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Measuring Subjective Alcohol Effects in Daily Life Using Contemporary Young Adult Language

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Abstract

Young adults' subjective feelings of alcohol's effects are a key predictor of engagement in risky behavior such as deciding whether to drive after drinking. To best inform prevention messaging and tailor intervention techniques that target high-risk drinking, it is critical that our measurement best captures subjective feelings. Standard sliding scales (0 to 100 rating of, "how drunk do you feel?") may have some challenges with distinguishing between levels of subjective responses to alcohol. The current daily diary study compared the utility of the standard sliding scale to a newly developed sliding scale that uses contemporary, crowd-sourced language from young adults as evenly-spaced anchors (*slightly buzzed*, *tipsy/"happy"*, *drunk*, and *wasted*) along a continuum of subjective effects of alcohol. Participants were 154 young adult substance users (58% women) who completed up to 14 consecutive daily reports of their substance use behavior. The four-anchored sliding scale performed similarly well as the standard scale in predicting alcohol use outcomes while showing the advantages of recording higher means/standard deviations and demonstrating that participants used the anchors to denote varying degrees of subjective effects. Findings suggest that the four-anchored subjective alcohol effects sliding scale is a viable alternative to the standard scale. By providing evenly-spaced anchors that reflect incremental differences in language young adults use to describe their subjective states, the proposed scale may provide a guide for participants to indicate how they feel after drinking and may better capture variability in alcohol's effects.

Keywords

alcohol use; young adults; subjective effects; daily diary

Approximately 40% of adults in their early 20s report recent excessive alcohol use (Schulenberg, Johnston, O'Malley, Bachman, Miech, & Patrick, 2018). Moreover, many young adults report acute negative consequences from drinking such as blacking out, getting into physical fights, or sustaining an alcohol-induced injury (White & Hingson, 2013). Ecological momentary assessment (EMA) or assessments of behavior in real or near real

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time, has become ubiquitous for identifying heavy drinking in an alcohol user's natural environment (see Piasecki, 2019) with promising implications for delivering intervention content in moments of risk (Bae, Chung, Ferreira, Dey, & Suffoletto, 2018). In designing momentary interventions such as just-in-time adaptive interventions, there are multiple elements to consider including tailoring variables, decision points, and distal or proximal outcomes (Nahum-Shani, Smith, Spring, Collins, Witkiewitz, Tewari, & Murphy, 2018). Applied to addictive behaviors, a fundamental piece for identifying high-risk alcohol use episodes and tailoring intervention content is based on actual use behaviors. While many options for measuring objective levels of use or intoxication are available (e.g., self-reported alcohol use, level of breath/transdermal alcohol concentration; Fairbairn & Kang, 2019; Piasecki, 2019), there are several concerns with these approaches including potential inaccurate reporting from participants, a device's delay in detection of intoxication (Karns-Wright, Doughtery, Hill-Kapturczak, Mathias, & Roache, 2018), and issues with how to use self-reported number of drinks to best classify binge or "high-risk" drinking (Linden-Carmichael, Russell, & Lanza, 2019; Pearson, Kirouac, & Witkiewitz, 2016).

Subjective intoxication or subjective feelings of alcohol's effects is a critical factor to consider when assessing and intervening on alcohol use behavior. Young adults – especially when heavily intoxicated – tend to underestimate their degree of impairment (Grant, LaBrie, Hummer, & Lac, 2012; Rossheim et al., 2017; Thombs, Olds, & Snyder, 2003). Importantly, decisions to engage in risky behavior, such as whether to drive home after drinking, may be guided more by how drunk they feel than their actual intoxication level (see Aston & Liguori, 2013), likely due in part to higher levels of self-efficacy to drive safely among those who feel less subjectively intoxicated (Rossheim et al., 2015). Such effects are observed in both laboratory-based studies (Marczinski & Fillmore, 2009; Morris, Treloar, Niculete, & McCarthy, 2014) and daily diary work observing real-world behavior (Quinn & Fromme, 2012). Unsurprisingly, subjective intoxication is associated with experience of negative alcohol-related consequences including illicit drug use, unsafe sexual behavior, aggression, and property crime (e.g., Lau-Barraco & Linden-Carmichael, 2019; Quinn, Stappenbeck, & Fromme 2013) and is a robust predictor of blacking out from drinking (Marino & Fromme, 2018).

Common measurement of subjective intoxication in event-level work includes one-item sliding scales of, "How drunk do you feel?" or "How intoxicated do you feel?" accompanied by two anchors ranging from 0 (*not at all drunk* or *completely sober*) to 100 (*extremely drunk* or *drunkest I've ever felt*) (e.g., Heinz, de Wit, Lilje, & Kassel, 2013; Quinn & Fromme, 2011). Although iterations of these metrics are widely used in daily diary/EMA studies and associate with alcohol use outcomes, there is some concern regarding the way in which participants may be using the scale. The terminology individuals use to describe feelings of intoxication has been studied widely (e.g., Cameron et al., 2000; Levine, 1981; Levitt, Sher, & Batholow, 2009; Thickett et al., 2013) with several studies focusing specifically on the use of the word "drunk" (e.g., Barry, Chaney, Stellefson, & Dodd, 2013; Levitt et al., 2009; Reich, Darkes, & Goldman, 2012) given its widespread use in measures of subjective intoxication. In one critical study, the word "drunk" failed to distinguish moderate from high levels of perceived effects from alcohol such that college-aged drinkers used the word "drunk" to reflect a general level of intoxication between moderate and heavy

(Levitt, Sher, & Bartholow, 2009). These differences may, in part, be due to differences in expectancies and one's typical drinking behavior: lighter drinkers tend to rate the word "drunk" as more negative and sedative whereas heavier drinkers tend to rate "drunk" as more positive and arousing. Furthermore, several studies have observed differences in language – including the use of the word "drunk" – to describe feelings of intoxication by gender (Kerr, Yi, & Moreno, 2018; Levitt, Schlauch, Bartholow, & Sher, 2013) and culture and region (Cameron et al., 2000; Thickett et al., 2013). Consequently, standard measures assessing someone's degree of "drunkenness" may not capture the upper bounds of one's intoxication. It is possible that participants may sometimes assign arbitrary values or use the scale to indicate extreme high/low levels of drunkenness. Together, these studies suggest that young adults have an extensive vocabulary for alcohol intoxication, and cautions the use of a single word in self-report measures of subjective intoxication.

Building upon the idea that participants may commonly use certain words to describe incremental differences in alcohol intoxication, Linden-Carmichael, Masters, and Lanza (2020a) developed a sliding scale that incorporates common and contemporary language as anchors. Specifically, Linden-Carmichael and colleagues crowd-sourced data across the U.S., asking young adult participants to generate language they would use to describe how they feel after imbibing in low, moderate, and heavier alcohol use episodes. Researchers identified the most commonly used words used and asked a second sample to rank order these words in order of impairment. This resulted in a sliding scale asking participants, "How did/do you feel after drinking alcohol?" with four evenly-spaced anchors ranging from 0 to 100: *slightly buzzed*, *tipsy/"happy"*, *drunk*, and *wasted*. A key finding from this study in gathering participant data was that participants did not identify the word "drunk" as the top level of intoxication. In fact, in another study using these data, 34% of participants used the word "drunk" to describe a light (3% of participants) or moderate (31% of participants) alcohol use episode (Linden-Carmichael, Allen, & Lanza, 2020b). In contrast, the word "wasted" was commonly used and was used to describe a heavy episode by 100% of the participants who generated this word. Altogether, by providing anchors to guide participants along this continuum of impairment and by intentionally using participants' own language, this scale has the potential to allow participants to better express their own feelings on this anchored metric. Furthermore, there is incredible value in using young adults' language to guide campaign messaging against drunk driving (e.g., the "Buzzed Driving is Drunk Driving" media campaign from the National Highway Traffic Safety Administration). However, to be most effective in reaching higher-risk young adults, media campaigns should be highly selective in the framing of their messaging (Rossheim et al., 2016).

Current Study

The four-anchored sliding scale of alcohol's effects was designed to be used as an efficient assessment tool for use in laboratory-based protocols or EMA studies. Importantly, the extent to which the anchored scale predicts alcohol use outcomes such as number of drinks, high-risk drinking cutoffs, or alcohol-related consequences, has yet to be tested. Consequently, the goal of the current study was to compare the use of the nuanced four-anchored scale ("How did/do you feel after drinking alcohol?" ranging from *slightly buzzed,*

tipsy/"happy", drunk, and *wasted*) to the standard scale ("How drunk did you feel after drinking?" ranging from *not at all* to *drunkest I have ever felt*) in a daily diary study of young adult substance users. The current study had two main aims. First, we sought to descriptively compare the use of both scales on naturally occurring light to moderate drinking days (1 – 3 drinks for women, 1 – 4 drinks for men), heavy episodic drinking (HED) days (4+ drinks for women, 5+ drinks for men; National Institute on Alcohol Abuse and Alcoholism, 2004), and high-intensity drinking days (8+ drinks for women, 10+ drinks for men; Linden-Carmichael, Calhoun, Patrick, & Maggs, 2018; Patrick, 2016). Second, we examined the four-anchored scale and standard scale as individual predictors of alcohol use outcomes including number of drinks consumed, whether HED occurred, whether high-intensity drinking occurred, number of alcohol-related negative consequences, and specific types of alcohol-related consequences. As prior work has identified differences in subjective alcohol responses and language used to describe subjective states across key person-level characteristics (e.g., Grant et al., 2012; Levitt et al., 2013; Pedersen & McCarthy, 2009; Richner, Corbin, & Menary, 2018; Treloar, Celio, Lisman, Miranda, & Spear, 2017), we also tested gender, racial-ethnic group, age, and typical drinking behavior as moderators in all analyses.

Method

Participants and Procedure

The current study is a secondary data analysis of a daily diary study focused on substance use behavior among young adults who use alcohol and cannabis (Linden-Carmichael, Van Doren, Masters, & Lanza, 2020c). To be eligible, participants must have (1) been 18 to 25 years old, (2) reported HED at least once in the past two weeks, and (3) reported combining alcohol and cannabis use at least once in the past month. Participants were recruited through the local university's online research database and through flyers around campus and the surrounding community. Interested participants completed a brief survey to determine eligibility and gather general information. Eligible participants were e-mailed instructions for completing the daily surveys after completing the baseline.

Each morning for 14 consecutive days, participants were sent an e-mail and text message reminder to complete short (M = 3.75 min. per survey) assessments regarding the prior day's behavior. Participants were compensated up to $48 for completing the baseline and daily surveys ($10 for baseline, $2 for each daily survey, and a $10 bonus if they completed 12+ surveys). Compliance for daily surveys was high with participants completing an average of 13.13 (SD = 1.95) out of a possible 14 surveys per person. Data were collected from October 2018 to March 2019. One hundred sixty-one participants were eligible for the current study; of these, 154 participants completed at least one daily survey and were retained for study analyses. Participants were primarily women (57.8%), White (72.7%), and current college students (88.3%). Further details concerning the sample demographics and recruitment process can be found in the parent study (Linden-Carmichael et al., 2020c). All ethical guidelines were followed and study procedures were approved by the institutional review board at The Pennsylvania State University.

Daily Measures

Alcohol use.—Each day, participants were asked whether they had consumed alcohol the day prior and, if so, were provided with follow-up questions regarding the number of standard alcoholic drinks they consumed for each type of alcohol (e.g., beer, wine, liquor). Participants were shown examples of standard alcoholic drinks for reference. Number of drinks were summed across all types of alcoholic beverages to create a composite score. Days with 1 to 3 drinks for women and 1 to 4 drinks for men were coded as *light/moderate alcohol use days*. Days with 4 or more drinks for women and 5 or more drinks for men were coded as *heavy episodic drinking (HED) days.* Days with 8 or more drinks for women and 10 or more drinks for men were coded as *high-intensity drinking days.*

Subjective intoxication.—On days when participants indicated any alcohol use, they were provided with follow-up questions concerning their subjective intoxication using the standard scale and the new four-anchored scale. For the standard scale, participants were asked, "How drunk did you feel yesterday?" with a sliding scale ranging from 0 (*not at all*) to 100 (*drunkest I have ever felt*). For the four-anchored scale, participants were prompted, "Please indicate how you felt after drinking alcohol yesterday" with a sliding scale of anchors at the 0 percentile (labeled *slightly buzzed*), 33rd percentile (labeled *tipsy/"happy"*), 66th percentile (labeled *drunk*), and at the 99th percentile (labeled *wasted*). The standard scale was presented first and the four-anchored scale was presented second. To ameliorate testing effects, participants were asked other questions in between these scales.

Drinking-related negative consequences.—On days involving any substance use, participants were provided the Daily Alcohol-Related Consequences and Evaluations Measure for Young Adults (Lee et al., 2017). Participants were asked to indicate whether a variety of positive and negative consequences occurred as a result of their alcohol or other substance use yesterday with *yes* (1) and *no* (0) response options. Negative consequences were examined for the purpose of the current study and included: had/am having a hangover, became aggressive, felt/am feeling nauseated, hurt/injured self by accident, forgot/am forgetting what I did, embarrassed self, and was rude/obnoxious. Number of negative consequences was determined by summing the number of negative consequences participants positively endorsed.

Data Analytic Plan

A series of multilevel models (MLMs) were used to compare how well the four-anchored subjective effects scale predicted daily-level alcohol consumption and negative consequences in comparison to the standard alcohol intoxication scale. MLMs accounted for the nesting of days within individuals, which violated the assumption of independence in generalized linear regression. Linear MLMs were used to predict the number of drinks participants consumed on a given day, logistic MLMs were used to predict participants' odds of engaging in HED and HID, and Poisson MLMs were used to predict the number of negative consequences experienced. Logistic MLMs were also used to predict odds of experiencing each specific negative consequence. All models were estimated using the lmer() and glmer() functions in the lme4 package (Bates, Maechler, Bolker, & Walker, 2015) of R 3.5 (R Core Team, 2018)

First, bivariate models were estimated to determine the magnitude of the association between each intoxication scale and alcohol outcome variable. Since the two scales both measured subjective alcohol effects and were highly correlated ($r = .92$, $p < .001$), we examined each scale in separate models to reduce the potential of multicollinearity. Three indicators of model fit were used to compare each pair of models. Pseudo-R^2 values for the model fixed effects were calculated using the r.squaredGLMM() function in the MuMIn package (Bartoń, 2019), which uses calculations described by Nakagawa and colleagues (2013, 2017). Pseudo-R^2 values, which are intended to mimic R^2 values from OLS regression (though not perfectly), quantified the amount of variance in the outcome variable accounted for by each model's single fixed effect (i.e., the intoxication scale) and served as the primary indicator of model fit. *Higher* pseudo-R^2 values indicated greater proportions of variance accounted for by the intoxication scale and better model fit. Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) values were used as additional indicators of model fit. *Lower* AIC and BIC values indicated better model fit. Second, individual moderators of gender (men = 1, women = 0), racial-ethnic group (1 = White, 0 = Non-White), age (1 = 21+, 0 = under 21), and typical drinking behavior (1 = binge drank 1+ time during a typical week, 0 = did not binge drink during a typical week) were separately added to each model to determine whether associations between the scales and alcohol outcomes differed as a function of these person-level characteristics. For example, the models testing for moderation by gender used the following general equation:

$$y(\text{Outcome})_{ij} = \gamma_{00} + \gamma_{01}(\text{Gender})_j + \gamma_{10}(\text{Intoxication Scale})_{ij} + \gamma_{11}(\text{Gender})_j(\text{Intoxication Scale})_{ij} + u_{0j}.$$

Results

Descriptive Statistics

Participants provided a total of 2,022 daily surveys; 651 involved any alcohol use and were retained in study analyses. Of alcohol use days, 233 (35.8%) days involved light to moderate alcohol use (1 to 3 drinks for women, 1 to 4 drinks for men), 265 (40.7%) days involved HED but not high-intensity drinking (4 to 7 drinks for women, 5 to 9 drinks for men), and 153 (23.5%) days involved high-intensity drinking (8+ drinks for women, 10+ drinks for men). The mean score reported on the standard scale was 37.52 ($SD = 24.85$) and the mean score on the four-anchored scale was 42.81 ($SD = 28.12$). A scatterplot of scores on the two scales conditioned by level of drinking is presented in Figure 1. This plot shows a strong, positive association between the two scales (as noted above, $r = .92$, $p < .001$) and that level of drinking seemed to increase with intoxication on both scales. Further, it shows that scores on the four-anchored scale (y-axis) appeared to cluster at the 0th, 33rd, 66th, and 99th percentiles. The correlation between the two intoxication scales was .91 ($p < .001$) for women and .93 ($p < .001$) for men.

Standard Subjective Intoxication Scale on Alcohol Use Outcomes

As expected, the standard intoxication scale was positively associated with the amount of alcohol students consumed and the number of consequences they experienced (Table 1). Participants consumed an average of .22 more drinks for each 10-unit increase in reported

intoxication on the standard scale. The pseudo-R^2 value for the fixed effects of this model (i.e., for the standard intoxication scale variable) was .53 meaning that the standard scale predicted approximately 53% of the variance in the number of drinks participants consumed (Nakagawa et al., 2013, 2017). Similarly, each 10-unit increase in reported intoxication on the standard scale was associated with 3.63 and 2.36 times the odds of the participant engaging in HED and high-intensity drinking, respectively. The pseudo-R^2 values for these models were .63 and .42 suggesting that the standard scale predicted approximately 63% and 42% of the variance in HED and high-intensity drinking. Lastly, participants reported experiencing an average of 10% more consequences for each 10-unit increase in reported intoxication on the standard scale. The pseudo-R^2 value for the fixed effects of this model was .09 suggesting that scores on the standard scale accounted for approximately 9% of the variance in negative consequences.

Gender, racial-ethnic group, and age did not moderate the association between standard scale responses and alcohol outcome in any of the four models above (ps < .05). Typical drinking behavior moderated the association between standard scale responses and the likelihood of participants engaging in HED (OR = 1.60, 95% CI = [1.03, 2.50], p < .05). For participants who did not report typically binge drinking on any day of the week, each 10-unit increase in intoxication on the standard scale was associated with 2.39 times the odds of participants engaging in HED (OR = 2.39, 95% CI = [1.58, 3.63], p < .001). For those who reported typically binge drinking on at least one day of the week, each 10-unit increase in intoxication on the standard scale was associated with 3.83 times the odds of engaging in HED (OR = 3.83, 95% CI = [2.85, 5.14], p < .001).

The standard alcohol intoxication scale was positively associated with all specific negative consequences except for having felt nauseated (Table 2). Odds ratios ranged from 1.27 to 2.12 and pseudo-R^2s for fixed effects ranged from .04 to .32 across the six models in which the standard scale significantly predicted a specific negative consequence. For instance, each 10-point increase on the standard scale was associated with 2.12 times the odds of the participant hurting or injuring themselves. The pseudo-R^2 value for the fixed effects in this model was .32, indicating that the standard scale predicted approximately 32% of the variance in participants' reports of getting hurt or injured as a result of drinking.

Four-Anchored Subjective Alcohol Effects Scale on Alcohol Use Outcomes

The four-anchored subjective effects scale performed similarly well as the standard scale in predicting alcohol use outcomes (Table 1). Participants consumed an average of .20 more drinks for each 10-unit increase in reported intoxication on the four-anchored scale. The pseudo-R^2 value for the fixed effects of this model was .56 meaning that the four-anchored scale predicted approximately 56% of the variance in number of drinks (compared to approximately 53% for the standard scale). Similarly, each 10-unit increase in intoxication on the four-anchored scale was associated with 4.06 and 2.30 times the odds of the participant engaging in HED and high-intensity drinking, respectively. Lastly, participants experienced approximately 9% more negative consequences for each 10-unit increase in reported intoxication on the four-anchored scale. Across models predicting these four alcohol use outcomes, pseudo-R^2, AIC, and BIC values suggested that those using the

four-anchored scale fit the data as well as, if not slightly better than, those using the standard scale as evidenced by comparable or *higher* pseudo-R^2 values and comparable or *lower* AIC and BIC values. Gender, age, racial-ethnic group, and typical drinking behavior did not moderate the association between the four-anchored scale and alcohol outcomes in any of the four models above.

The four-anchored subjective alcohol effects scale also performed similarly well in predicting specific negative consequences (Table 2). Odds ratios ranged from 1.23 to 2.20 and pseudo-R^2s for fixed effects ranged from .05 to .44 across the six models in which the four-anchored scale predicted a specific negative consequence. For six of the seven specific negative consequences (i.e., all but blacking out), pseudo-R^2 values suggested that models using the four-anchored scale fit the data as well as or slightly better than those using the standard scale. For all seven specific negative consequences, AIC and BIC values indicated that models using the four-anchored scale fit the data as well as or slightly better than those using the standard scale.

Discussion

The subjective effects a young adult experiences from consuming alcohol is a key factor that predicts their likelihood of engaging in risky behaviors such as deciding whether they feel sober enough to drive after drinking (see Aston & Liguori, 2013). To best inform prevention messaging and tailor momentary intervention techniques, it is critical that our measurement best captures subjective feelings. Thus, the current study examined the utility of a newly developed scale assessing subjective alcohol effects (Linden-Carmichael et al., 2020a). While standard subjective intoxication scales generally ask individuals to mark on a scale ranging from 0 to 100 how intoxicated or drunk they felt, the four-anchored alcohol effects scale uses self-generated and self-rank-ordered contemporary young adult language as anchors along a sliding scale. Given potential variations in young adults' perceptions of the word "drunk" (Levitt et al., 2009; Linden-Carmichael et al., 2020b) and potential arbitrary assignments along a 100-point continuum, the four-anchored scale may (1) serve as a guide for participants in expressing their subjective states and (2) provide researchers with an understanding of how young adults describe alcohol's effects at different levels of drinking and when engaging in risky behavior. Consequently, we assessed the utility of the four-anchored scale in a daily diary study of young adult substance users and compared it to a standard subjective intoxication scale.

As expected, the four-anchored sliding scale was found to be highly correlated with the standard subjective intoxication scale. Ratings on the four-anchored scale were also significantly and positively associated with alcohol use behavior including number of drinks, HED, high-intensity drinking, and number of negative consequences experienced. The four-anchored sliding scale performed similarly well as the standard scale, but there are several key features for consideration. First, the mean levels and standard deviations obtained were slightly higher for the four-anchored sliding scale than the standard scale. This suggests that participants were using the full range more liberally in the four-anchored scale relative to the standard scale. The four-anchored scale used a top anchor of "wasted", which is unambiguously associated with very high levels of intoxication (Linden-Carmichael et al.,

2020a, 2020b). In prior work, the word “drunk” does not consistently differentiate moderate and high levels of intoxication (Levitt et al., 2009) or differentiate moderate from heavy drinking occasions (Linden-Carmichael et al., 2020b), which may cause concerns with using “drunk” as a top-level anchor in standard scales with anchors of “not at all drunk” and “extremely drunk.”

A second, related takeaway from scatterplots was that clusters appeared around the anchors of slightly buzzed, tipsy/”happy”, and drunk. This indicates that participants were using the anchors as guides for describing less extreme levels in addition to using the “wasted” anchor. It is possible that these anchors provide an easier reference point for participants. Although not directly related to the current study, the parent study that developed the four-anchored sliding scale for alcohol’s effects also developed a four-anchored sliding scale for cannabis’s effects using the same procedures. Though data are not presented here, spontaneous feedback was provided by one participant after completing the daily diary study in which they were provided a standard sliding scale of 0 (*not at all high*) to 100 (*extremely high*) as well as a four-anchored scale ranging from *relaxed*, *calm/chill*, *high*, and *stoned/baked* (Linden-Carmichael et al., 2020a). Commenting on the four-anchored cannabis effect sliding scale, a participant wrote: “The number scale of how high did you feel is sort of arbitrary. Some days I may have felt more high than other days but I may have put a number lower than the day before because the numbers don’t mean anything. The scale of relaxed, chill, high is a much better gauge.” Future work could build upon these findings by conducting qualitative research to understand participants’ preferences for expressing alcohol’s effects for both scales.

A final takeaway was that in statistically comparing both scales, models using the four-anchored scale fit the data as well as, if not slightly better than, those using the standard scale across nearly all alcohol use outcomes. Overall, if the results are comparable and participants opt to use the anchors as a guide and the full range of the scale, researchers may consider using this scale in future work assessing subjective effects given its advantage of assigning meaningful, contemporary language to perceived levels of intoxication.

An important next step for disseminating this measure is to examine how participants’ language corresponds to objective levels of intoxication in laboratory-based and momentary assessment studies. While the current study showed strong associations between subjective effects and number of drinks consumed, identifying language used under various BAC levels in a controlled, laboratory-based alcohol administration study, would be highly advantageous (Fleming et al., 2016; Morean et al., 2013; Schuckit, Smith, & Tipp, 1997). Similarly, deployment of this scale in an EMA design could inform how subjective language changes across the course of a drinking episode and corresponds to estimated BAC or transdermal BAC (Piasecki, 2019) in natural environments with multiple external cues (Aston & Liguori, 2013). Findings could serve as the building blocks for developing personalized momentary interventions; for example, based on participants’ subjective feelings, individually tailored messaging could be sent to participants to prevent risky behavior.

Identifying language used at ascending and descending limbs of BAC curves may have important implications for public health campaigns. Specifically, understanding how young adults describe how they feel when they are legally intoxicated but willing to drive could inform framing and messaging in public anti-drunk driving service announcements (Niederdeppe, Avery, & Miller, 2017; Teng, Zhao, Li, Liu, & Shen, 2019). For example, media campaigns from the National Highway Traffic Safety Administration such as "Buzzed Driving is Drunk Driving" have the intentions of suggesting that driving while feeling "buzzed" is equally risky as driving while feeling "drunk." Given that young adults generally view buzzed as describing a lighter drinking episode (i.e., the lowest level of our scale) – an episode that may actually involve only one drink – they may disregard such messaging. As noted by Rossheim and colleagues (2016), media campaigns should be sensitive when using young adult language in anti-drunk driving campaigns; framing messages around "driving after drinking" may better articulate risks to young adults.

There are a few limitations that should be noted. First, the current study sample consisted of young adults who reported recent HED and simultaneous use of alcohol and cannabis. As part of our study aims were to determine whether both scales mapped onto different levels of drinking, it was necessary to include individuals who have recently engaged in heavy drinking to ensure we would receive enough HED reports across a two-week period. Prior work using these data did find that subjective alcohol intoxication did not differ between days in which individuals used only alcohol or used alcohol with cannabis (Linden-Carmichael et al., 2020c), but findings may not necessarily generalize to lighter drinkers or to individuals who do not combine alcohol with cannabis. Second, data were collected from participants residing in a small town adjacent to a large university; thus, most participants were current college students. Study findings may differ in more urban settings or within a sample of non-college-attending young adults. Relatedly, the goals of the study were to develop sliding scales for young adult drinkers as this age group is at highest risk for heavy alcohol use and use disorder relative to any other age group (Substance Abuse and Mental Health Services Administration, 2019). However, many adolescents, middle-aged adults, and elderly adults are at risk for heavy alcohol use. As the language we used was derived from young adult drinkers, our sliding scales may not be as useful for other age groups. Similar procedures could be used to appropriate sliding scales for other age groups. Third, daily diary findings were based on self-reported alcohol use behaviors. Although inquiring about participants' behavior the day after it occurred likely reduces the potential for recall biases, self-reports may still be impacted by social desirability concerns. Finally, the presentation order of the sliding scales was fixed; although we asked other questions in between the scales to reduce the potential of testing effects, it is possible that study findings may have been impacted by order effects.

Findings from the current daily diary study suggest that a four-anchored sliding scale using contemporary young adult language to assess subjective effects of alcohol is a viable alternative to the standard subjective intoxication sliding scale. By providing evenly-spaced anchors that reflect incremental differences in language young adults use to describe their subjective sates, the proposed scale may provide a guide for participants to indicate how they feel after drinking and may better capture variability in alcohol's effects. Future work may consider incorporating these measures in laboratory-based or momentary assessment studies

to examine individual covariation in subjective intoxication language and objective measures of intoxication.

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Public Health Significance:

A newly developed four-anchored sliding scale using contemporary young adult language for assessing subjective alcohol effects is a viable alternative to the standard subjective intoxication sliding scale. By providing evenly-spaced anchors that reflect incremental differences in language young adults use to describe their subjective states, the proposed scale may provide a guide for participants to indicate how they feel after drinking and may better capture variability in alcohol's effects.

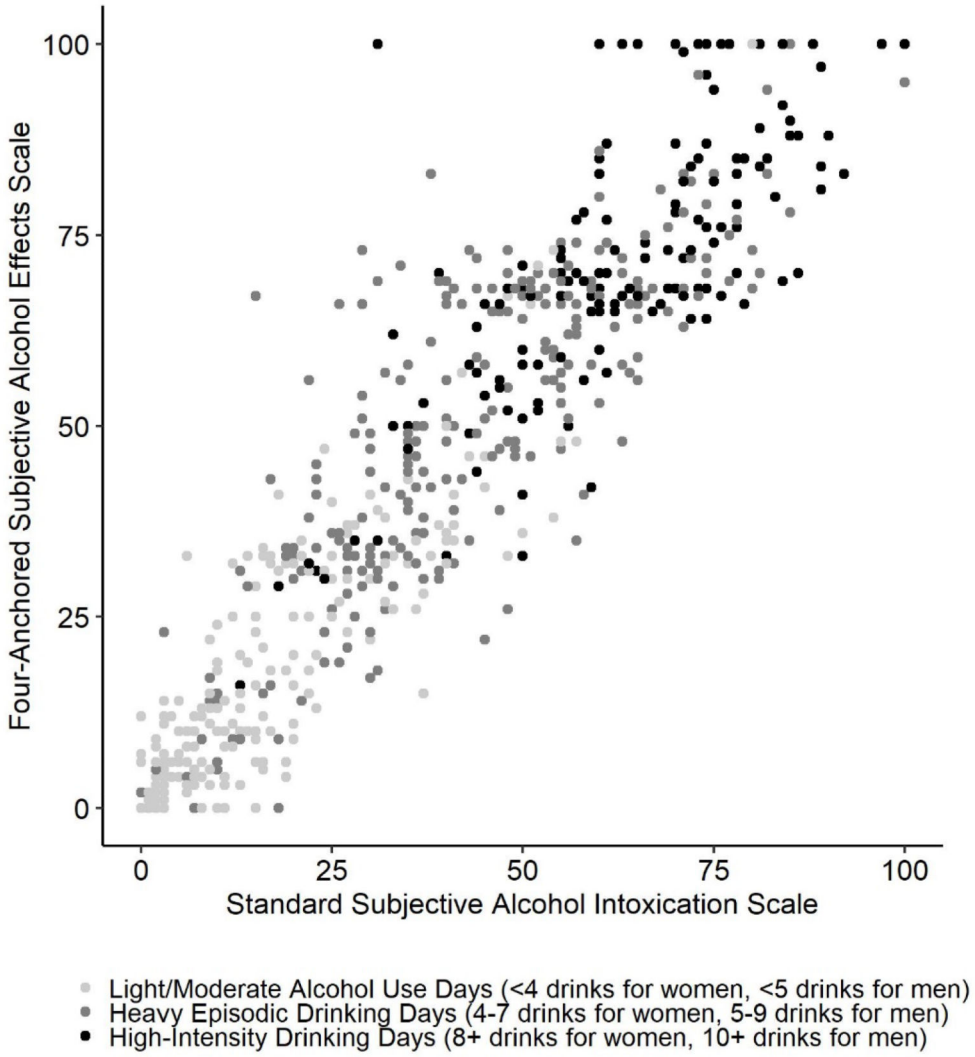

Figure 1.

Scatterplot of scores on the standard subjective alcohol intoxication scale and the four-anchored subjective alcohol effects scale, conditioned by level of drinking.

Table 1

Multilevel Models Predicting Four Alcohol Use Outcomes Using Each Intoxication Scale

Outcome	Scale	Beta (*SE*)	Pseudo-R^2	AIC	BIC
Number of drinks	Standard	.22 (.01)*	.53	894.6	912.5
	Four-anchored	.20 (.01)*	.56	841.2	859.1
Outcome	**Scale**	**Odds Ratio [95% *CI*]**	**Pseudo-R^2**	**AIC**	**BIC**
Heavy episodic drinking (HED)	Standard	3.63 [2.77, 4.74]*	.63	470.7	484.2
	Four-anchored	4.06 [2.84, 5.79]*	.66	428.7	442.1
High-intensity drinking	Standard	2.36 [1.97, 2.83]*	.42	476.5	489.9
	Four-anchored	2.30 [1.90, 2.77]*	.45	466.9	480.3
Outcome	**Scale**	**Incidence Rate Ratio [95% *CI*]**	**Pseudo-R^2**	**AIC**	**BIC**
Number of negative consequences	Standard	1.10 [1.08, 1.13]*	.09	2096.2	2109.6
	Four-anchored	1.09 [1.07, 1.12]*	.10	2080.5	2093.9

Note. N = 635–649 days nested within 147–148 individuals. Pseudo-R^2 indicates the proportion of variance in the outcome variable accounted for by the single fixed effect (Nakagawa et al., 2013, 2017). AIC = Akaike Information Criterion; BIC = Bayesian Information Criterion.

* $p < .001$.

Table 2

Logistic Multilevel Models Predicting Specific Negative Consequences Using Each Intoxication Scale

Outcome	Scale	Odds Ratio [95 % *CI*]	Pseudo-R^2	AIC	BIC
Hangover	Standard	1.90 [1.33, 2.69]**	.10	270.4	283.7
	Four-anchored	1.56 [1.28, 1.91]**	.16	269.8	283.2
Became aggressive	Standard	1.76 [1.46, 2.12]**	.27	323.3	336.6
	Four-anchored	1.73 [1.45, 2.05]**	.33	310.7	324.1
Felt nauseated	Standard	.95 [.87, 1.03]	.00	743.8	757.2
	Four-anchored	.96 [.89, 1.04]	.00	742.4	755.8
Hurt or injured self	Standard	2.12 [1.71, 2.63]**	.32	357.0	370.4
	Four-anchored	2.20 [1.77, 2.73]**	.44	336.1	349.5
Blacked out	Standard	1.66 [1.48, 1.85]**	.25	675.7	689.0
	Four-anchored	1.54 [1.40, 1.69]**	.23	676.4	689.7
Embarrassed self	Standard	1.27 [1.15, 1.40]**	.06	707.9	721.2
	Four-anchored	1.23 [1.13, 1.34]**	.06	704.3	717.6
Was rude or obnoxious	Standard	1.62 [1.07, 2.43]*	.04	124.3	137.7
	Four-anchored	1.53 [1.09, 2.14]*	.05	123.2	136.5

Note. N = 631–637 days nested within 145–148 individuals. Pseudo-R^2 indicates the proportion of variance in the outcome variable accounted for by the single fixed effect (Nakagawa et al., 2013, 2017). AIC = Akaike Information Criterion; BIC = Bayesian Information Criterion.

* $p < .05$

** $p < .001$.