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Examining the Ecological Validity of the Prototype Willingness Model for Adolescent and Young Adult Alcohol Use

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Abstract

Objective: The present study is the first ecologically valid, daily-level test of the Prototype Willingness (PWM), a model previously tested with hypothetical scenarios to investigate the social reaction and reasoned pathways toward engaging in health-risk behavior. The purpose of the present study is to examine whether days with elevated alcohol-favorable PWM cognitions are also associated with greater intentions and willingness to drink and increased drinking behavior on that day.

Methods: Participants included 15-25 year olds (N = 124; 57.3% female; mean age 18.7 (*SD* = 2.87)) who were part of an ecological momentary assessment (EMA) study on drinking cognitions (including willingness, intentions, perceived vulnerability, social norms, prototype favorability)

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Part of these findings were presented at the annual Collaborative Perspectives on Addiction Meeting, Providence, RI.

and alcohol use, reported across three weeks. Analyses accounted for the multilevel structure of the data and the various outcome distributions.

Results: Findings supported and advanced the PWM by using real-time, real-world daily data that captured within-person variation of PWM cognitions across days and showed daily-level associations between PWM cognitions and alcohol use and negative consequences among adolescents and young adults, thus supporting the social reaction and reasoned pathways at the daily level.

Conclusions: Current results may improve interventions by precisely informing the use of technology to bring interventions to adolescents and young adults in moments when they are at highest risk (i.e., days with higher than usual PMW alcohol cognitions).

Keywords

Prototype Willingness Model; ecological momentary assessment; alcohol; drinking; cognitions; adolescent; young adult; underage

An estimated 30% of 12th grade high school students report any alcohol use in the past 30 days and 13.8% report having 5 or more drinks in the past two weeks (Johnston et al., 2019). Research concerning the initiation and progression of adolescent alcohol use indicates that most youth initiate use by experimenting with alcohol during adolescence and that early experimentation can lead to later hazardous alcohol use (e.g., Bolland et al., 2016). Accordingly, identifying important cognitive factors and testing theoretical models associated with alcohol use in adolescence and young adulthood may help inform the development and refinement of effective prevention programs.

Prototype Willingness Model of Health-Risk Decision Making

The Prototype Willingness Model (PWM) is a modified dual process model positing that health-risk decision making is influenced by two pathways to health risk: one that is based on heuristics and affect (and therefore reactive to social situations) and one that is based on analytic reasoning (Gerrard, Gibbons, Houlihan, Stock, & Pomery, 2008). The social reaction pathway centers around behavioral willingness, which varies as a function of perceived vulnerability, descriptive norms, and prototypes. Perceived vulnerability is the perceived chance of experiencing a consequence if one were to engage in a behavior (Gerrard et al., 2008). Descriptive norms refer to the perceived quantity and frequency of peer behavior (Cialdini, Kallgren, & Reno, 1991). Prototypes are images of the type of person who engages in specific risk behaviors (Gerrard et al., 2008). Central to the PWM, health behaviors are viewed as social reactions to risk-conducive situations and are captured by willingness, which is defined as an openness to risk opportunity, and is measured by questions about what individuals would be willing to do in hypothetical situations (Gerrard et al., 2008). The reasoned pathway relies on reasoned processing as seen in the Theory of Reasoned Action (TRA; Fishbein & Ajzen, 1975) and is based on intentions, which vary as a function of attitudes and injunctive norms. Intentions are goals that are formulated after some consideration, and attitudes reflect the global positive and negative evaluations of a behavior (Armitage & Conner, 2001). Injunctive norms refer to the perceived correctness of

a behavior (Cialdini et al., 1991). The PWM addresses intentional behavior as well as volitional behavior that is reactive to risk-conducive situations (i.e., circumstances that facilitate but do not require or demand risky behaviors) involving social interactions and peers. Moreover, the PWM suggests that the reasoned and social reaction pathways can, and often do, operate simultaneously (Gerrard et al., 2008). As such, the dual-processing nature of the PWM may improve prediction of adolescent and young adult health-risk outcomes compared to other models.

The PWM has been applied to a variety of health-risk behaviors including cigarette smoking, marijuana use, other illicit substance use, and unsafe sex (e.g. Andrews, Hampson, & Barckley, 2008; Dodge, Stock, & Litt, 2013; Hampson, Andrews, & Barckley, 2008; Houlihan et al., 2008; Rivis, Sheeran, & Armitage, 2010). The predictive utility and validity of the PWM at the cross-sectional and longitudinal levels has been well supported. Research has demonstrated that the social reaction pathway explains variance over and above the reasoned pathway (i.e., the traditional pathway of the TRA) when examining adolescent and young adult substance use, including alcohol (Gerrard, Gibbons, Cleveland, Brody, & Murry, 2005; Litt et al., 2014; Pomery, Gibbons, Reis-Bergan, & Gerrard, 2009; Zimmermann & Sieverding, 2010). This extant research, relying on retrospective reports in cross-sectional or longitudinal studies, has largely focused on between-person differences, showing that people who report more alcohol-favorable PWM cognitions also report higher intentions and willingness to drink (e.g., Andrews, Hampson, & Peterson, 2011; Litt et al., 2014; Zimmerman & Sieverding, 2010). Because of the nature of retrospective self-report, research on the PWM also focuses largely on the global, hypothetical assessment of willingness (e.g., Suppose you are at a party with friends who were drinking, and they offered you alcohol. How willing would you be to drink?). Little is known about how willingness translates to naturally occurring health-risk situations, or how it relates to behavior on specific occasions. Hypothetical scenarios do not allow for an examination of 1) variability in willingness that results from real-world situations, and 2) variability in willingness due to fluctuations in PWM risk cognitions (i.e., perceived vulnerability, descriptive and injunctive norms, and prototypes).

Testing Ecological Validity of PWM Through Ecological Momentary Assessment

Ecological Momentary Assessment (EMA; Shiffman, Stone, & Hufford, 2008; Shiffman, 2009) methods are designed to help researchers obtain ecologically valid data about behavior and cognitions over time, while avoiding the pitfalls of retrospective recall. Specifically, EMA involves repeated administration of assessments in real time (or close to real-time for when the behavior of interest occurs) in subjects' natural environments (Shiffman et al., 2008). EMA data may further enhance the predictive utility of the PWM by examining relevant constructs in naturally occurring situations, increasing potential to develop or refine interventions based on daily risk cognitions in relation to risk-conducive situations. Notably, EMA data allow us to distinguish the *within*- vs. *between*-person effects of variation in cognitions about alcohol use. This allows the examination of real-world fluctuations in these cognitions (i.e., within-person across days) independent of individual

differences in the cognitions (i.e. between-person) (Curran & Bauer, 2011; Enders & Tofighi, 2007).

The Present Study

Adolescent and young adult alcohol use is an ideal health risk behavior in which to examine an ecologically valid, daily-level test of the PWM. The current study is the first ecologically valid, daily-level examination of the PWM that evaluates both within-person effects (e.g., whether on days people report elevated alcohol-favorable PWM drinking cognitions, do they also report more intentions and willingness to drink and increased drinking behavior?), and between-person effects (e.g., do people who have more favorable alcohol PWM drinking cognitions, on average across days, have higher intentions and willingness to drink on any given day?). EMA methodology allows for a more explicit test of in-the-moment decision-making cognitions effects on alcohol behaviors among adolescents and young adults. Differences in risk-conducive situations from day-to-day (that cannot be examined in global, hypothetical scenarios) may help to explain individual differences in the strength of the daily association between PWM risk cognitions and risk behavior.

Focusing on within-person variation, we expected that on days with more approving attitudes and higher injunctive norms than average, individuals would report higher intentions to drink, subsequent drinking, and consequences (*reasoned pathway*). On days with lower perceived vulnerability, higher descriptive norms, and higher prototype favorability than average, we expected individuals would report higher willingness, drinking, and consequences (*social reaction pathway*).

We also expected all between-person findings to replicate those of prior studies. Individuals, who on average, reported more approving attitudes and injunctive norms would report higher average intentions to drink, more drinking, and more consequences across the study period (*reasoned pathway*). Individuals, who on average, reported lower perceived vulnerability, higher descriptive norms, and higher prototype favorability were expected to report higher average willingness to drink, more drinking, and more consequences across the study period (*social reaction pathway*).

Although the focus of the current study was to examine the ecological validity of the PWM on adolescent and young adult alcohol use, it is important to consider other relevant between- and/or within-person factors related to alcohol use. Thus, we considered daily-level affect and perceived access to alcohol as important covariates.

While the present findings are predicted based on the PWM, this study is of importance because the theory may not necessarily hold true at the daily level. Prior research has shown inconsistent findings when comparing cross-sectional and longitudinal research to daily or ecological momentary research (e.g., the associations between alcohol expectancies and alcohol outcomes or associations between use of protective behavioral strategies and alcohol outcomes, e.g., Lewis, Patrick, Lee, Kaysen, Mittman, & Neighbors, 2012; Nicolai, Demmel, & Moshagen, 2010; Patrick, Cronce, Fairlie, Atkins, & Lee, 2016; Pearson,

D'Lima, & Kelley, 2013; Sell, Turrisi, Cleveland, & Mallett, 2018). Thus, the present study will be significantly extending the PWM by testing it at the daily level.

Method

Participants

Participants included 15-25 year olds (N=124) who were part of an EMA study of drinking cognitions and alcohol use reporting across three weeks. Participants completed an online screening assessment, phone verification call, and an in-person baseline assessment and in-person EMA training session. Following the training session, participants were assessed using a 3-week EMA design.

Mean age of those enrolled in the EMA study was 18.7 years (SD = 2.87). Biological sex, ethnic, and racial representation of the sample was 57.3% female, 7.3% Hispanic/Latino, 59.7% White, 15.3% Asian, 13.7% more than one race, 7.3% Black, and 4.0% Other/Mixed. The majority (86.3%) of the sample reported being a current student. Of those who were current students, 40.3% were in high school, 33.9% attended a 4-year college, 4.8% attended a 2-year college, 4.8% were attending pre-college courses in high school, 1.6% attended graduate or professional school, and 0.8% attended an alternative high school. For highest degree, 43.5% had less than a high school diploma, 23.4% had some college, 18.5% had a high school diploma, 9.7% had a bachelor's degree, and 4.8% had an associate's degree.

Procedures

All study procedures were approved by the University's Institutional Review Board, and no adverse events were reported. Recruitment for this study was conducted in the greater Seattle metropolitan area through online recruitment, print advertisements, participant referrals, and flyers. Interested individuals were asked to complete a brief, online screening survey to determine eligibility for the EMA study. Eligibility criteria were 1) being age 15 to 25; 2) either reporting drinking alcohol at least once a month (over the last 6 months) if age 18 or over, or no drinking criteria for those age 15-17; 3) residing in the Seattle area; 4) providing valid contact and demographic information (including first and last name, phone number and email address, birthdate consistent with their age, birth sex, and gender); 5) agreeing to receive text reminders on their cell phone about completing the surveys; 6) if female, must not be pregnant or trying to get pregnant; 7) correctly answering validity check items to rule out computerized responses; 8) have internet access throughout the day; and 9) be willing to come to study offices for a 1-1.5 hour in-person session. Figure 1 provides details about the number of individuals at each stage of the screening and recruitment process and reasons that individuals were excluded.

All individuals read a brief informational statement ahead of the screening survey and were required to provide consent to complete the screening survey. Individuals 15-17 years old who completed the screening survey were required to provide valid contact information for at least one parent (i.e., first and last name, phone number, email, mailing address). Those who met initial eligibility had at least one parent/guardian contacted to obtain informed

consent. Consent for the teen's (15-17) participation in the study was obtained from one parent/guardian either online or by phone (see details in Figure 1).

Participants ages 15-17 whose parents had provided consent and 18-25 year olds who had met initial eligibility on the screening were then stratified based on demographic needs (i.e., biological sex, age, typical drinks per month) to ensure a diverse sample. Within each age category (e.g., 15 year olds), individuals were stratified by biological sex and typical drinks per month (0 drinks per month, 1-5 drinks per month, 6+ drinks per month). After stratification, eligible participants were telephoned to complete a phone screen to verify certain information and to exclude individuals who may have provided false answers or were professional survey takers. Screening phone calls typically lasted 5 minutes, and those with continuing eligibility were invited to complete an in-person training session and baseline assessment (N=142). Of the 142 participants that were invited, 124 participants completed the baseline survey and the in-person session.

In-person session for consent, baseline, and training.—Participants read an online information statement that described the procedures for the full study (including the daily surveys). After providing consent online, participants completed the baseline survey on a secure computer in the study lab. Participants were then trained on how to complete the daily survey portion of the study with a trained staff member and received a study pamphlet and a calendar depicting when the daily surveys would occur. The staff member reviewed the pamphlet, including the incentive schedule, how to complete the daily surveys, and provided an explanation of the terms "willingness" and "intentions" to engage in a behavior.

EMA methods.—This study utilizes EMA data collection to assess the daily associations between drinking cognitions and alcohol use across three weekends and four random weekdays. Participants received three weeks of surveys: up to 11 online surveys per week for 3 consecutive weeks, for a possible total of 33 online surveys. Participants always received 3 surveys on both Friday and Saturday, and 1 survey on Sunday. For two of the three weeks, participants received 3 surveys on a random weekday between Monday and Thursday, which was always followed by 1 morning survey the next day (i.e., 3 surveys on Tuesday, 1 survey on Wednesday morning). Online surveys were programmed to be completed either on a smartphone or computer. On average, the time to complete the surveys was 6.54 minutes for the morning (SD =11.17), 6.93 minutes for the afternoon (SD =14.05), and 4.54 for the evening (SD =10.78).

Surveys occurred in 3 time windows: 1) morning surveys were available between 6:00 AM-10:00 AM at a 2-hour time window chosen by the participant; 2) afternoon surveys were available between 12:00 PM-4:00 PM, and 3) evening surveys were available between 5:00 PM-10:00 PM. Participants did not choose the time they received their afternoon and evening surveys; these surveys were available to participants in randomly selected 2-hour time windows. Participants received a text and email invitation when each survey window was opened and had two hours to complete each survey (i.e., if a participant was invited at 12:00 PM, they had until 2PM to complete their survey). If participants had not yet completed their survey 30 minutes prior to the close of the survey window, they received a text and email reminder at that time. If a participant missed a morning survey, additional

questions were administered in the next survey completed that same day (either afternoon or evening) to obtain responses on key questions (e.g., alcohol use on the previous day) from the missed morning survey.

Participants earned up to $111 for study participation: $50 for baseline, $1 for each morning survey, $2 for each afternoon and evening survey, and a $10 bonus if they completed 90% or more of the daily surveys during the study period. More than 85% of the daily surveys were completed across all participants (85.43% for morning, 89.43% for afternoon, 87.10% for evening; see Figure 1 for details).

Measures

Baseline measures.—Participants reported demographics, including age and biological sex (coded 0 = female and 1 = male). Perceived access to alcohol, assessed at baseline, was included as a covariate and was measured with a modified version of The Perceived Access to Alcohol and Other Drug Scale (Kuntsche, Kuendig, & Gmel, 2008). Four items assessed how difficult the participant thought it would be to get: alcohol (any type), beer, wine, or spirits (α = .94). Responses were on a 5-point scale ranging from 0 (*impossible*) to 4 (*extremely easy*).

Daily measures.—In the morning survey, participants reported on alcohol use and consequences from the previous day. Daily reports of all PWM cognitions were taken from the afternoon survey. To examine how PWM cognitions are associated with later day drinking, we utilized afternoon cognitions that would likely occur prior to drinking, which typically occurs later in the evening. Unless otherwise noted, mean scores were used in the analyses.

Alcohol use.: Participants were asked, “Since the time you woke up to the time you went to sleep yesterday, did you drink alcohol?” (0 = *no* and 1 = *yes*). If yes, participants reported the number of drinks consumed yesterday from 1 (*1 drink*) to 15 (*15 or more drinks*). One drink was defined as 5 oz. of wine, 12 oz. of beer (e.g., 10 oz. of Microbrew; 8 oz. of Malt Liquor), 10 oz. of wine cooler, or 1 cocktail with 1 oz. of 100 proof liquor or 1 ¼ oz. of 80 proof liquor.

Alcohol-related consequences.: Participants reported whether or not each of 12 things happened to them yesterday while they were drinking, or today because of their alcohol use yesterday (0 = *no* and 1 = *yes*). Items were adapted from (Lee et al., 2016) and included had a hangover, became aggressive, felt nauseated or vomited, injured myself by accident, couldn’t remember what I did while drinking, unable to do schoolwork, was rude or obnoxious, did something that embarrassed me, got in trouble, did something I regret, did something I wouldn’t normally do when sober, and got into a fight/argument. Items were summed to create a total score for number of consequences experienced as a result of drinking.

Drinking intentions.: Drinking intentions or plans for tonight were measured using the question stem, “I intend to drink….” Three items referred to participants’ intention to drink different amounts of alcoholic drinks tonight: 1) 4/5 or more (females/males) alcoholic

drinks, 2) 1-3/1-4 (females/males) alcoholic drinks, and 3) any alcoholic drinks. Responses were on a 5-point scale ranging from 0 (*strongly disagree*) to 4 (*strongly agree*) (α = .92).

Drinking willingness.: Drinking willingness was measured using the question stem, "If a situation arises where you have the opportunity, how willing (i.e., open) are you to drink…." Three items referred to participants' willingness to drink different amount of alcoholic drinks tonight (see "drinking intentions" measure). Responses were on a 5-point scale ranging from 0 (*not at all willing to drink*) to 4 (*very willing to drink*) (α = .94).

Attitudes.: Drinking attitudes were measured using the question stem, "On this [DAY OF SURVEY (e.g., "Friday")] night, you think that drinking [amount of alcohol] would be…" Three items referred to participants' attitudes about drinking different amounts of alcoholic drinks (see "drinking intentions" measure). Responses were on a 5-point scale ranging from 0 (*very bad*) to 4 (*very good*) (α = .92).

Injunctive norms.: Injunctive norms were measured using the question stem, "On this [DAY OF SURVEY (e.g., "Friday")] night, your friends think that drinking [amount of alcohol] would be…." Three items referred to drinking different amounts of alcoholic drinks (see "drinking intentions" measure). Responses were on a 5-point scale ranging from 0 (*very bad*) to 4 (*very good*) (α = .93).

Perceived vulnerability.: Perceived vulnerability was measured using the question stem, "How likely is it that something bad will happen to you tonight if you…." Four items referred to drinking different amounts of alcoholic drinks (see "drinking intentions" measure for three items). The fourth item referred to, "do not drink alcohol" (reverse-scored). Responses were on a 5-point scale ranging from 0 (*not at all likely*) to 4 (*very likely*) (α = .76).

Descriptive norms.: Three items assessed descriptive norms by asking participants to estimate their friends' drinking tonight. Participants were queried about how many alcoholic drinks, on average, they think their friends will individually consume with responses from 1 (*1 drink*) to 15 (*15 or more drinks*). Using open-ended items from 0% to 100%, participants reported the percentage of friends they thought would drink alcohol tonight and the percentage of friends they think will drink 4/5 [females/males] or more alcoholic drinks. Prior to calculating the mean scores, response values were rescaled so that all three items were on a similar scale: number of drinks was divided by 10 and the two items asking percentages were each divided by 100 (α = .85).

Prototype favorability.: Prototypes were assessed by instructing participants to "think about the typical [male/female] your age who drinks alcohol on [DAY OF SURVEY (e.g., "Friday")]". Participants rated the degree to which each of six words describes the image of that person. The six words were smart, attractive, and popular as well as impulsive, immature, and careless (reverse-scored). Responses were on a 5-point scale ranging from 0 (*not at all*) to 4 (*extremely*) (α = .81).

Affect.: For inclusion as covariates, positive and negative affect were measured with the 20-item Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegan, 1988). Ten items assessed positive affect, including interested, excited, and enthusiastic (α = .91). Ten items assessed negative affect, including distressed, upset, and irritable (α = .89). Participants reported the extent to which they felt each emotion "right now." Affect was only assessed in the evening survey. Responses were on a 4-point scale ranging from 0 (*very slightly or not at all*) to 3 (*quite a bit*).

Analytic Plan

To predict intentions and willingness, we estimated multilevel models with the nlme package in R 3.4.2 (Pinheiro, Bates, DebRoy, Sarkar & R Core Team, 2018). To predict alcohol use, we used a mixed effects hurdle negative binomial model with the glmmADMB package, (Skaug, Fournier, Nielsen, Magnusson, & Bolker, 2013), because there was sufficient variability in the number of drinks reported among those who reported drinking in order to separately predict the occurrence of drinking that day and the number of drinks consumed. Because alcohol consequences were sparse, consequences were best estimated as presence/absence in a mixed effects logistic regression model with lme4 using the glmer function (Bates, Maechler, Bolker, & Walker, 2015). All models were specified as random intercept-only models to account for clustering within individuals. We did not estimate random slopes for any predictors as we did not have hypotheses about individual differences in the reasoned or social reaction pathways to drinking consequences; thus, reducing potential estimation problems and concerns about model over-fitting (McNeish, Stapleton, & Silverman, 2017). All daily predictors were centered both between- and within-person, which created independent estimates of daily fluctuations from a person's own average (within-person) as well as differences between person-level averages and the sample mean (between-person). In this approach, within-person variables are computed by subtracting each person's mean from each of their daily observations, while between-person variables are created by averaging all daily observations for each person, and subtracting that person-specific average from the grand mean of the sample (Enders & Tofighi, 2007).

We tested a series of three models for each of the reasoned and social reaction pathways. We first tested whether within- and between-person variability in cognitions were associated with intentions (or willingness) to drink. Then, we tested the effects of cognitions and intentions (or willingness) on alcohol use and alcohol consequences.

Although the focus of the current study was to examine the ecological validity of the PWM on adolescent and young adult alcohol use, it is important to consider other relevant between- and/or within-person factors related to alcohol use. Affect regulation is central to several theoretical models of substance use, with many models positing that individuals drink alcohol in part because of its actual or expected effects for decreasing negative affect and for increasing positive affect (Cooper, 1994; Cox & Klinger, 1988). We controlled for negative and positive affect (within-person), age, sex, and access to alcohol in all models. We also included weekend/weekday, day of the survey, and month as covariates to control for potential time and seasonality effects.

Results

Descriptive Information

Table 1 provides descriptive statistics and correlations of all variables (all correlations are significant at $p < .001$). There was a large correlation between intentions and willingness ($r = .78$), and all PWM cognitions were generally moderately to highly correlated. Overall, participants reported drinking on 21% of days, with a mean of 3.97 drinks per drinking occasion (range = 1 – 15). Among participants ages 15-18, drinking was reported on 8% of days, with a mean of 5.23 drinks per drinking occasion (range = 1 – 15). Among participants ages 19-25, drinking was reported on 39% of days, with a mean of 3.70 drinks per drinking occasion (range = 1 – 13). For the full sample, participants reported alcohol-related consequences on 7% of all days, or 35% of all drinking days. Among younger participants (ages 15-18), alcohol-related consequences were reported on 3% of all days, or 37% of all drinking days. Among older participants (ages 19-25), alcohol-related consequences were reported on 12% of all days, or 30% of all drinking days. Being older was associated with more drinking occasions ($r = .40$, $p < .01$) and more consequences ($r = .19$, $p < .01$); however, being younger was associated with more drinks per occasion ($r = -.15$, $p < .01$).

The Reasoned Pathway

Predicting intentions to drink.—First, we tested the effects of reasoned pathway variables (i.e., attitudes, injunctive norms) on intentions to drink using multilevel models. Results (presented in top half of Table 2) indicated that, controlling for the covariates, within-person variation in attitudes and injunctive norms were associated with same-day intentions to drink. On days when a person reported elevated positive alcohol-related attitudes or injunctive norms (i.e., higher than their own average), they also reported higher intentions to drink that day. Between-person variation in attitudes, but not injunctive norms, was associated with higher intentions to drink that same day. Participants who reported an average level of attitudes that were more positive than other participants, also tended to report a higher average level of intentions than other participants across the sampled days.

Predicting alcohol use.—For the reasoned pathway (see Table 3), only intentions to drink (between- and within-person), predicted either the likelihood of drinking or the count of drinks. When all other covariates were at zero, people who reported higher intentions than what was usual for them (RR = 1.33; OR = 2.71), or those who had higher intentions on average overall (RR = 1.47; OR = 2.61), were more likely to drink and report a higher number of drinks on a given day.

Predicting alcohol-related consequences.—In terms of alcohol-related consequences (see Table 4), only within-person variation in intentions was associated with the likelihood of consequences. Holding all other covariates at zero, when a person's intentions to drink were 1 unit higher than what was typical for them, their odds of reporting alcohol-related consequences were nearly 3 times higher (OR = 2.92).

The Social Reaction Pathway

Predicting willingness to drink.—Within- and between-person variation in nearly all predictors was associated with willingness to drink. Within-person, on days when descriptive norms were elevated, or prototypes were viewed as more favorable than what was usual, participants were more willing to drink on a given day. The effect of within-person fluctuations in perceived vulnerability was not significant. Between-persons, people who reported higher descriptive norms, viewed prototypes more favorably, and reported lower perceived vulnerability across the study period were more willing to drink across all observations. See bottom portion of Table 2.

Predicting alcohol use.—Above and beyond the effects of the covariates, between- and within-person variation in willingness was associated with a higher likelihood of and level of alcohol use (see Table 5). A person who reported higher than typical willingness to drink on any given day was more likely to later report alcohol use and to drink more that same day (OR = 2.47, RR = 1.24). People who reported higher willingness to drink than others were more likely to report drinking and to drink more (OR = 2.06, RR = 1.23). Within-person variation in norms were associated with both the likelihood (OR = 1.53) and level (RR = 1.52) of alcohol use, while only between person differences in prototypes were associated with the likelihood (OR = 1.51) of drinking.

Predicting alcohol-related consequences.—For the social reaction pathway (see Table 6), within-person (OR = 2.29) and between-person (OR = 1.99) fluctuations in willingness to drink were associated with a higher likelihood of alcohol-related consequences. Within-person fluctuations in norms (OR = 2.13) were also associated with consequences.

Discussion

The present findings provide unique support for the PWM. This is the first study to show that PWM cognitions varied from day to day within persons, and that fluctuations in PWM cognitions (e.g., elevated cognitions on a given day) predicted drinking behavior in a sample of adolescents and young adults. Overall, findings support the reasoned pathway of the PWM: within-person fluctuations for attitudes and intentions were associated with higher same-day intentions to drink, which predicted that a person was more likely to: 1) drink, 2) report a higher number of drinks, and 3) have a higher likelihood of consequences on a given day. In terms of the social reaction pathway of the PWM, within-person variations in descriptive norms and prototype favorability (but not perceived vulnerability) were associated with higher willingness to drink, which was associated with a higher likelihood to: 1) drink, 2) report more drinks, and 3) experience more consequences. As part of the social reaction pathway of the PWM, perceived vulnerability may be more context-specific than the other social reaction pathway cognitions. Future research may need to examine perceived vulnerability throughout a drinking occasion in order to conduct a more in depth and context-specific assessment of this construct.

The present findings may be expected based on the basic tenets of the PWM; however, our ability to test the research questions using daily-level data is important because the theory

may not necessarily have held true at the daily level. For example, research has demonstrated inconsistent patterns of findings comparing cross-sectional and longitudinal research to daily or ecological momentary research (e.g., the associations between alcohol expectancies and alcohol outcomes or associations between use of protective behavioral strategies and alcohol outcomes, e.g., Lewis, Patrick, Lee, Kaysen, Mittman, & Neighbors, 2012; Nicolai, Demmel, & Moshagen, 2010; Patrick, Cronce, Fairlie, Atkins, & Lee, 2016; Pearson, D'Lima, & Kelley, 2013; Sell, Turrisi, Cleveland, & Mallett, 2018). Findings from the present study significantly move the field forward as they advance the PWM by using real-time, real-world daily data that captures within-person variation across all constructs of the PWM, demonstrating its ecological validity. To date, research on the PWM has exclusively focused on how between-person differences in retrospective reports of hypothetical scenarios predict between-person differences in health-risk behavior, including alcohol use. It has long been established that traits (referring to between-person differences) and states (referring to psychological processes that can vary over time for a given individual) are poorly correlated. Further, retrospective recall of substance use is known to be biased for many reasons (Shiffman, 2009). The current state of the PWM literature can only attest to the notion that when asked to recall retrospectively, people who say they are generally more willing to drink also report more drinking overall. Consequently, existing PWM literature that focuses on between-person differences cannot make the much-needed contributions that can advance interventions because this research does not identify *when* risk is highest. The present findings move the field forward as they have potential to improve the ways and the precision of delivering preventative-interventions to adolescents and young adults in moments when they are at an increased risk, through the use of technology; thus, having potential for significant public health impact. Demonstrating within-person variation of all PWM risk cognitions and how days with elevated PWM risk cognitions (compared to one's own average) relate to increased risk behavior supports in-the-moment targeting of risk cognitions. Moreover, examining an ecologically valid, daily-level test of the PWM with adolescent and young adult alcohol use can inform PWM-based interventions related to other health-risk behaviors at the daily level, such as tobacco use, other substance use, and sexual decision making.

With major shifts in technology (e.g., smartphone apps) that allow for more efficient and efficacious tailoring, we have the ability to personalize interventions by focusing on days and moments that individuals report elevated high-risk PWM cognitions. For example, smartphone app technology can apply the findings from this study to advance interventions to include personalized, continuous, and extended intervention delivery. The PWM posits that for some, risk behavior is a reaction to being in risk-conducive situations, and an app has the potential to reach adolescents and young adults when they are the most at risk, specifically on days with higher than average PWM risk cognitions. A smartphone app intervention would allow modification of intervention content based on individual's current in-the-moment cognitions. The information provided from the current findings can shed light on the necessary precision regarding which cognitive factors to target thus offering the potential to make a substantial impact on lasting behavioral changes in health-risk behavior, such as alcohol use, other substance use, and sexual decision making.

The results should be viewed in light of certain limitations. The items are self-report; however, research has not found evidence of bias in self-report confidential surveys, consistent with other studies suggesting self-report is more accurate and cost-effective than collateral data. We also only assessed weekend drinking and one random week day, which means other drinking days during the 3-week period may not have been assessed; however, research demonstrates that most drinking occurs on Friday and Saturday among adolescents and young adults (Kauer, Reid, Sanci, & Patton, 2009; Woodyard & Hallam, 2010). Additional limitations of the current study stem from our sample. Our sample primarily identified racially as White and were current students. Also, participants who will and can come to the lab for an in-person training may be different from the general population either through motivation levels and/or available resources. Both of these limitations may impact the generalizability of these findings. To expand the current study's findings, future studies should include a more diverse sample and account for motivation level of the participant. Affect was only assessed in the evening survey and used as a covariate in the present study. It may be true that fluctuations in PMW variables might not be apparent prior to entering the drinking context. In this study, we use afternoon reports of the PWM constructs; however, it is possible that these cognitions vary within-a-day and in relation to when alcohol use occurred. Future research should consider how cognitions and affect vary within-a-day in relation to drinking and other contextual factors.

Although this is a valuable first step in examining the PWM at the daily level, our limited sample size disallowed the examination of all the components of the PWM simultaneously as well as examining the possible shift from willingness to intentions based on experience. To further clarify the relations among the hypothesized constructs, future studies with sufficiently large samples could test the full model simultaneously. Regarding the shift from willingness to intentions, future work should examine if the hypothesized shift occurs because of experience, using a longitudinal EMA framework. To further understand how experience may shift from willingness to intentions for engaging in drinking behavior, future studies should test both experience and age as moderators, including consideration of legal age (21+ for alcohol). Given that age is sometimes used as a weak proxy for development, it may be that the development of decision making regarding substance use may be based more on experience and less on age, similar to findings by Pomery et al. (2009).

Overall, the present study provides meaningful information to help understand how dual-process models such as the PWM may operate at the daily level. An examination of PWM risk cognitions at the daily level has potential to enhance our understanding of adolescent and young adult health risk behavior decision making in more nuanced ways. Given that the PWM has been used to predict a variety of health risk behaviors in addition to alcohol use, the results from the present study have potential to inform a wide variety of targeted in-the-moment health behavior interventions among adolescents and young adults.

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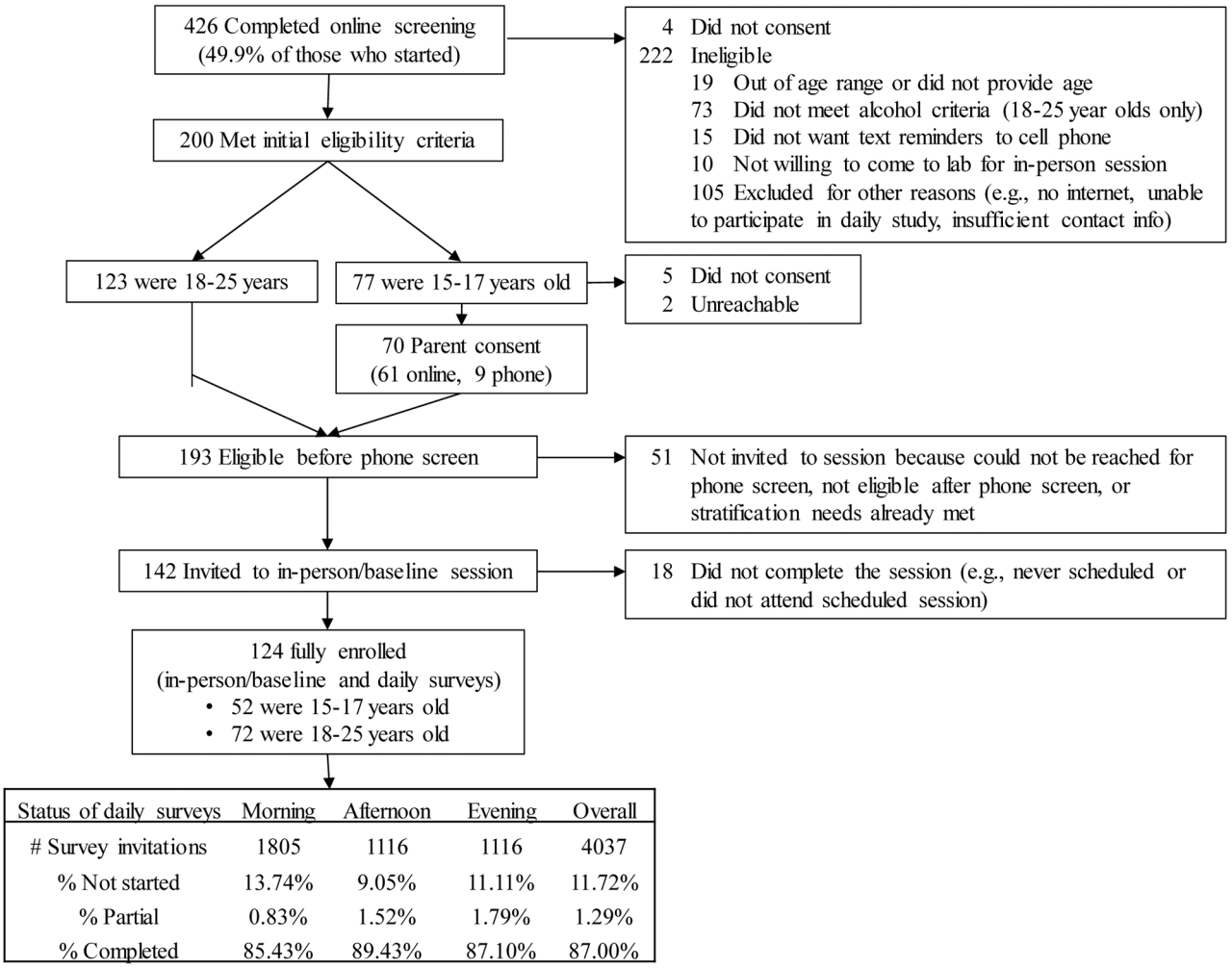

Status of daily surveys	Morning	Afternoon	Evening	Overall
# Survey invitations	1805	1116	1116	4037
% Not started	13.74%	9.05%	11.11%	11.72%
% Partial	0.83%	1.52%	1.79%	1.29%
% Completed	85.43%	89.43%	87.10%	87.00%

Figure 1.
Study Flowchart

Table 1

Descriptive Information on Alcohol Use, Consequences, and PWM cognitions

	n	M	SD	Skew	Kurtosis	1	2	3	4	5	6	7	8
1. Any Drinking	1,521	0.22	0.42	1.33	−0.24	-							
2. Any Consequences	1,490	0.07	0.26	3.26	8.61	0.55	-						
3. Intentions	978	1.83	1.20	1.27	0.35	0.63	0.44	-					
4. Willingness	990	2.17	1.36	0.81	−0.73	0.54	0.37	0.78	-				
5. Attitudes	981	2.41	1.11	0.47	−0.59	0.50	0.28	0.68	0.76	-			
6. Injunctive Norms	966	2.91	1.20	0.03	−0.89	0.38	0.23	0.49	0.56	0.67	-		
7. Perceived Vulnerability	980	3.19	0.90	0.19	−0.60	−0.27	−0.11	−0.32	−0.34	−0.40	−0.27	-	
8. Descriptive Norms	975	1.48	1.16	0.60	−0.50	0.47	0.31	0.58	0.54	0.56	0.67	−0.31	-
9. Prototypes	979	3.06	0.69	−0.45	0.42	0.34	0.18	0.34	0.39	0.50	0.55	−0.31	0.41

Note. All correlations are significant at $p < .001$.

Table 2

Predicting Drinking Intentions and Willingness to Drink

	b	SE	LCL	UCL
Predicting Drinking Intentions				
(Intercept)	1.40	0.68	0.06	2.74
Person Level				
Sex	0.17	0.10	−0.03	0.36
Age	0.03	0.02	−0.02	0.07
Access to Alcohol	0.03	0.06	−0.10	0.15
Attitudes	0.60***	0.07	0.46	0.74
Injunctive Norms	−0.05	0.07	−0.19	0.09
Daily Level				
Weekend vs Weekday	0.09	0.07	−0.04	0.22
Month of Year	−0.04	0.07	−0.17	0.09
Day of Survey	−0.01	0.01	−0.02	0.00
Negative Affect	−0.06	0.08	−0.22	0.09
Positive Affect	0.19*	0.06	0.08	0.30
Attitudes	0.66***	0.04	0.58	0.74
Injunctive Norms	0.09*	0.04	0.00	0.18
Predicting Willingness to Drink				
(Intercept)	1.78	1.03	−0.23	3.80
Person Level				
Sex	0.05	0.15	−0.26	0.35
Age	−0.01	0.04	−0.08	0.07
Access to Alcohol	0.05	0.09	−0.14	0.24
Norms	0.42***	0.10	0.24	0.61
Perceived Vulnerability	−0.25**	0.08	−0.40	−0.09
Prototype	0.21*	0.09	0.04	0.38
Daily Level				
Weekend vs Weekday	−0.02	0.09	−0.19	0.15
Month of Year	0.13	0.10	−0.07	0.32
Day of Survey	−0.03***	0.01	−0.05	−0.01
Negative Affect	0.06	0.09	−0.12	0.24
Positive Affect	0.20**	0.07	0.07	0.32
Norms	0.60***	0.05	0.50	0.70
Perceived Vulnerability	−0.11	0.06	−0.23	0.01
Prototype	0.29**	0.09	0.11	0.47

Note. * $p < .05$. ** $p < .01$. *** $p < .001$. *We controlled for negative and positive affect (within-person), age, sex, access to alcohol, weekend/weekday, day of the survey, and month as covariates.*

Table 3

Reasoned Pathway: Predicting the Count of Drinks and the Likelihood of Drinking

	Predicting the Count of Drinks					Predicting the Likelihood of Drinking				
	b	**SE**	**RR**	**RR LCL**	**RR UCL**	**b**	**SE**	**OR**	**OR LCL**	**OR UCL**
Intercept	−0.13	1.06	0.88	0.11	6.98	−9.32	2.12	0.00	0.00	0.01
Person Level										
Sex	0.28*	0.13	1.32	1.02	1.70	−0.60	0.30	0.55	0.30	0.98
Age	−0.02	0.04	0.98	0.91	1.05	0.35***	0.07	1.42	1.23	1.63
Access to Alcohol	0.21	0.11	1.23	0.99	1.53	0.24	0.21	1.27	0.84	1.91
Attitudes	−0.06	0.14	0.94	0.71	1.25	0.16	0.26	1.17	0.70	1.96
Injunctive Norms	0.05	0.12	1.05	0.83	1.34	0.27	0.22	1.31	0.85	2.02
Intentions	0.38**	0.11	1.47	1.18	1.82	1.00***	0.24	2.71	1.69	4.35
Daily Level										
Weekend vs Weekday	0.34*	0.14	1.41	1.06	1.87	0.27	0.32	1.31	0.69	2.48
Month of Year	−0.02	0.09	0.98	0.82	1.18	0.06	0.20	1.06	0.72	1.55
Day of Survey	0.02	0.01	1.02	1.00	1.04	0.00	0.03	1.00	0.94	1.07
Negative Affect	0.17	0.12	1.18	0.93	1.50	0.22	0.36	1.25	0.62	2.53
Positive Affect	0.26**	0.09	1.29	1.09	1.53	0.73**	0.26	2.07	1.24	3.45
Attitudes	−0.06	0.10	0.94	0.78	1.14	0.44	0.23	1.56	1.00	2.43
Injunctive Norms	0.09	0.10	1.10	0.90	1.34	0.24	0.22	1.28	0.83	1.96
Intentions	0.29***	0.06	1.33	1.19	1.49	0.96***	0.16	2.61	1.90	3.58

Note. * $p < .05$. ** $p < .01$. *** $p < .001$. *We controlled for negative and positive affect (within-person), age, sex, access to alcohol, weekend/weekday, day of the survey, and month as covariates.*

Table 4

Reasoned Pathway: Predicting the Likelihood of Alcohol-Related Negative Consequences

	b	SE	OR	OR LCL	OR UCL
Intercept	−7.86	2.93	0.00	0.00	0.12
Person Level					
Sex	−0.34	0.39	0.71	0.33	1.53
Age	0.09	0.10	1.10	0.91	1.32
Access to Alcohol	0.64	0.34	1.89	0.97	3.69
Attitudes	0.11	0.39	1.12	0.52	2.38
Injunctive Norms	0.10	0.32	1.11	0.59	2.06
Intentions	0.57	0.33	1.77	0.93	3.38
Daily Level					
Weekend vs Weekday	1.19*	0.57	3.29	1.08	10.05
Month of Year	−0.17	0.28	0.84	0.48	1.46
Day of Survey	0.06	0.04	1.06	0.98	1.16
Negative Affect	0.66	0.48	1.93	0.75	4.94
Positive Affect	0.82*	0.34	2.26	1.15	4.45
Attitudes	−0.15	0.33	0.86	0.45	1.63
Injunctive Norms	0.19	0.32	1.21	0.64	2.28
Intentions	1.07***	0.22	2.92	1.89	4.50

Note. * $p < .05$. *** $p < .001$. OR = odds ratio; LCL = 95% lower confidence limit; UCL = 95% upper confidence limit. *We controlled for negative and positive affect (within-person), age, sex, access to alcohol, weekend/weekday, day of the survey, and month as covariates.*

Table 5

Social Reaction Pathway: Predicting the Count of Drinks and the Likelihood of Drinking

	Predicting the Count of Drinks					Predicting the Likelihood of Drinking				
	b	**SE**	**RR**	**RR LCL**	**RR UCL**	**b**	**SE**	**OR**	**OR LCL**	**OR UCL**
Intercept	−1.22	0.95	0.29	0.05	1.88	−8.65	2.04	0.00	0.00	0.01
Person Level										
Sex	0.32	0.12	1.37	1.09	1.73	−0.37	0.30	0.69	0.39	1.23
Age	0.01	0.03	1.01	0.95	1.07	0.35***	0.07	1.42	1.23	1.62
Access to Alcohol	0.18	0.10	1.20	0.99	1.46	0.20	0.20	1.22	0.83	1.80
Norms	0.42***	0.09	1.52	1.27	1.81	0.42*	0.20	1.53	1.04	2.24
Perceived Vulnerability	0.04	0.09	1.04	0.87	1.23	−0.18	0.20	0.84	0.57	1.24
Prototype	0.15	0.08	1.16	0.99	1.36	0.41*	0.18	1.51	1.05	2.16
Willingness	0.20*	0.08	1.23	1.04	1.44	0.72***	0.18	2.06	1.45	2.92
Daily Level										
Weekend vs Weekday	0.18	0.16	1.20	0.87	1.64	0.06	0.37	1.07	0.52	2.21
Month of Year	0.08	0.09	1.08	0.90	1.29	−0.15	0.19	0.86	0.59	1.26
Day of Survey	0.03*	0.01	1.03	1.01	1.05	0.03	0.03	1.03	0.97	1.10
Negative Affect	0.11	0.12	1.12	0.88	1.42	0.13	0.36	1.13	0.56	2.31
Positive Affect	0.36***	0.09	1.43	1.21	1.69	0.84**	0.26	2.30	1.38	3.84
Norms	0.36***	0.09	1.44	1.21	1.71	0.69**	0.22	2.00	1.30	3.08
Perceived Vulnerability	−0.05	0.11	0.96	0.78	1.18	−0.18	0.28	0.83	0.48	1.44
Prototype	−0.26	0.16	0.77	0.57	1.06	0.47	0.43	1.59	0.69	3.69
Willingness	0.21***	0.06	1.24	1.11	1.38	0.90***	0.15	2.47	1.85	3.29

Note. * $p < .05$. *** $p < .001$; PV=Perceived Vulnerability. OR = odds ratio; RR = risk ratio; LCL = 95% lower confidence limit; UCL = 95% upper confidence limit. *We controlled for negative and positive affect (within-person), age, sex, access to alcohol, weekend/weekday, day of the survey, and month as covariates.*

Table 6

Social Pathway: Predicting the Likelihood of Alcohol-Related Negative Consequences

	b	SE	OR	OR LCL	OR UCL
Intercept	−7.57	2.75	0.00	0.00	0.11
Person Level					
Sex	−0.06	0.39	0.94	0.44	2.01
Age	0.10	0.09	1.10	0.93	1.30
Access to Alcohol	0.70*	0.34	2.02	1.04	3.91
Norms	0.16	0.27	1.18	0.69	2.00
Perceived Vulnerability	0.33	0.28	1.39	0.81	2.40
Prototype	0.29	0.25	1.33	0.81	2.18
Willingness	0.69**	0.26	1.99	1.21	3.29
Daily Level					
Weekend vs Weekday	1.09	0.65	2.97	0.84	10.59
Month of Year	−0.40	0.28	0.67	0.39	1.16
Day of Survey	0.10*	0.04	1.10	1.01	1.20
Negative Affect	0.63	0.48	1.88	0.73	4.81
Positive Affect	1.05***	0.34	2.86	1.46	5.63
Norms	0.76*	0.33	2.13	1.12	4.06
Perceived Vulnerability	−0.19	0.40	0.82	0.38	1.79
Prototype	−0.53	0.60	0.59	0.18	1.90
Willingness	0.83***	0.20	2.29	1.56	3.36

Note. * $p < .05$. *** $p < .001$; PV=Perceived Vulnerability. OR = odds ratio; LCL = 95% lower confidence limit; UCL = 95% upper confidence limit. *We controlled for negative and positive affect (within-person), age, sex, access to alcohol, weekend/weekday, day of the survey, and month as covariates.*

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