stage include craving and alterations in executive function.

Three phenotypes of craving are hypothesized based on the three-pathway psychobiological model of craving: reward, relief, and habit drinkers. These phenotypes might be similar as craving phenotypes draw similarities to the addiction cycle domains (Verheul et al., 1999; Witkiewitz et al., 2022). Reward and relief craving have been identified and validated within samples of majoritized individuals seeking treatment for AUD (Grodin et al., 2019; Glöckner-Rist et al., 2013; Roos, Mann, & Witkiewitz, 2017; Witkiewitz et al., 2019; Votaw et al., 2022), while habit drinking is less commonly studied.

The reward craving pathway described in the three-pathway psychobiological model of alcohol craving draws similarity to the binge-intoxication stage of the addiction cycle (Verheul et al., 1999). Reward drinkers feel tempted to drink alcohol in contexts that they associate alcohol with providing positive internal or external effects. Positive internal effects might include positive mood or pleasant feelings, while positive external events might include social interaction, approval, or acceptance (Verheul et al., 1999). The relief craving pathway draws similarity to the withdrawal/negative affect phase of the addiction cycle. Relief drinkers crave alcohol in contexts that are associated with relieving distress, negative affect, and/or negative physical states (Verheul et al., 1999). In these contexts, alcohol acts as a negative reinforcer by reducing negative affect or stress. Intrapersonal factors might also influence reward or relief craving, such as hyperreactivity to external or internal stress or affinity for rewarding social interactions (Verheul et al., 1999).

Understanding potential structural and historical effects on negative emotionality might help inform contextually-informed treatment and precision medicine. Relief from stress and negative emotional states has been reported by AI people with lived experience of substance use disorder to be an individual-level motivating factor for substance use within the context of historical trauma (Les Whitbeck, 2004; Skewes, 2021; Nutton & Fast, 2015). Cultural leaders conceptualize substance use as a way to cope with negative feelings related to the loss of identity caused by historical trauma and oppression (Skewes et al., 2021). When thinking about historical loss, AI people tend to experience negative emotional reactions, most commonly and frequently of which are sadness, depression, and anger (Whitbeck et al, 2004).

The third phenotype of craving is habit drinking, also characterized as compulsive or obsessive drinkers, who crave alcohol broadly and in situations that tend to not be cue-specific. Habit drinking is motivated by loss of control over use and executive dysfunction, and might reflect the preoccupation/anticipation stage of the addiction cycle. Habit drinkers and relief drinkers are not well differentiated phenotypically, therefore this phenotype may be captured by relief drinking (Grodin et al., 2019).

Reward and relief dimensions of temptation to use substances have yet to be examined within an AI sample. Validating phenotypes of craving in AI people may provide relevant clinical information on assessment by including context surrounding mechanisms influencing a lapse into drinking or substance use.

Although craving is an important factor in substance use disorders, it is a complex and multidimensional construct for which empirical operationalizations are variable (Sayette, 2016; Abrams, 2000). Craving and temptation to drink have been both related to drinking outcomes after SUD treatment (Witkiewitz, 2013). Measures of temptation have been interpreted as measures of craving in previous literature (Witkiewitz, 2013; Glöckner-Rist et al., 2013). Temptation to drink might approximate subjective experiences of craving by assessing situational influences on desire for drinking or drug use.

Present Study

The intention of the current study was to create and test research questions grounded in lived experience of people of minoritized communities with the intention of leveraging the resources of the scientific community to reduce health disparities. Specifically, the present study aims to test the phenotypic presentation of substance use temptation profiles within an AI, treatment-seeking sample using the temptation subscale of the Alcohol and Drug Use Self-Efficacy Scale (ADUSES-T; Brown et al., 2002). Phenotypic presentation of reward and relief temptation have not been examined in samples of minoritized people such as AI samples and have not been examined in people who use both alcohol and substances. Additionally, the criterion validity of reward and relief temptation have not been examined in an AI treatment seeking sample.

Because reward and relief craving have not been examined within AI communities, and cultural, contextual, and historical factors have not been examined quantitatively as risk factors for craving or placed within context, we also aimed to study whether certain items of our survey might better capture AI phenotypes of reward and relief drinking. To do this, we examined brief psychometric properties of the reward and relief subscales of the ADUSES-T. We compared fit of a previously published model of reward and relief drinking (Glockner-Rist et al., 2013) to a theoretically derived contextually informed model (Skewes et al., 2021).

We expected 1.) the contextually informed model would be a better fit to these data than the original model, 2.) our hypothesized four-profile solution would consist of a low overall profile (low reward/low relief), a high overall profile (high reward/high relief), a reward profile (high reward, moderate relief); and a relief profile (high relief/moderate reward), 3.) the reward and relief profiles would display good criterion validity, such that high reward profiles would correlate well with scores on the Scale of Ethnic Experience (SEE) Social Affiliation subscale and items from the Inventory of Drug Use Consequence (InDUC); and relief profiles would correlate well with scores on the Brief Symptom Inventory (BSI) and Beck Hopelessness Scale (BHS). Gender and cannabis use will be covaried to examine differences by profile membership.

METHODS

Participants

Study participants (n=79) were recruited from an outpatient, Southwest reservation-based treatment center, and eligible to participate in the study if they were 18 years or older, a Tribal member, lived on or near this Tribal reservation, were seeking treatment for a substance use disorder, were diagnosed with a DSM-IV-TR substance use disorder, and were conversationally fluent in English.

Procedure

The current study was a secondary data analysis of a randomized controlled trial examining treatment efficacy of culturally tailored evidence-based SUD treatment (see Venner et al., 2021 for details). Recruitment took place from May 2011 to November 2012. Participants at an outpatient substance use disorder treatment facility were offered the opportunity to participate in the study by the intake worker. Interested participants then met with the study staff in a separate location for screening of eligibility criteria. Participants who met inclusion criteria and provided informed consent were enrolled in the study.

Measures

The ADUSES (DiClemente et al., 1994; Brown et al., 2001) consists of two parallel 20-item subscales, one 20 item scale designed to assess confidence to abstain from alcohol or drug use (ADUSES-C) and one 20 item scale designed to assess temptation to drink alcohol or use substances (ADUSES-T) across situations. The ADUSES-T prompts participants to rate the degree to which they would be tempted to drink alcohol or use substances across various scenarios, on a 5-point Likert scale from 1 (not at all tempted) to 5 (extremely tempted).

The ADUSES is a modified form of the AASE whose only modifications include the addition of the word drug next to the word alcohol in the survey items. For example, the AASE asks participants to rate their temptation to drink alcohol “When I am being offered a drink in a social situation” while the ADUSES asks participants to rate their temptation to drink alcohol or use substances “When I am being offered a drink or drug in a social situation.” The AASE is an alcohol-specific measurement instrument that also consists of two parallel 20-item subscales measuring temptation to drink and confidence to abstain from alcohol use. The AASE is a reliable and valid measure in majoritized populations with nonsignificant gender differences (DiClemente et al., 1994; McKiernan et al., 2011; Brown et al., 2001).

Further analyses in majoritized samples on the AASE-T show that it can be reliably shortened from 20 items into 10 items to analyze continuous dimensions of relief and reward temptation (Glöckner-Rist et al., 2013). These two subscales displayed good internal consistency and reliability for both relief temptation (COMBINE: α=.88; MATCH: α=.88) and reward temptation (COMBINE: α=.92; MATCH: α=.90) within a sample of predominately majoritized participants (Roos et al., 2017). In our AI sample, using these same items from the ADUSES-T, from both the 5-item reward temptation subscale and the 5-item relief temptation subscale displayed good internal consistency and reliability (reward: α=.886; relief: α=.812).

The Structured Clinical Interview for the DSM-IV (SCID-IV; First et al., 2002) is a semi-structured clinical interview used to assess DSM-IV diagnoses and associated symptoms. The SCID alcohol use disorder assessment seems to be valid within AI populations (Gilder et al., 2014; Serier et al., 2019). Questions assessing craving were added to the administration of the SCID-IV for each substance endorsed by the participant to follow DSM-5 substance use disorder (SUD) criteria (see Venner et al., 2021 for details). SCID-IV craving items were used to assess general construct validity of temptation to use substances. AUD and SUD diagnoses were assessed to examine any potential difference in profile membership by SUD type, since literature on reward and relief craving within SUDs other than AUD or within people with comorbid AUD and SUD is scarce. Lack of endorsement to screening items for alcohol and substance use disorders were coded as 0, as well as missing items, since missing substance use disorder diagnosis were a result of denial of the screening items.

The Brief Symptom Inventory-18 (BSI; Derotagis, 1999, 2004) is a widely used measure of psychological distress. The BSI is a shortened, 18-item questionnaire adapted from the SCL-90. The BSI assesses three dimensions of psychological distress; somatization, depression, and anxiety. Three subscales corresponding to those three dimensions are assessed with each subscale containing 6 items each. The BSI has been shown to produce reliable and valid scores across diverse clinical samples with nonsignificant gender differences (Derotagis, 2004; Recklitis, 2006). The items ask participants to rate the extent that they have been distressed or bothered by each of 18 symptoms in the prior 7 days. Responses are on a 5-point Likert scale from 1 (not at all) to 5 (extremely). In our sample, this measure showed good internal consistency and reliability (α=.939). We hypothesized the BSI would be higher among those most likely classified in profiles characterized by higher relief.

The Beck Hopelessness Scale (BHS; Beck et al., 1974) is designed to assess hopelessness in clinical samples. It contains 20 items assessing hopelessness, with two answer choices being possible; true or false. In our sample, the BHS displayed reasonable internal consistency and reliability (α=.763). We hypothesized the BHS would be higher among those most likely classified in profiles characterized by higher relief.

The Scale of Ethnic Experience (SEE; Malcarne et al., 2006) is a scale designed to assess cognitive constructs related to ethnicity that is internally valid and consistent across several ethnic groups. The SEE has good test-retest reliability (Malcarne et al., 2006). It consists of four subscales: ethnic identity, perceived discrimination, mainstream comfort, and social affiliation. The social affiliation subscale consists of 5 items designed to capture attitudes toward social interaction among the participant's ethnic group. The internal consistency of the social affiliation subscale in our sample was reasonable (α=.768). We hypothesized the SEE would be higher among those most likely classified in profiles characterized by higher reward.

The Inventory of Drug Use Consequence (InDUC; Tonigan & Miller, 2002) is a scale designed to assess consequences related to drug use. This measure contains 6 subscales: Physical, Interpersonal, Intrapersonal, Impulse Control, Social Responsibility, and Control subscales. Each item asks participants to rate how often each consequence has happened to them, on a scale of 0 (never) to 3 (daily or almost daily). Items will be correlated with the reward profiles, specifically items number: "5. I have enjoyed drinking or using drugs," "15. Drinking or using drugs has helped me to relax," "35. When drinking or using drugs, my life has been more enjoyable." These items pulled from the control subscale were used to assess convergent validity for the reward subscale. We hypothesized composite scores on these three INDuC items would be higher among those most likely classified in profiles characterized by higher reward.

Data Analysis Plan

The focus of our analyses was to examine reward and relief substance use temptation phenotypes in our sample of treatment-seeking AI. We also examined basic psychometric properties of our reward and relief subscales to ensure good fit within this AI sample. For both our original model and our contextually informed model, we compared fit of a hypothesized four-profile solution to three and five profile solutions in our data (n=79) with gender and cannabis use as covariates. Our hypothesized four-profile solution consisted of a low overall profile (low reward/low relief), a high overall profile (high reward/high relief), a reward profile (high reward, moderate relief); and a relief profile (high relief/moderate reward).

We compared fit using sample size appropriate fit indices to ascertain the better fitting models. The Lo-Mendell Rubin (LMR) and Bootstrap Likelihood Ratio Test (BLRT) are a significance test that compares a model with k profiles to a model with k-1 profiles. AIC and BIC are measures of how well the model fits the data in relation to mean prediction error, and are used to compare nested models to decide the best fitting model, where lower AIC and BIC indicate a better model. aBIC is a sample-size adjusted measure of BIC, and a large discrepancy between BIC and aBIC indicates sample size effects. Entropy is a measure of classification precision. We used these fit indices (AIC, BIC, aBIC, LMR, and BLRT) to determine best fitting profile solutions, as well as substantive considerations (Nylund et al., 2007) We anticipated a significant LMR and BLRT for 4-profile solutions compared to 3-profile solutions, and non-significant LMR and BLRT for 5 profile solutions compared to 4-profile solutions. Sensitivity analyses were conducted using the estimates obtained from our models to run a Monte Carlo simulation study with a sample size of 1000 to test whether substantive conclusions regarding number of profiles and profile membership were influenced by our small sample size.

Gender and cannabis use were also included as covariate predictors of profile membership in both models, based on prior literature showing some gender differences in reward and relief drinking (Witkiewitz et al., 2022) and to control for cannabis use given lack of literature on reward and relief craving in people who also use cannabis. Criterion validity was assessed by including scores on the SEE subscale, INDuC items, BHS, and BSI as predictors of profile membership using a 3-step BCH procedure (Bolck et al., 2004; Croon, 2002). The BCH procedure is a method to examine the effect of distal outcomes or predictors on profile membership. First, the model is estimated, and posterior probabilities are saved for each participant by way of probability of membership in each class. Then, the predictors are robustly examined in relation to each profile (Nylund et al., 2019).

RESULTS

Participants were 68% male (n=54) and 32% female (n=25). Average age was 33, with a range from 18-55. Participants reported most commonly using alcohol and cannabis; all but one participant reported past 30-day alcohol use and all but two participants reported past 30-day cannabis use. Most participants reported alcohol as their primary substance of concern (n=57, 72.2%), with cannabis as the next most common substance of concern reported (n=21, 26.6%). Most people met diagnostic criteria for alcohol use disorder (AUD) in the past month (n=77, 97.5%) at baseline. About two thirds of our sample met diagnostic criteria for cannabis use disorder (CUD) in the past month at baseline (n=53, 67.1%). Additional information on substance use at baseline is presented in Table 1.

Table 1

Participants Meeting Criteria for Substance Use Disorders

Meets Diagnostic Criteria Past 30 Days	Frequency	Percent
Alcohol	77	97.5
Cannabis	53	67.1
Opioids	1	1.3
Cocaine	9	11.4
Poly Drug	1	1.3

Table 2

Item Means and Standard Deviations

Scale	Item	Item Description	Mean	SD
Relief	Rel 1	When I am feeling depressed	2.56	1.16
	Rel 2	When I am very worried	2.06	1.05
	Rel 3	When I am physically tired	2.03	0.862
	Rel 4	When I feel like blowing up because of frustration	2.44	1.26
	Rel 5	When I sense everything is going wrong for me	2.48	1.12
	Rel 6	When I am feeling angry inside	2.59	1.22
Reward	Rew 1	When I am excited or celebrating with others	3.15	1.11
	Rew 2	When people I used to drink or use drugs with encourage me to drink or use drugs	2.7	1.03
	Rew 3	When I see others drinking at a bar or drinking or using drugs at a party	2.81	1.04
	Rew 4	When I am being offered a drink or drug in a social situation	2.94	1.16
	Rew 5	When I am on vacation and want to relax	2.81	1.06

Based on initial analyses of the psychometric properties of our 5-item relief and reward subscales used to test our a priori hypotheses, we slightly altered the indicators used in previous literature to more precisely describe relief drinking in a contextually appropriate manner within AI communities. Item descriptives are presented in Table 2. The development of this contextually informed (CI) model was informed by qualitative literature on cultural factors influencing substance use behaviors in AI communities (Brave Heart et al., 2003, Skewes et al., 2021; Whitbeck et al., 2004), and on initial brief psychometric analyses.

Within the original (ORG) relief subscale, Rel 3 ("When I am physically tired") had the lowest correlations across items, with a range of $r=0.06$ to $r=0.33$. For our CI model, we substituted Rel 3 with Rel 4 ("When I feel like blowing up because of frustration,") an item pulled from the 20-item ADUSES-T. The CI Relief subscale produced better inter-item correlations, with a range for Rel 4 from $r=0.53$ to $r=0.64$. This item replacement also improved reliability and consistency within the relief subscale from $\alpha=0.812$ to $\alpha=0.887$. Otherwise, item correlations were mostly within the moderate range. The ORG Reward subscale also produced correlations mostly in the moderate range, with a range from $r=0.37$-0.72; this subscale remained unaltered. Full correlation matrices are shown in Table 3.

Table 3

Correlation Matrices for Original Relief Scale, Contextually-Informed Relief Scale, and Reward Scale

Subscale	Correlation matrix						Reliability (α)
Original reward							
		Rew 1	*Rew 2*	*Rew 3*	*Rew 4*	*Rew 5*	0.886
	Rew 1	1	0.625	0.559	0.368	0.72	
	Rew 2	0.625	1	0.693	0.575	0.645	
	Rew 3	0.559	0.693	1	0.629	0.659	
	Rew 4	0.368	0.575	0.629	1	0.601	
	Rew 5	0.72	0.645	0.659	0.601	1	
Original relief							
		Rel 1	*Rel 2*	*Rel 3*	*Rel 5*	*Rel 6*	0.812
	Rel 1	1	0.567	0.062	0.579	0.619	
	Rel 2	0.567	1	0.28	0.561	0.586	
	Rel 3	0.062	0.28	1	0.333	0.156	
	Rel 5	0.579	0.561	0.333	1	0.714	
	Rel 6	0.619	0.586	0.156	0.714	1	
Contextually informed relief							
		Rel 1	*Rel 2*	*Rel 4*	*Rel 5*	*Rel 6*	0.887
	Rel 1	1	0.567	0.635	0.579	0.619	
	Rel 2	0.567	1	0.53	0.561	0.586	
	Rel 4	0.635	0.53	1	0.693	0.634	
	Rel 5	0.579	0.561	0.693	1	0.714	
	Rel 6	0.619	0.586	0.634	0.714	1	
Contextually informed reward							
		Rew 1	*Rew 2*	*Rew 3*	*Rew 4*	*Rew 5*	0.886
	Rew 1	1	0.625	0.559	0.368	0.72	
	Rew 2	0.625	1	0.693	0.575	0.645	
	Rew 3	0.559	0.693	1	0.629	0.659	
	Rew 4	0.368	0.575	0.629	1	0.601	
	Rew 5	0.72	0.645	0.659	0.601	1	

From the results of our latent profile analysis, we concluded that a two-profile solution of indicators was the best fit for the original model (AIC=2179.540; BIC=2252.993; aBIC=2155.248; LMR (*p*)=0.195) with excellent classification precision (entropy=0.884) compared to one, three, and four profile models. LMR (p=0.195) indicated that a one-profile model may have fit better than a two-profile model, but BIC decreased substantially from the 1 profile solution (BIC=2437.919) to the 2-profile solution (BIC=2252.99), indicating that a two-profile solution was a better fit to the data. For full fit statistics and profile descriptions, see Tables 3 and 4. These two profiles can be best classified as high reward/relief (n=29, 36.7%) and low reward/relief (n=50, 63.3%).

A latent profile analysis of the contextually informed model indicated that a two-profile solution of indicators was the best fit for the data (AIC=2191.350; BIC=2264.803; aBIC=2167.058; LMR (*p*)=0.003) with excellent classification precision (entropy=0.908). The LMR was significant for the two profile solution compared to a one profile solution (*p*=0.003). These two profiles can be best classified as high reward/relief temptation (n=31, 39.2%) and low reward/relief temptation (n=48, 60.8%).

Across both contextually informed and original models, and all profile solutions for each model, aBIC continues to decline as number of profiles increase. This indicates that sample size played a role in selecting the best-fitting profile solution, since aBIC includes a sample size adjustment. Additionally, as number of profile solutions increased, differences in aBIC values between contextually informed and original models decrease.

Table 4

Fit Statistics for Original and Contextually-Informed Models

Fit statistic	Number of profiles (original model)				Number of profiles (culturally informed model)			
	1	2	3	4	1	2	3	4
AIC	2390.530	2179.540	2132.809	2094.816	2450.303	2191.350	2146.401	2107.982
BIC	2437.919	2252.993	2232.235	2220.397	2497.692	2264.803	2245.918	2233.563
aBIC	2374.858	2155.248	2099.987	2053.285	2434.631	2167.058	2113.489	2066.451
LMR		0.195	0.212	0.118		0.003*	0.183	0.161
LMR-A		0.200	0.216	0.121		0.004*	0.190	0.167
BLRT		<0.001*	<0.001*	<0.001*		<0.001*	<0.001*	<0.001*
Entropy		0.884	0.888	0.939		0.908	0.903	0.936

Note. *=$p < 0.05$

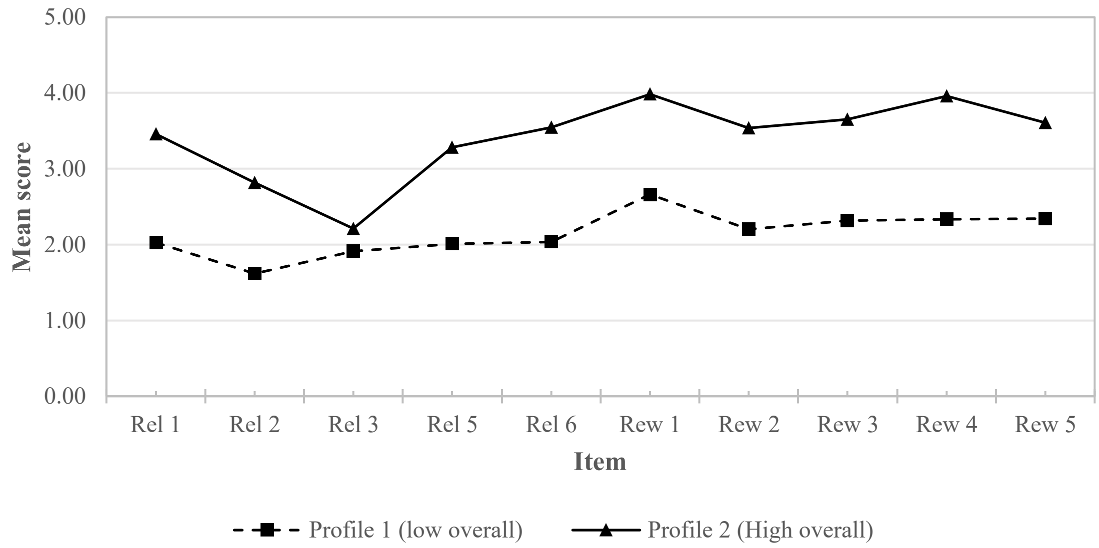

Figure 1. Original 2-profile model item distribution.

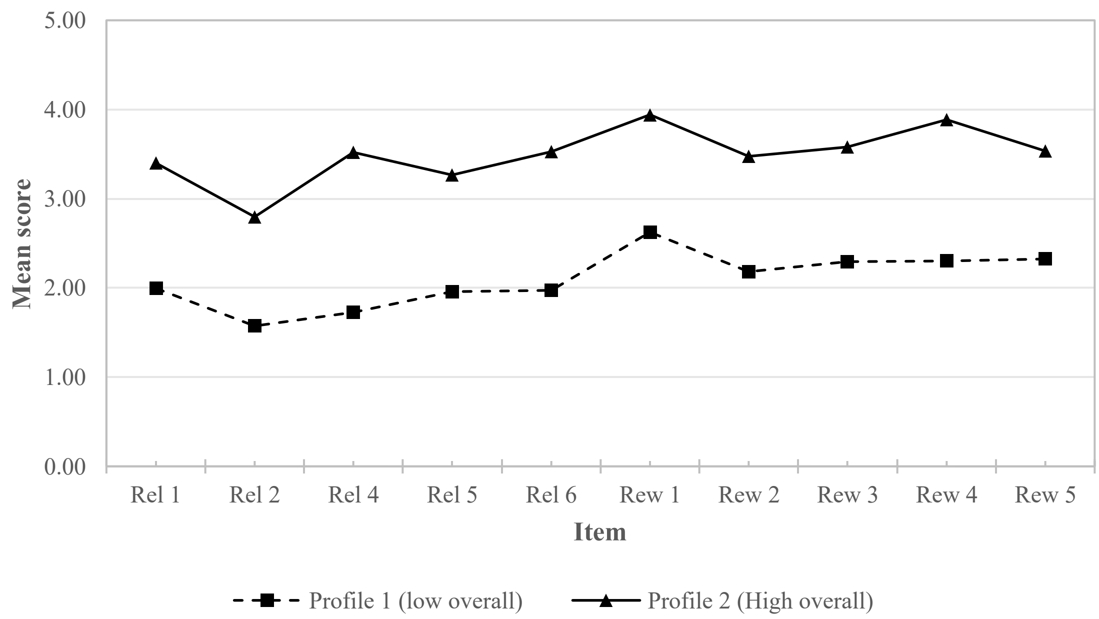

Figure 2. Contextually informed 2-profile model item distribution.

Table 5

Reward and Relief Item Means by Model for Selected Profile Solutions

Model	Subscale	Item	Profile 1 (low overall)		Profile 2 (high overall)	
			Mean	S.E.	Mean	S.E.
Original						
	Relief		9.38	0.40	15.71	0.67
		Rel 1	2.03	0.26	3.46	0.29
		Rel 2	1.62	0.22	2.82	0.25
		Rel 3	1.92	0.11	2.21	0.24
		Rel 5	2.01	0.26	3.28	0.25
		Rel 6	2.04	0.32	3.54	0.29
	Reward		11.64	0.43	19.1	0.61
		Rew 1	2.66	0.17	3.98	0.48
		Rew 2	2.2	0.23	3.54	0.21
		Rew 3	2.32	0.15	3.65	0.4
		Rew 4	2.33	0.19	3.96	0.37
		Rew 5	2.34	0.16	3.61	0.52
Contextually informed						
	Relief	Overall	9.021	0.417	16.816	0.713
		Rel 1	1.99	0.153	3.4	0.225
		Rel 2	1.57	0.13	2.8	0.214
		Rel 4	1.73	0.147	3.52	0.243
		Rel 5	1.96	0.15	3.27	0.219
		Rel 6	1.97	0.165	3.53	0.24
	Reward		11.519	0.433	18.734	0.585
		Rew 1	2.63	0.15	3.94	0.22
		Rew 2	2.18	0.17	3.47	0.16
		Rew 3	2.3	0.14	3.58	0.21
		Rew 4	2.3	0.15	3.89	0.21
		Rew 5	2.33	0.13	3.54	0.23

We examined the impact of gender and cannabis use as predictors of profile membership. We conducted model-based multinomial logistic regression using profile membership as our outcome and SCID-IV craving items, SCID-IV diagnoses, SEE, BHS, BSI, and InDUC scores as outcomes to examine construct validity. Results are presented in Table 5. For both the original and contextually informed models, scores on the BHS and SEE did not significantly predict profile membership and did not indicate good criterion validity as conceptualized by these measures. BSI and scores on the InDUC predicted profile membership, such that higher scores on the BSI and items from the InDUC predicted membership in the high reward/relief temptation profile, and lower scores on the BSI and items from the InDUC predicted membership in the low reward/relief temptation profile.

We also examined craving items from the SCID-IV to assess construct validity of temptation to drink or use substances. For our contextually informed model, craving for alcohol was more frequently reported by participants who were most likely classified in the high relief/reward profile ($p<0.001$), consistent with the notion of temptation to drink and craving for alcohol measuring similar constructs. However, cannabis craving was not significantly associated with profile membership ($p=0.133$), suggesting that temptation to use cannabis is not a corollary to craving for cannabis. In our original model, we found similar results, with alcohol craving more likely to be endorsed more frequently by participants most likely to be classified in the high reward/relief profile ($p<0.001$), while cannabis craving was not significantly associated with profile membership ($p=0.291$). Results are presented in Table 5.

Table 6

Covariate Association with Profile Membership

Model	Covariate	Profile 1 (low reward/relief)	Profile 2 (high reward/relief)	Overall test (p)
Original				
	Male gender	0.386	0.198	0.089
	BSI	6.312	18.528	<0.001
	BHS	3.378	3.452	0.921
	SEE	3.173	3.389	0.292
	INDuC	3.091	5.273	<0.001
	AUD	2.961	2.93	0.712
	CUD	2.405	2.233	0.475
	Alcohol Craving	1.849	2.839	<0.001
	Cannabis Craving	1.787	2.191	0.133
Contextually-informed				
	Male gender	0.335	0.289	0.685
	BSI	6.712	17.021	0.001
	BHS	3.259	3.624	0.613
	SEE	3.204	3.326	0.978
	INDuC	3.103	5.092	<0.001
	AUD	2.959	2.935	0.763
	CUD	2.468	2.152	0.175
	Alcohol Craving	1.845	2.77	<0.001
	Cannabis Craving	1.824	2.105	0.291

Note. *=$p < 0.05$

Given our small sample size, we wanted to explore potential differences in profile solution when using a larger sample size. We used a Monte Carlo simulation to estimate data based on posterior probabilities of profile membership for each participant which were then saved to simulate a dataset of n=1000. We did this for 2, 3, and 4 classes based on our contextually informed model to explore whether our best fitting profile would match hypothesized profiles with a larger simulated sample size. We compared the model fit indices for our latent profile analysis based on this dataset with 2, 3, and 4 profile models, and found that a 4-profile solution of indicators provided the best fit to the simulated data (AIC=25422.69; BIC=25693.80; aBIC=25525.47; LMR (p) < 0.001) with excellent classification precision (entropy=0.948). For full fit statistics, see Table 7. We found a high reward, low relief profile (high reward/low relief; n=48.9, 4.89%), a high reward/high relief profile (high overall; n=259.3, 25.9%), a moderate relief/moderate reward profile (moderate overall; n=401.6, 40.2%), and a low relief/low reward profile (low overall; n=290.2, 29.0%). Our high reward/low relief profile best matched our hypothesized profile solution.

Table 7

Fit Statistics for Monte-Carlo Simulation Models

Model	AIC	BIC	aBIC	Entropy	LMR (p)	LMR-A (p)
2-class CI	27086.986	27239.126	27140.668	0.975	< 0.001*	< 0.001*
3-class CI	26206.91	26413.036	26279.641	0.926	< 0.001*	< 0.001*
4-class CI	25433.69	25693.801	25525.47	0.948	< 0.001*	< 0.001*

Note. *=$p < 0.05$

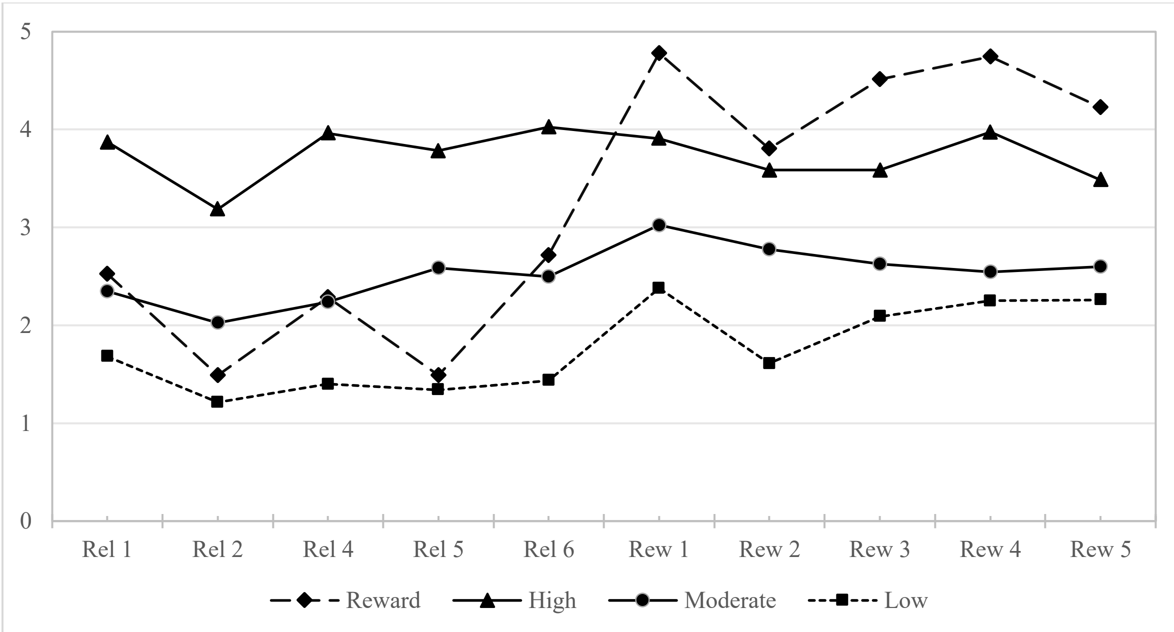

Figure 1. Item distribution for 4-profile CI Monte-Carlo simulation.

DISCUSSION

The aims of our study were to examine the phenotypic presentation of reward and relief craving in treatment-seeking AI. We derived a contextually informed model of relief drinking based on sociodemographic factors affecting AI substance use in combination with an existing scale of reward drinking in order to more precisely assess relief drinking. We found that the contextually informed model seemed to be more internally consistent than the original relief subscale. In an examination of both models, we hypothesized that our contextually informed model would be better at capturing relief drinking than our original model, by way of better delineating relief profiles that were more consistent with hypothesized profiles. We also expected a four-profile solution would best fit the data, aligning with previously described profile solutions testing reward and relief phenotypes using subscales from the AASE (Glockner-Rist et al.,, 2013).

Contextually-Informed Subscale

In creation of our scale, we attempted to incorporate more strongly the influence of contextually specific negative emotionality on craving. Specifically, in the development of our contextually informed model, we replaced the item described in the original relief scale (Glockner-Rist et al., 2013), “When I am physically tired,” with the item pulled from the full administered AASE, “When I feel like blowing up because of frustration.” Literature suggests that thoughts of historical trauma most commonly provoke feelings of anger, followed by sadness and anxiety, and these emotions are commonly used to measure the individual impact of historical trauma (Whitbeck et al., 2004). Addition of this item in conjunction to “When I feel angry” in replacement of “when I feel physically tired” was intended to capture the weight of feelings of anger in relation to historical trauma. Other items in the scale had appropriately addressed both sadness and anxiety, through items "When I am feeling depressed" and "When I am very worried." These results provide initial evidence that incorporating context surrounding relief craving may help more clearly operationalize this construct in AI.

Model Results

The results of our latent profile analyses indicated that the original and contextually-informed models fit, on the whole, approximately equally well. However, the original model had lower AIC and BIC indicating better fit. For the original model, the LMR indicated that a 2-profile solution was not better than a 1-profile solution, however this model was selected based on lower AIC and BIC relative to the 1-profile model. For the CI model, the LMR indicated that a 2-profile solution was a significantly better fit than a 1-profile solution. While Rel 3 did not differ meaningfully between profiles within the original model, within the contextually-informed model, Rel 4 did differ between profiles. This difference likely drives the contextually-informed model to better approximate hypothesized profiles compared to the original model. Due to these results, and theoretical considerations, we focused our analysis on the contextually informed model, since it seems to be more appropriate for use within this population. Taken together, these results indicate that incorporating contextual effects on substance use for AI in assessment of craving might improve phenotypic differentiation.

In terms of our profile solutions, we did not find a four-profile solution for either the original nor contextually informed models. Instead, we found a two-profile solution consisting with high reward/relief and low reward/relief for both models. These profiles did not match our hypothesized profiles entirely, but did match two out of four profiles (high reward/relief and low reward/relief) most found in similar studies using reward and relief scales derived from the AASE (Glockner-Rist et al., 2013). Notably, BIC continued to decrease as number of profiles increased for both models, but more notably for the contextually-informed model. Across sample size and number of profiles for continuous indicators, BIC is the most consistent selector of the correct number of profiles (Nylund et al., 2007). A larger sample size might have led us to select a solution with a larger number of profiles, if the correct solution is one with more profiles as hypothesized.

Given concerns about small sample size limiting our ability to detect more hypothesized profiles (Nylund et al., 2007), we conducted an exploratory Monte Carlo simulation analysis to examine the impact that a larger sample size may have had on our data. The results of this analysis described a low reward/relief, moderate reward/relief, high reward/relief, and high reward/low relief profiles. Notably, the size of the high reward/low relief profile was small with a sample size of 1,000, consisting of only around 4% of the simulated sample. The results of this indicated that a larger sample size might have matched the profiles described by Glockner-Rist et al. more closely, but the results of this particular analysis should be cautiously interpreted since this was an exploratory and novel use of Monte Carlo analyses.

Reward Drinking

Our results indicate that the reward dimension of craving was more frequently reported in this population than relief craving, even within profiles. Because we did not find a hypothesized relief profile in any analysis, and reward scores were higher overall, it could be that the influence of social factors on substance use in AI is: a.) more impactful in AI, therefore making reward drinking more common and b.) that negative emotionality is more strongly tied to reward drinking in this population than in other samples, making the phenotypic presentation harder to differentiate. Social factors in reward drinking may be especially emphasized within AI communities in relation to substance use due to a tendency toward a collectivist and communal nature. Community members may be unsupportive of others changing their drinking or drug use habits due to internalized oppression (Skewes et al., 2021). Relatedly, social undermining, or negative social support, conflict, and hinderance, are more related to negative alcohol, substance use, and mental health outcomes than social support in AI (Oetzel et al., 2007). Social undermining is related to negative affect and negative evaluation, factors that intertwine with our understanding of relief craving in this study (Finch, 2008; Oetzel et al., 2007; Vinokur & Van Ryn, 1993). Additionally, recent research on brief measures of reward and relief drinking suggest that measures of negative emotionality are better at differentiating reward and relief profiles than measures of reward (Grodin et al., 2019). To the contrary, strong peer relations are protective against mental health outcomes in AI (Walters & Simoni, 2002). Therefore, in this sample, negative emotionality in consideration to its stronger relation to social factors and mental health outcomes might be more useful in understanding reward and relief phenotypes. In this context, we may have been limited by our sample size in light of what might be a more tightly tied nature of reward and relief drinking in this sample. It should be emphasized that noting the influence of peer support and social undermining on reward drinking is not the fault of the individuals; historical oppression and historical trauma has widespread and devastating effects on communities, and the responsibility lies with the historical devastation of colonization.

Relief Drinking

Interestingly, though AUD diagnosis was common, mean relief craving was lower than reward. We found low average scores on the BSI, our measure intended to provide construct validity to relief craving via negative emotionality, relative to other studies of relief and reward craving. The mean BSI Global Severity Index raw score was 11 relative to the maximum score of 72, which was much lower than a previous examination of the BSI in relation to negative emotionality in an alcohol use disorder treatment-seeking sample which reported a mean of 60 at baseline (Witkiewitz et al., 2022). This might indicate that negative emotionality was lower overall in this sample, which may have influenced our ability to differentiate relief profiles, since relief craving is hypothesized to be motivated by relief from negative emotionality.

This study was conducted with a reservation-based sample, but these results may vary when applied to urban AI. AI people living in urban environments experience high levels of discrimination, and that residing in an environment lacking resemblance to traditional family structure is a source of stress; therefore, when examining an urban sample, relief drinking might be higher, and consequently, differentiation of reward and relief craving might be improved (Brown et al., 2016; Dickerson et al., 2019). There may be relatively more availability of cultural protective factors in a reservation-based environment, such as community, cultural events, and spiritual practices.

Because we had a large percentage of abstinence at baseline, this may have influenced lower relief scores. Relief craving is associated with number of drinks per drinking day and percent heavy drinking days (Witkiewitz et al., 2022). Recent research on brief measures of reward and relief drinking suggest that measures of negative emotionality are better at differentiating reward and relief profiles than are measures of reward (Grodin et al., 2019). Therefore, in this sample, negative emotionality, in consideration to its aforementioned potentially stronger relation to social factors and mental health outcomes, might be more useful in understanding reward than relief phenotypes.

Construct Validity

Overall, reward and relief craving showed acceptable construct validity in relation to our measures of reward and relief temptation, with some exceptions that may be due to sample size and misoperationalization with these measures in this sample. Neither gender nor cannabis use differed between profiles, indicating that cannabis craving did not differ between reward and relief profiles. This indicates that reward and relief craving for alcohol as defined by this study is not applicable to cannabis craving. Diagnosis of other substance use disorders also did not differ by profile membership, although our proportion of alcohol and comorbid other SUD was very low. Neither AUD nor CUD differed by profile membership, indicating that neither reward nor relief craving differed by AUD or CUD severity.

In terms of criterion validity, the BSI indicated good validity for relief craving, whereas higher relief craving was associated with higher scores on the BSI, while the BHS did not differ between high and low profiles. One likely explanation for this is that the BHS has not been validated in AI, and internal consistency of this scale was acceptable, but not excellent (α=.763). Additionally, since the BSI has not been psychometrically validated in AI, this might indicate that this measure does not capture negative emotionality appropriately in AI. Construct validity for reward craving was acceptable. As indicated by the INDuC, reward craving showed good construct validity by being more associated with high overall profile, but the SEE did not differ between high and low profiles. This scale also had reasonable, but not excellent internal consistency (α=.768). However, since we did not find high relief/low reward and high reward/low relief profiles, our ability to determine construct validity may be hampered. Scores on these two measures only indicate that they are more present on the high overall profile and less on the low overall profile.

Limitations and Future Directions

This study was conducted with a small Southwest Tribe, within a reservation-based treatment center, with treatment-seeking adults. These results may not generalize to other contexts or populations. Additionally, a large proportion of our sample was abstinent at baseline which might have dampened our overall ability to capture reward and relief drinking in this sample (Witkiewitz et al., 2022). Being a secondary data analysis, the most appropriate measures specific to our research questions were unavailable, and measures are often not validated in AI samples. In the future, measures of historical trauma, validated measures of incentive salience and negative emotionality, discrimination, and cultural identity should be utilized. Factor analyses of the contextually informed and original relief and reward scales should be conducted.

The primary limitation of our study was the small sample size with which to conduct our analysis. While this is a relatively large treatment-seeking sample for this population, future studies should replicate this analysis in larger samples. One method for improving sample size within existing datasets is integrative data analysis, which allows for combination of data and measures to test hypotheses. This method could be especially valuable when working with AI communities because of the relatively few measures that are validated in this population, increasing likelihood of finding consistent measures to combine. Additionally, our use of a Monte Carlo simulation to examine the effect of sample size on our results was exploratory, and these results should be interpreted carefully. Our intention in conducting these analyses was to provide information about how model selection in the latent profile analysis might have been influenced by sample size, with results indicating potentially more profiles would have been selected consistent with our hypotheses if a larger sample size was available. However, we cannot assume that the same parameters will be derived using a different, larger dataset, therefore future work should replicate these results with a larger sample.

Future studies might assess reward and relief drinking using other measures used in the literature. Previously, the Inventory of Drinking Situations (IDS; Davis et al., 1987), Drinking Motives Questionnaire (DMQ; Stuart, 1996), and various measures of negative emotionality and incentive salience have been used to analyze reward and relief substance use (Witkiewitz et al., 2022). There may be an effect of the way these constructs are conceptualized by the measure and asked to participants. For example, the DMQ asks primarily about internal states and perceptions, while the IDS tends to ask about situational behavior. Whether situational or internal conceptualizations of these constructs are best used with AI people is a direction for future study, and may indicate need for further incorporation of specific context into these measures.

CONCLUSION

Overall, this study indicated some relative benefit in incorporating context into assessment and examination of reward and relief craving in an AI sample. A contextually-informed model indicated some improved substantive benefit in understanding phenotypes of reward and relief craving, with several limitations that should be addressed by replication in a larger sample or by integrative data analysis, in addition to extensive psychometric validation of each measure used in AI samples.-Future work should be focused on contextualizing risk factors relating to reward and relief drinking. Given the structural and sociopolitical influences that minoritized people face, and their impacts on subsequent barriers to recovery from substance use disorder, this context should not be neglected in study of precision medicine approaches to treatment.

REFERENCES

Abrams, D. B. (2000). Transdisciplinary concepts and measures of craving: Commentary and future directions. *Addiction*, *95*(8s2), 237–246. https://doi.org/10.1046/j.1360-0443.95.8s2.12.x

Akins, S., Lanfear, C., Cline, S., & Mosher, C. (2013). Patterns and correlates of adult American Indian substance use. *Journal of Drug Issues*, *43*, 497–516. https://doi.org/10.1177/0022042613491100

Beck, A. T., Weissman, A., Lester, D., & Trexler, L. (1974). The measurement of pessimism: The Hopelessness Scale. *Journal of Consulting and Clinical Psychology*, *42*(6), 861–865. https://doi.org/10.1037/h0037562

Berridge, K. C., & Robinson, T. E. (2016). Liking, wanting and the incentive-sensitization theory of addiction. *The American Psychologist*, *71*(8), 670–679. https://doi.org/10.1037/amp0000059

Blume, A. W. (2001). Negative reinforcement and substance abuse: Using a behavioral conceptualization to enhance treatment. *The Behavior Analyst Today*, *2*(2), 86. https://doi.org/10.1037/h0099916

Bolck, A., Croon, M., & Hagenaars, J. (2004). Estimating latent structure models with categorical variables: one-step versus three-step estimators. *Political Analysis*, *12*(1), 3–27. https://doi.org/10.1093/pan/mph001

Boness, C. L., Gonzalez, J. C., Sleep, C., Venner, K., & Witkiewitz, K. (2022). *Evidence-based assessment of substance use disorder*. PsyArXiv. https://doi.org/10.31234/osf.io/rxzt7

Boness, C. L., Watts, A. L., Moeller, K. N., & Sher, K. J. (2021). The etiologic, theory-based, ontogenetic hierarchical framework of alcohol use disorder: a translational systematic review of reviews. *Psychological Bulletin*, *147*(10), 1075–1123. https://doi.org/10.1037/bul0000333

Brave Heart, M. Y., & DeBruyn, L. M. (1998). The American Indian Holocaust: Healing historical unresolved grief. *American Indian and Alaska Native Mental Health Research: Journal of the National Center*, *8*(2), 56–78.

Brave Heart, M. Y. H. (2003). The historical trauma response among Natives and its relationship with substance abuse: a Lakota illustration. *Journal of Psychoactive Drugs*, *35*(1), 7–13. https://doi.org/10.1080/02791072.2003.10399988

Brave Heart, M. Y. H., Lewis-Fernández, R., Beals, J., Hasin, D. S., Sugaya, L., Wang, S., Grant, B. F., & Blanco, C. (2016). Psychiatric disorders and mental health treatment in American Indians and Alaska Natives: Results of the National Epidemiologic Survey on Alcohol and Related Conditions. *Social Psychiatry and Psychiatric Epidemiology*, *51*(7), 1033–1046. https://doi.org/10.1007/s00127-016-1225-4

Brown, R. A., Dickerson, D. L., & D’Amico, E. J. (2016). Cultural identity among urban American Indian/Alaska Native youth: implications for alcohol and drug use. *Prevention Science: The Official Journal of the Society for Prevention Research*, *17*(7), 852–861. https://doi.org/10.1007/s11121-016-0680-1

Carise, D., & McLellan, A. T. (1999). *Increasing Cultural Sensitivity of the Addiction Severity Index (ASI): An Example with Native Americans in North Dakota. Special Report*. Treatment Research Institute, University of Pennsylvania, 600 Public Ledger Building, 150 S. https://eric.ed.gov/?id=ED449953

Center for Disease Control. (2005). *Alcohol-Attributable Deaths and Years of Potential Life Lost Among American Indians and Alaska Natives—United States, 2001—2005*. https://www.cdc.gov/mmwr/preview/mmwrhtml/mm5734a3.htm

Chartier, K., & Caetano, R. (2010). Ethnicity and health disparities in alcohol research. *Alcohol Research & Health*, *33*(1–2), 152–160.

Chong, J., & Lopez, D. (2008). Predictors of relapse for American Indian women after substance abuse treatment. *American Indian and Alaska Native Mental Health Research: The Journal of the National Center*, *14*(3), 24–48.

Croon, M. (2002). Using predicted latent scores in general latent structure models. In *Latent Variable and Latent Structure Models*. Psychology Press.

Cunningham, J. K., Solomon, T. A., & Muramoto, M. L. (2016). Alcohol use among Native Americans compared to whites: Examining the veracity of the “Native American elevated alcohol consumption” belief. *Drug and Alcohol Dependence*, *160*, 65–75. https://doi.org/10.1016/j.drugalcdep.2015.12.015

Davis, C. S., Graham, J. M., & Ontario. Addiction Research Foundation. (1987). *Inventory of drinking situations (IDS): user's guide*. Addiction Research Foundation.

Derogatis, L. R., & Savitz, K. L. (1999). The SCL-90-R, Brief Symptom Inventory, and matching clinical rating scales. In *The Use of Psychological Testing for Treatment Planning and Outcomes Assessment, 2nd ed* (pp. 679–724). Lawrence Erlbaum Associates Publishers.

Dickerson, D. L., Brown, R. A., Klein, D. J., Agniel, D., Johnson, C., & D’Amico, E. J. (2019). Overt perceived discrimination and racial microaggressions and their association with health risk behaviors among a sample of urban American Indian/Alaska Native adolescents. *Journal* *of Racial and Ethnic Health Disparities*, *6*(4), 733–742. https://doi.org/10.1007/s40615-019-00572-1

DiClemente, C. C., Carbonari, J. P., Montgomery, R. P. G., & Hughes, S. O. (1994). The Alcohol Abstinence Self-Efficacy Scale. *Journal Of Studies On Alcohol*, 8.

Duran, B., Oetzel, J., Parker, T., Malcoe, L. H., Lucero, J., & Jiang, Y. (2009). Intimate partner violence and alcohol, drug, and mental disorders among American Indian women from southwest tribes in primary care. *American Indian and Alaska Native Mental Health Research: The Journal of the National Center*, *16*(2), 11–27.

Espey, D. K., Jim, M. A., Cobb, N., Bartholomew, M., Becker, T., Haverkamp, D., & Plescia, M. (2014). Leading causes of death and all-cause mortality in American Indians and Alaska Natives. *American Journal of Public Health*, *104*(S3), S303–S311. https://doi.org/10.2105/AJPH.2013.301798

Evans-Campbell, T. (2008). Historical trauma in American Indian/Native Alaska communities: A multilevel framework for exploring impacts on individuals, families, and communities. *Journal of Interpersonal Violence*, *23*(3), 316–338. https://doi.org/10.1177/0886260507312290

Finch, J. F. (1998). Social undermining, support satisfaction, and affect: A domain-specific lagged effects model. *Journal of Personality*, *66*(3), 315–334. https://doi.org/10.1111/1467-6494.00014

First, M. B. (1997). Structured Clinical Interview for DSM-IV Axis I Disorders. *Biometrics Research Department*. https://cir.nii.ac.jp/crid/1573387451015011328

First, M. B. (2015). Structured Clinical Interview for the DSM (SCID). In *The Encyclopedia of Clinical Psychology* (pp. 1–6). John Wiley & Sons, Ltd. https://doi.org/10.1002/9781118625392.wbecp351

Gilder, D. A., Gizer, I. R., Lau, P., & Ehlers, C. L. (2014). Item response theory analyses of DSM-IV and DSM-5 stimulant use disorder criteria in an American Indian community sample. *Drug and Alcohol Dependence*, *135*, 29–36. https://doi.org/10.1016/j.drugalcdep.2013.10.010

Glöckner-Rist, A., Lémenager, T., Mann, K., & PREDICT Study Research Group. (2013). Reward and relief craving tendencies in patients with alcohol use disorders: Results from the PREDICT study. *Addictive Behaviors*, *38*(2), 1532–1540. https://doi.org/10.1016/j.addbeh.2012.06.018

Grant, B. F., Saha, T. D., Ruan, W. J., Goldstein, R. B., Chou, S. P., Jung, J., Zhang, H., Smith, S. M., Pickering, R. P., Huang, B., & Hasin, D. S. (2016). Epidemiology of DSM-5 drug use disorder: results from the National Epidemiologic Survey on Alcohol and Related Conditions–III. *JAMA Psychiatry*, *73*(1), 39–47. https://doi.org/10.1001/jamapsychiatry.2015.2132

Greenfield, B. L., & Venner, K. L. (2012). Review of substance use disorder treatment research in Indian Country: future directions to strive toward health equity. *The American Journal of Drug and Alcohol Abuse*, *38*(5), 483–492. https://doi.org/10.3109/00952990.2012.702170

Grodin, E. N., Bujarski, S., Venegas, A., Baskerville, W.-A., Nieto, S. J., Jentsch, J. D., & Ray, L. A. (2019). Reward, relief and habit drinking: initial validation of a brief assessment tool. *Alcohol and Alcoholism*, *54*(6), 574–583. https://doi.org/10.1093/alcalc/agz075

Heinz, A., Löber, S., Georgi, A., Wrase, J., Hermann, D., Rey, E.-R., Wellek, S., & Mann, K. (2003). Reward craving and withdrawal relief craving: assessment of different motivational pathways to alcohol intake. *Alcohol and Alcoholism*, *38*(1), 35–39. https://doi.org/10.1093/alcalc/agg005

Higgins, S. T., Heil, S. H., & Lussier, J. P. (2004). Clinical implications of reinforcement as a determinant of substance use disorders. *Annual Review of Psychology*, *55*(1), 431–461. https://doi.org/10.1146/annurev.psych.55.090902.142033

Hobfoll, S. E., Jackson, A., Hobfoll, I., Pierce, C. A., & Young, S. (2002). The impact of communal-mastery versus self-mastery on emotional outcomes during stressful conditions: A prospective study of Native American women. *American Journal of Community Psychology*, *30*(6), 853–871. https://doi.org/10.1023/A:1020209220214

Hussong, A. M., Jones, D. J., Stein, G. L., Baucom, D. H., & Boeding, S. (2011). An internalizing pathway to alcohol use and disorder. *Psychology of Addictive Behaviors*, *25*, 390–404. https://doi.org/10.1037/a0024519

Koob, G. F., & Moal, M. L. (1997). Drug abuse: hedonic homeostatic dysregulation. *Science*, *278*(5335), 52–58. https://doi.org/10.1126/science.278.5335.52

Koob, G. F., & Volkow, N. D. (2010). Neurocircuitry of addiction. *Neuropsychopharmacology*, *35*(1), Article 1. https://doi.org/10.1038/npp.2009.110

Koob, G. F., & Volkow, N. D. (2016). Neurobiology of addiction: A neurocircuitry analysis. *The Lancet Psychiatry*, *3*(8), 760–773. https://doi.org/10.1016/S2215-0366(16)00104-8

Kwako, L. E., Momenan, R., Litten, R. Z., Koob, G. F., & Goldman, D. (2016). Addictions Neuroclinical Assessment: A neuroscience-based framework for addictive disorders. *Biological Psychiatry*, *80*(3), 179–189. https://doi.org/10.1016/j.biopsych.2015.10.024

Landen, M., Roeber, J., Naimi, T., Nielsen, L., & Sewell, M. (2014). Alcohol-attributable mortality among American Indians and Alaska Natives in the United States, 1999–2009. *American Journal of Public Health*, *104*(S3), S343–S349. https://doi.org/10.2105/AJPH.2013.301648

Les Whitbeck, B., Chen, X., Hoyt, D. R., & Adams, G. W. (2004). Discrimination, historical loss and enculturation: Culturally specific risk and resiliency factors for alcohol abuse among American Indians. *Journal of Studies on Alcohol*, *65*(4), 409–418. https://doi.org/10.15288/jsa.2004.65.409

Litten, R. Z., Ryan, M. L., Falk, D. E., Reilly, M., Fertig, J. B., & Koob, G. F. (2015). Heterogeneity of alcohol use disorder: Understanding mechanisms to advance personalized treatment. *Alcoholism, Clinical and Experimental Research*, *39*(4), 579–584. https://doi.org/10.1111/acer.12669

Malcarne, V. L., Chavira, D. A., Fernandez, S., & Liu, P.-J. (2006). The Scale of Ethnic Experience: development and psychometric properties. *Journal of Personality Assessment*, *86*(2), 150–161. https://doi.org/10.1207/s15327752jpa8602_04

McKiernan, P., Cloud, R., Patterson, D. A., Wolf Adelv Unegv Waya, S., Golder, S., & Besel, K. (2011). Development of a brief abstinence self-efficacy measure. *Journal of Social Work Practice in the Addictions*, *11*(3), 245–253. https://doi.org/10.1080/1533256X.2011.593445

Mohatt, N. V., Thompson, A. B., Thai, N. D., & Tebes, J. K. (2014). Historical trauma as public narrative: A conceptual review of how history impacts present-day health. *Social Science & Medicine*, *106*, 128–136. https://doi.org/10.1016/j.socscimed.2014.01.043

Muthén, B., & Muthén, L. (2017). Mplus. In *Handbook of Item Response Theory*. Chapman and Hall/CRC.

Nutton, J., & Fast, E. (2015). Historical trauma, substance use, and Indigenous Peoples: seven generations of harm from a "Big Event." *Substance Use & Misuse*, *50*(7), 839–847. https://doi.org/10.3109/10826084.2015.1018755

Nylund, K. L., Asparouhov, T., & Muthén, B. O. (2007). Deciding on the number of classes in latent class analysis and growth mixture modeling: A Monte Carlo Simulation dtudy. *Structural Equation Modeling: A Multidisciplinary Journal*, *14*(4), 535–569. https://doi.org/10.1080/10705510701575396

Nylund-Gibson, K., Grimm, R. P., & Masyn, K. E. (2019). Prediction from latent classes: a demonstration of different approaches to include distal outcomes in mixture models. *Structural Equation Modeling: A Multidisciplinary Journal*, *26*(6), 967–985. https://doi.org/10.1080/10705511.2019.1590146

Oetzel, J., & Duran, B. (2004). Intimate partner violence in American Indian and/or Alaska Native communities: A social ecological framework of determinants and interventions. *American Indian and Alaska Native Mental Health Research (Online)*, *11*(3), 49–68. https://doi.org/10.5820/aian.1103.2004.49

Oetzel, J., Duran, B., Jiang, Y., & Lucero, J. (2007). Social support and social undermining as correlates for alcohol, drug, and mental disorders in American Indian women presenting for primary care at an Indian Health Service hospital. *Journal of Health Communication*, *12*(2), 187–206. https://doi.org/10.1080/10810730601152771

Oluwoye, O., Kriegel, L. S., Alcover, K. C., Hirchak, K., & Amiri, S. (2020). Racial and ethnic differences in alcohol-, opioid-, and co-use-related deaths in Washington State from 2011 to 2017. *Addictive Behaviors Reports*, *12*, 100316. https://doi.org/10.1016/j.abrep.2020.100316

Recklitis, C. J., Blackmon, J. E., & Chang, G. (2017). Validity of the Brief Symptom Inventory-18 (BSI-18) for identifying depression and anxiety in young adult cancer survivors: Comparison with a Structured Clinical Diagnostic Interview. *Psychological Assessment*, *29*, 1189–1200. https://doi.org/10.1037/pas0000427

Robinson, T. E., & Berridge, K. C. (1993). The neural basis of drug craving: An incentive-sensitization theory of addiction. *Brain Research. Brain Research Reviews*, *18*(3), 247–291. https://doi.org/10.1016/0165-0173(93)90013-p

Robinson, T. E., & Berridge, K. C. (2001). Incentive-sensitization and addiction. *Addiction*, *96*(1), 103–114. https://doi.org/10.1046/j.1360-0443.2001.9611038.x

Roos, C. R., Bold, K. W., Witkiewitz, K., Leeman, R. F., DeMartini, K. S., Fucito, L. M., Corbin, W. R., Mann, K., Kranzler, H. R., & O'Malley, S. S. (2021). Reward drinking and naltrexone treatment response among young adult heavy drinkers. *Addiction*, *116*(9), 2360–2371. https://doi.org/10.1111/add.15453

Roos, C. R., Mann, K., & Witkiewitz, K. (2017). Reward and relief dimensions of temptation to drink: Construct validity and role in predicting differential benefit from acamprosate and naltrexone. *Addiction Biology*, *22*(6), 1528–1539. https://doi.org/10.1111/adb.12427

Roos, C. R., & Witkiewitz, K. (2016). Adding tools to the toolbox: The role of coping repertoire in alcohol treatment. *Journal of Consulting and Clinical Psychology*, *84*(7), 599–611. https://doi.org/10.1037/ccp0000102

Russo, D., Purohit, V., Foudin, L., & Salin, M. (2004). Workshop on Alcohol Use and Health Disparities 2002: A call to arms. *Alcohol (Fayetteville, N.Y.)*, *32*, 37–43. https://doi.org/10.1016/j.alcohol.2004.01.003

Sayette, M. A. (2016). The role of craving in substance use disorders: theoretical and methodological issues. *Annual Review of Clinical Psychology*, *12*(1), 407–433. https://doi.org/10.1146/annurev-clinpsy-021815-093351

Serier, K. N., Venner, K. L., & Sarafin, R. E. (2019). Evaluating the validity of DSM-5 alcohol use disorder diagnostic criteria in a sample of treatment seeking Native Americans. *Journal of Addiction Medicine*, *13*(1), 35–40. https://doi.org/10.1097/ADM.0000000000000452

Sher, K. J. (2015). Moving the Alcohol Addiction RDoC forward. *Alcoholism, Clinical and Experimental Research*, *39*(4), 591. https://doi.org/10.1111/acer.12661

Skewes, M. C., & Blume, A. W. (2019). Understanding the link between racial trauma and substance use among American Indians. *American Psychologist*, *74*(1), 88–100. https://doi.org/10.1037/amp0000331

Skewes, M. C., Gameon, J. A., Hallum-Montes, R., & Ricker, A. (2021). Determinants of relapse and opportunities for growth: perspectives on substance use among American Indian community members. *Journal of Psychoactive Drugs*, *0*(0), 1–9. https://doi.org/10.1080/02791072.2021.1986241

Skinner, M. D., & Aubin, H.-J. (2010). Craving's place in addiction theory: Contributions of the major models. *Neuroscience & Biobehavioral Reviews*, *34*(4), 606–623. https://doi.org/10.1016/j.neubiorev.2009.11.024

Stewart, S. H., Zeitlin, S. B., & Samoluk, S. B. (1996a). Examination of a three-dimensional drinking motives questionnaire in a young adult university student sample. *Behaviour Research and Therapy*, *34*, 61–71. https://doi.org/10.1016/0005-7967(95)00036-W

Stewart, S. H., Zeitlin, S. B., & Samoluk, S. B. (1996b). Examination of a three-dimensional Drinking Motives Questionnaire in a young adult university student sample. *Behaviour Research and Therapy*, *34*(1), 61–71. https://doi.org/10.1016/0005-7967(95)00036-W

Stohs, M. E., Schneekloth, T. D., Geske, J. R., Biernacka, J. M., & Karpyak, V. M. (2019). Alcohol Craving Predicts Relapse After Residential Addiction Treatment. *Alcohol and Alcoholism*, *54*(2), 167–172. https://doi.org/10.1093/alcalc/agy093

Substance Abuse and Mental Health Services Administration, Office of Applied Studies. (2007). *Treatment Episode Data Set (TEDS). Highlights – 2007. National Admissions to Substance Abuse Treatment Services (DHHS Publication No. 09-4360), 2009. Available at http://wwwdasis.samhsa.gov/*

Tein, J.-Y., Coxe, S., & Cham, H. (2013). Statistical power to detect the correct number of classes in latent profile analysis. *Structural Equation Modeling : A Multidisciplinary Journal*, *20*(4), 640–657. https://doi.org/10.1080/10705511.2013.824781

Tingey, L., Cwik, M., Chambers, R., Goklish, N., Larzelere-Hinton, F., Suttle, R., Lee, A., Alchesay, M., Parker, A., & Barlow, A. (2017). Motivators and influences on American Indian adolescent alcohol use and binge behavior: A Qualitative Exploration. *Journal of Child & Adolescent Substance Abuse*, *26*(1), 75–85. https://doi.org/10.1080/1067828X.2016.1210552

Tonigan, J. S., & Miller, W. R. (2002). The Inventory of Drug Use Consequences (InDUC): Test-retest stability and sensitivity to detect change. *Psychology of Addictive Behaviors*, *16*(2), 165–168. https://doi.org/10.1037/0893-164X.16.2.165

Tonigan, J. S., Miller, W. R., & Brown, J. M. (1997). The reliability of Form 90: An instrument for assessing alcohol treatment outcome. *Journal of Studies on Alcohol*, *58*(4), 358–364. https://doi.org/10.15288/jsa.1997.58.358

Venner, K. L., Serier, K., Sarafin, R., Greenfield, B. L., Hirchak, K., Smith, J. E., & Witkiewitz, K. (2021). Culturally tailored evidence-based substance use disorder treatments are efficacious with an American Indian Southwest tribe: An open-label pilot-feasibility randomized controlled trial. *Addiction*, *116*(4), 949–960. https://doi.org/10.1111/add.15191

Verheul, R., van den Brink, W., & Geerlings, P. (1999). A three-pathway psychobiological model of craving for alcohol. *Alcohol and Alcoholism*, *34*(2), 197–222. https://doi.org/10.1093/alcalc/34.2.197

Vinokur, A. D., & Van Ryn, M. (1993). Social support and undermining in close relationships: Their independent effects on the mental health of unemployed persons. *Journal of Personality and Social Psychology*, *65*, 350–359. https://doi.org/10.1037/0022-3514.65.2.350

Votaw, V. R., Mann, K., Kranzler, H. R., Roos, C. R., Nakovics, H., & Witkiewitz, K. (2022). Examining a brief measure and observed cutoff scores to identify reward and relief drinking profiles: Psychometric properties and pharmacotherapy response. *Drug and Alcohol Dependence*, *232*, 109257. https://doi.org/10.1016/j.drugalcdep.2021.109257

Walls, M. L., Johnson, K. D., Whitbeck, L. B., & Hoyt, D. R. (2006). Mental health and substance abuse services preferences among American Indian people of the Northern Midwest. *Community Mental Health Journal*, *42*(6), 521–535. https://doi.org/10.1007/s10597-006-9054-7

Walters, K. L., & Simoni, J. M. (2002). Reconceptualizing native women's health: An "indigenist" stress-coping model. *American Journal of Public Health*, *92*(4), 520–524. https://doi.org/10.2105/AJPH.92.4.520

Wang, Y., Kim, E., & Yi, Z. (2022). Robustness of latent profile analysis to Measurement noninvariance between profiles. *Educational and Psychological Measurement*, *82*(1), 5–28. https://doi.org/10.1177/0013164421997896

Whitbeck, L. B., Adams, G. W., Hoyt, D. R., & Chen, X. (2004). Conceptualizing and measuring historical trauma smong American Indian people. *American Journal of Community Psychology*, *33*(3–4), 119–130. https://doi.org/10.1023/B:AJCP.0000027000.77357.31

Whitesell, N. R., Beals, J., Crow, C. B., Mitchell, C. M., & Novins, D. K. (2012). Epidemiology and etiology of substance use among American Indians and Alaska Natives: risk, protection, and implications for prevention. *The American Journal of Drug and Alcohol Abuse*, *38*(5), 376–382. https://doi.org/10.3109/00952990.2012.694527

Wilson, A. D., Bravo, A. J., Pearson, M. R., & Witkiewitz, K. (2016). Finding success in failure: using latent profile analysis to examine heterogeneity in psychosocial functioning among heavy drinkers following treatment. *Addiction (Abingdon, England)*, *111*(12), 2145–2154. https://doi.org/10.1111/add.13518

Witkiewitz, K. (2013). Temptation to drink as a predictor of drinking outcomes following psychosocial treatment for alcohol dependence. *Alcoholism: Clinical and Experimental Research*, *37*(3), 529–537. https://doi.org/10.1111/j.1530-0277.2012.01950.x

Witkiewitz, K., & Marlatt, G. A. (2004). Relapse prevention for alcohol and drug problems: that was Zen, this is Tao. *American Psychologist*, *59*(4), 224–235. https://doi.org/10.1037/0003-066X.59.4.224

Witkiewitz, K., & Marlatt, G. A. (2007). Modeling the complexity of post-treatment drinking: It's a rocky road to relapse. *Clinical Psychology Review*, *27*(6), 724–738. https://doi.org/10.1016/j.cpr.2007.01.002

Witkiewitz, K., Roos, C. R., Mann, K., & Kranzler, H. R. (2019). Advancing precision medicine for alcohol use disorder: replication and extension of reward drinking as a predictor of naltrexone response. *Alcoholism: Clinical and Experimental Research*, *43*(11), 2395–2405. https://doi.org/10.1111/acer.14183

Witkiewitz, K., Stein, E. R., Votaw, V. R., Hallgren, K. A., Gibson, B. C., Boness, C. L., Pearson, M. R., & Maisto, S. A. (2022). Constructs derived from the addiction cycle predict alcohol use disorder treatment outcomes and recovery 3 years following treatment. *Psychology of Addictive Behaviors*, No Pagination Specified-No Pagination Specified. https://doi.org/10.1037/adb0000871