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Affect, motivation, temptation, and drinking among alcohol-dependent outpatients trying to maintain abstinence: An Ecological Momentary Assessment study

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ABSTRACT

Objectives: Using Ecological Momentary Assessment we aimed to describe the time course of temptation episodes in alcohol-dependent outpatients in a real-life setting. We also examined whether affective and motivational variables were cross-sectionally and prospectively associated with temptation episodes. Additionally, we tested whether outpatients who drank against treatment goals (i.e., "lapsers") differed in craving, affect, and motivation from abstainers.

Methods: Participants were 43 alcohol-dependent outpatients (13 female). Using personal digital assistants (PDAs), patients were signaled to complete three random assessments per day for 4 weeks. They were also instructed to complete a temptation assessment whenever they experienced the temptation to drink alcohol.

Results: The number of temptation assessments declined over time and did not differ between lapsers and abstainers. Overall, craving was generally higher in lapsers (n = 14) than abstainers (n = 27). In lapsers, but not abstainers, abstinence motivation was lower at temptation assessments vs. random assessments. Across all patients, negative affect was prospectively associated with entry of temptation assessments later the same day. There were no significant effects for positive affect.

Conclusions: In alcohol-dependent outpatients attempting to remain abstinent, negative affect is cross-sectionally associated with entry of temptation assessments. There is more evidence that negative affect precipitates temptations than vice versa. Professionals should be watchful of outpatients who report generally high levels of craving, and who report more negative affect and lower abstinence motivation, when tempted.

1. Introduction

Many patients with substance use disorder frequently report desires to use when abstaining from substance use (Epstein et al., 2009). In studies with alcohol-dependent individuals, however, overall craving ratings are often low and seem to show very little variation over time (Glöckner-Rist et al., 2013; Oslin et al., 2009; Tiffany, 1990). Although recent studies have assessed craving in real-world settings (e.g., Serre et al., 2018), most studies of craving have been conducted in the laboratory. Therefore, there are limited data regarding whether alcohol-dependent individuals experience cravings of a different intensity in real-world settings, and whether cravings assessed in real-world settings are associated with clinically relevant affective and motivational variables.

Recently, researchers have used Ecological Momentary Assessment (EMA) to investigate experiences and behavior in real-world settings (Rot et al., 2012; Serre et al., 2015; van Os et al., 2014; Walz et al., 2014). EMA allows for daily monitoring of behaviors in a naturalistic

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setting. Besides random assessments (scheduled at random times throughout the day), patients can be asked to initiate assessments at times of particular interest. In the current study, patients were asked to initiate assessments when they experienced a temptation to drink (temptation assessments). A temptation can be defined as an acute rise in urge to use drugs or an occasion in which participants felt they had come to the brink of using drugs regardless of subjective urges (Shiffman et al., 1996b). Temptation assessments provide information on times when cravings are likely strong, although by this definition it is possible to experience a temptation when experiencing low levels of craving.

EMA using temptation assessments has been used in studies of smoking (Shiffman, 2009) and heroin/cocaine addiction (Waters et al., 2012). In these studies, temptation assessments (vs. random assessments) were characterized by higher negative affect and stress, at least in cocaine-dependent and heroin-dependent patients (Epstein et al., 2009; Marhe et al., 2013), and negative affect was also elevated prior to temptation assessments in smokers (Shiffman et al., 1996b). However, temptation assessments have not been used in alcohol-dependent patients using electronic devices (see Jones et al., 2018, for use in heavy drinkers). In an early study, Litt et al. (1998) did include temptation assessments in a study among alcohol-dependent patients, but recording was done using paper-and-pencil methods, resulting in low compliance to the recording of episodes and concerns about potential bias.

Laboratory studies that examined relationships between stress/negative affect and craving (Fox et al., 2007; Sinha et al., 2009) suggest that alcohol craving is associated with elevated negative affect. Craving may be caused by stress or negative affect, or the experience of craving itself acutely causes increases in stress or negative affect. However, in a recent EMA study in a French sample of addicted outpatients, Serre et al. (2018) reported that there was no evidence that negative mood was cross-sectionally or prospectively associated with craving in alcohol addicts. Serre et al. (2018) used only random assessments, and different effects may be found when using self-initiated temptation assessments, when craving is expected to be stronger. Therefore, in this study we examined whether stress/negative affect are cross-sectionally and prospectively associated with the risk of the occurrence of a temptation assessment. In addition, given that the experience of temptation may itself elicit negative affect/stress, we also examined whether experience of a temptation increases stress and negative affect later that day.

Positive affect has also been investigated in laboratory studies. For example, Fox et al. (2007) reported that positive affect decreased in response to cue-induced craving in treatment-seeking alcohol-dependent patients. On the other hand, inducing positive affect can increase craving in non-treatment seeking alcohol-dependent individuals (Mason et al., 2008). The relationship between craving and positive affect may be complex and deserves further scrutiny.

Another variable that may be important during temptation episodes is motivation to remain abstinent (here termed "abstinence motivation"). Commitment to abstinence predicts sustained abstinence after treatment (Laudet and Stanick, 2010). Specifically, a decline in momentary abstinence motivation has been proposed as one of the causal factors in relapse (Hedeker and Mermelstein, 1996; Witkiewitz and Marlatt, 2004), and an EMA study conducted in treatment seeking smokers reported that high levels of momentary abstinence motivation reduced the chance of relapse over the next few hours (Minami et al., 2014). However, we are not aware of an EMA study that assessed abstinence motivation in treatment seeking individuals with alcohol dependence.

In addition, motivation for abstinence decreases after an initial lapse, i.e., the abstinence violation effect (Curry et al., 1987; Witkiewitz and Marlatt, 2004). However, there are no data on abstinence motivation when patients experience a temptation episode. We expect that, during temptations, affect is relatively negative. In people who learned to drink to alleviate negative affect (Baker et al., 2004), abstinence motivation may thus decline during temptations, thereby increasing the risk for relapse.

Both theory (Robinson and Berridge, 2003; Witkiewitz and Marlatt, 2004) and data from EMA (Serre et al., 2018) suggest that craving may be associated with alcohol use in alcoholic patients. Therefore, individuals who experience more temptations may be at greater risk of lapsing. Although previous research in other addictions has shown that the frequency of temptations is not associated with lapse, the "severity" of temptations (vs. random assessments) has been associated with lapse (Fatseas et al., 2015; Marhe et al., 2013; Serre et al., 2018, but see Shiffman et al., 1996a). Marhe et al. (2013) reported that cocaine-dependent and heroin-dependent patients who reported greater increases in craving at temptation assessments (vs. random assessments) were more at risk of lapsing. In addition, in an interview study Dutch alcohol-dependents reported to have experienced more known determinants of relapse (such as craving and negative affect) prior to a relapse episode than prior to a craving episode (Snelleman et al., 2018). In the current study, we examined whether patients who drank during the study reported greater increases in known predictors of craving and lapse/relapse during temptation assessments than abstainers.

In this study, our goals were to 1) describe the natural occurrence (i.e., time course) of temptation episodes in alcohol-dependent outpatients; 2) examine whether affect/stress/abstinence motivation differed by assessment type (temptation assessments and random assessments) (cross-sectional analysis); 3) examine prospective associations between affect/stress/abstinence motivation, and assessment type (temptation assessments and random assessments), and vice versa; and 4) examine whether differences between temptation assessments and random assessments differed between lapsers and abstainers.

2. Methods

2.1. Participants

This study was an extension of a study on predictors of relapse and craving (Snelleman et al., 2015; Szeto et al., 2019) (see Supplementary Materials). The 43 patients were on average 48.47 years old (SD = 10.82), and 30.32% were female (see Table S1 for more information).

Inclusion criteria for the parent (larger) study were: (a) current diagnosis of alcohol dependence as defined in the DSM-IV (American Psychiatric Association, 2000) and as determined by the Composite International Diagnostic Interview (CIDI, American Psychiatric Association, 2000); (b) eighth-grade literacy level; and (c) a period of abstinence of at least two weeks prior to the first appointment of the first study. Patients were excluded if they (a) were diagnosed with an Axis II disorder according to the DSM-IV; (b) were diagnosed with a disorder in the psychotic spectrum; or (c) regularly used other addictive substances (except nicotine).

2.2. Procedure

Eligible patients were referred to the researcher who described the study to them. Written informed consent was obtained from all patients. Patients were trained in using a personal digital assistant (PDA). Thereafter four weeks of EMA started. The PDA was programmed to signal three times a day at random times (random assessments). Patients were also instructed to initiate an assessment themselves when they experienced a temptation episode, defined here as an acute increase in the urge to drink, or an occasion when they felt tempted to drink without actually doing so (temptation assessment). At each assessment, patients responded to items assessing subjective variables (see below). Subsequently, patients were presented with either an alcohol Stroop task or an alcohol IAT (data not reported). During weekly face-to-face appointments, the researcher downloaded data from the

PDA and checked protocol compliance and past-week alcohol consumption. Patients continued the study even if they had lapsed. After four weeks, patients received financial compensation for participation: €4.45 ($3.30) per day, max. €125 ($150). The protocol was approved by the Medical Ethical Committee of the Erasmus Medical Center (registration: MEC-2012-346).

2.3. EMA measures

2.3.1. Inclination to drink

As a manipulation check for temptation assessments, patients were asked about their inclination to drink using two items: 1) "I feel the inclination to drink right now" (Inclined Now), and 2) "In the past hour, I have felt the inclination to drink" (Inclined Past Hour), on a 7-point scale (1 = not at all to 7 = very much).

2.3.2. Craving

One item (7-point scale) assessed Craving: "In the past hour I felt an urge (craving) to drink", (1 = not at all to 7 = very much).

2.3.3. Positive and negative affect

We used the Positive and Negative Affect Schedule – short form (PANAS-SF; (Thompson, 2007), which consists five positive items (PANAS-PA) and five negative items (PANAS-NA). Patients indicated whether they agreed with statements (e.g., I feel upset right now) on a 5-point scale (1 = not; 2 = a little; 3 = moderately; 4 = quite a bit; 5 = extremely). Cronbach's alpha was good for both PANAS-PA (α = .90) and PANAS-NA (α = .89).

2.3.4. Stress

Stress was assessed using two items: 1) "I feel stressed right now" (Stressed Now); and 2) "In the past hour I felt stressed" (Stressed Past Hour) on a 5-point scale (same as PANAS).

2.3.5. Abstinence motivation

Motivation to maintain abstinence was assessed using one item (7-point scale): "How motivated are you right now to stay abstinent?" (1 = not at all to 7 = extremely).

2.4. Lapse

Patients indicated how many glasses of alcohol they consumed since the previous assessment (1 = no drinks; 2 = 1–2 glasses; 3 = 3–4 glasses; 4 = 5–6 glasses; 5 = 7 or more glasses) (in the Netherlands a standard glass contains 10 g of pure alcohol). A lapser was defined as an individual who had the goal of maintaining abstinence but who reported drinking any alcohol during the study. Two participants were designated as "controlled" drinkers because they did not intend to fully abstain from drinking; the 2 controlled drinkers were excluded from analyses involving lapse.

2.5. Data analyses

First, we examined the time course of temptations for all participants, and for lapsers (n = 14) and abstainers (n = 27) separately, using linear mixed models (LMMs) using SAS PROC MIXED.

Second, to compare ratings at temptation assessments and random assessments (Assessment Type), we also used linear mixed models (LMMs) (see Supplementary Materials).

Third, to examine prospective associations between Assessment Type and affect/abstinence motivation variables that were significantly associated with Assessment Type (Negative Affect, Stress Now, Stress Past Hour, Abstinence Motivation), we used SAS PROC GLIMMIX (using adaptive quadrature; see Supplementary Materials) to test whether a lagged affect/motivation variable (e.g., lagged Negative Affect) at time t was associated with Assessment Type (0 = random assessment, 1 = temptation assessment) at the following assessment, time t_{+1}. Conversely, we used SAS PROC MIXED to test whether lagged Assessment Type at time t was associated with an affect/motivation variable (e.g., Negative Affect) at time t_{+1}.. In supplementary analyses, we also used Generalized Estimating Equations (GEE; Zeger et al., 1988) (Supplementary Materials).

Fourth, we examined the association between drinking status and EMA variables. Drinking Status (lapsers vs. abstainers) and Assessment Type were included in all models. Given that it was expected that study measures would be significantly different during temptation assessments (vs. random assessments) and given that responses in temptation assessments might best differentiate lapsers from abstainers (Marhe et al., 2013), we tested the Drinking Status x Assessment Type interaction term. If a significant interaction was not observed, the interaction term was removed from the model.

For all analyses, α = .05 (2-tailed). In addition, a false discovery rate (FDR) procedure, the Benjamini and Hochberg Linear Step-Up (LSU) procedure (Benjamini and Hochberg, 1995), using Q = .05, where Q = "false discoveries"/("false discoveries" + "true discoveries"), was applied to p values from the four primary goals to help identify findings ("discoveries") that are likely to be more robust (see Supplementary Materials for more detail). When the uncorrected p value ≤ .024, the LSU procedure identified the finding as a "discovery".

3. Results

3.1. Descriptive statistics

All patients provided 1+ week of EMA data, and 39 (90.7%) completed all 4 weeks. Overall, the 43 patients completed 2020 assessments (1870 random assessments; 150 temptation assessments). (see Supplementary Materials for additional information).

3.2. Characteristics and time course of temptation episodes

Patients reported higher ratings on Inclined Now and Inclined Past Hour at temptation assessments (vs. random assessments) (Tables 1 and 2), confirming that, on average, they were more tempted to drink at temptation assessments vs. random assessments.

There was no significant difference in the number of temptation assessments per patient between lapsers and abstainers, F(1,845) = 0.10, p = .76, but over all patients, the number of reported temptation assessments per day declined over time, F(1,880) = 19.03, p < .0001 (Fig. 1). Lapsers reported higher craving ratings than abstainers at random assessments, F(1,1734) = 20.63, p < .001, and temptation assessments, F(1,113) = 10.22, p = .002 (Fig. 1). The same was true for Inclined Now and Inclined Past Hour (all p's < .01).

3.3. Difference between temptation assessments and random assessments in whole sample

As expected, at temptation assessments (vs. random assessments), patients reported higher ratings on Craving. Patients also reported higher ratings of Negative Affect, Stress Now, and Stress Past Hour, and lower ratings on Abstinence Motivation (Tables 1 and 2). For example, reported Negative Affect was 0.39 units higher (on a 1–5 scale) at temptation assessments than random assessments. This corresponded to a r value of 0.52, typically considered a large effect size (Field, 2017). Ratings of Positive Affect did not differ between Assessment Type (Tables 1 and 2). Because recent drinking could influence responses, we repeated analyses while omitting assessments at which drinking (since the previous assessment) was reported (leaving 1685 random assessments and 126 temptation assessments for analysis). LMMs revealed that Craving (p < .01), Negative Affect (p = .01), Stressed Now (p = .02), and Stressed Past Hour (p = .02), were elevated during temptation assessments (vs. random assessments). Positive Affect

Table 1
Summary statistics.

Measure ↓	Whole sample (N_2 = 43)		Lapsers (n_2 = 14)		Abstainers (n_2 = 27)	
	RAs n_1 = 1870	TAs n_1 = 150	RAs n_1 = 545	TAs n_1 = 58	RAs n_1 = 1232	TAs n_1 = 89
Inclined Now	1.71 (1.42)	2.55 (2.16)	2.67 (1.97)	3.84 (2.35)	1.30 (0,83)	1.71 (1.56)
Inclined Past Hour	1.73 (1.43)	2.45 (2.11)	2.75 (1.98)	3.74 (2.32)	1.31 (0.84)	1.63 (1.50)
Craving Past Hour	1.72 (1.41)[a]	2.54 (2.14)	2.70 (1.97)	3.88 (2.24)	1.31 (0.82)[d]	1.72 (1.59)
Positive Affect	3.25 (0.86)[a]	3.14 (0.86)	2.99 (0.87)	3.20 (0.91)	3.30 (0.83)[d]	3.09 (0.82)
Negative Affect	1.39 (0.63)[a]	1.62 (1.00)	1.56 (0.65)	2.02 (1.10)	1.34 (0.62)[d]	1.37 (0.86)
Stress Now	1.49 (0.81)[a]	1.78 (1.16)[b]	1.64 (0.86)	2.30 (1.18)[c]	1.46 (0.80)[d]	1.46 (1.05)
Stress Past Hour	1.46 (0.80)[a]	1.78 (1.16)[b]	1.57 (0.80)	2.30 (1.25)[c]	1.45 (0.79)[d]	1.45 (0.98)
Motivation	6.34 (1.34)[a]	5.95 (1.75)[b]	5.19 (1.90)	4.74 (2.14)[c]	6.84 (0.46)[d]	6.71 (0.83)

Note: Data are Mean (1 *SD*) aggregated over all pertinent assessments. n_1 = number of assessments, n_2 = number of subjects. [a] n = 1869; [b] n = 149; [c] n = 57; [d] n = 1231. Two participants were designated as "controlled drinkers" and were excluded from analyses involving lapse.

(p = .02), and Abstinence Motivation (p = .02) were lower during temptation assessments (vs. random assessments).

3.4. Lagged analyses in whole sample

LMMs confirmed that Negative Affect, Stress, and Abstinence Motivation were cross-sectionally associated with Assessment Type (0 = random assessment, 1 = temptation assessment), such that higher levels of Negative Affect and Stress Now, and lower level of Abstinence Motivation, increased the odds of a temptation assessment (vs. random assessment) (Table 3). For example, a 1-unit change in Negative Affect (1–5 scale) increases the odds of a temptation assessment (vs random assessment) by 4.58 times. These cross-sectional analyses essentially replicate the results shown in Table 2 (left column), except that Assessment Type is the DV (rather than IV).

Lagged analyses revealed that lagged Negative Affect and lagged Stress Past Hour increased the odds of a temptation assessment at the next assessment (on the same day) (Table 3). For example, a 1-unit change in Negative Affect (1–5 scale) doubled the odds of a temptation assessment (vs random assessment) at the next assessment the same day. Table 3 also reveals that there was no evidence that temptation assessments (vs. random assessments) increased Negative Affect, Stress Now, and Stress Past Hour at the next assessment (on the same day), or that temptation assessments (vs. random assessments) decreased Abstinence Motivation at the next assessment.

In additional analyses (Supplementary Materials), Negative Affect was cross-sectionally associated with Craving (1–7 scale). More important, lagged Negative Affect was associated with Craving (1–7 scale) at the next assessment, but lagged Craving (1–7 scale) was not associated with Negative Affect at the next assessment. A 1-unit change in Negative Affect (1–5 scale) increased Craving at the next assessment by 0.29 units (1–7 scale), but a 1-unit change in Craving (1–7 scale) only increased Negative Affect at the next assessment by 0.01 units (1–5 scale).

3.5. Difference between temptation assessments and random assessments by lapse groups

The difference between temptation assessments and random assessments tended to be larger in lapsers vs. abstainers for Negative Affect, Stress, and Motivation (Tables 1 and 2; Fig. S1). The Drinking Status x Assessment Type interaction was significant for Negative Affect, $F(1,1847) = 4.31$, $PE = 0.46$, $SE = 0.22$, p = .04 (but not a "discovery" using the FDR correction), and Motivation, $F(1,1847) = 5.33$, $PE = -0.58$, $SE = 0.25$, p = .02 (a discovery). The Drinking Status x Assessment Type interaction was not significant for Stress Now (p = .08), Stress Past Hour (p = .08), Positive Affect (p = .45), Inclined Now (p = .38), Inclined Past Hour (p = .65), and Craving (p = .94) (see Supplementary Materials).

Lagged analyses for lapsers (Table S2[5]) and abstainers (Table S3[5]) are reported in Supplementary Materials.

4. Discussion

This EMA study investigated motivational and affective factors related to temptation and lapse in alcohol-dependent outpatients. The main findings were as follows. First, patients reported on average 3.5 temptations during the 4-week study period, and the majority (81%) reported at least one temptation. Compared to abstainers, patients who lapsed did not report more temptations than abstainers, but they did report higher craving. Abstainers reported generally low levels of craving. Second, patients reported higher levels of craving, negative

Table 2
Differences between assessment types for whole sample, lapsers, and abstainers.

Item/Measure ↓	Whole sample (N_2 = 43)						Lapsers (n_2 = 14)						Abstainers (n_2 = 27)					
	df	*PE*	*SE*	*F*	*p*	*r*	*df*	*PE*	*SE*	*F*	*p*	*r*	*df*	*PE*	*SE*	*F*	*p*	*r*
Inclined Now	1, 34	0.84	0.23	13.30	**.0009**	.53	1,12	0.58	0.31	3.55	.08	.48	1,19	0.76	0.30	6.42	**.02**	.50
Inclined Past Hour	1, 34	0.48	0.16	9.45	**.004**	.47	1,12	0.44	0.23	3.85	.07	.49	1,19	0.49	0.27	3.28	.09	.38
Craving Past Hour	1, 34	0.50	0.18	8.00	**.008**	.44	1,12	0.28	0.27	1.12	.31	.29	1,19	0.61	0.29	4.48	.04	.44
Positive Affect	1, 34	−0.10	0.07	1.88	.18	.16	1,12	0.02	0.09	0.06	.81	.07	1,19	−0.15	0.11	2.05	.17	.31
Negative Affect	1, 34	0.39	0.11	12.54	**.001**	.52	1,12	0.70	0.20	12.58	**.004**	.72	1,19	0.18	0.12	2.39	.14	.34
Stress Now	1, 34	0.37	0.13	8.00	**.008**	.44	1,12	0.69	0.20	11.69	**.005**	.70	1,19	0.17	0.16	1.06	.32	.23
Stress Past Hour	1, 34	0.35	0.13	7.67	**.009**	.43	1,12	0.66	0.22	8.82	**.01**	.65	1,19	0.15	0.15	1.09	.31	.23
Motivation	1, 34	−0.34	0.11	9.59	**.004**	.47	1,12	−0.40	0.11	12.18	**.005**	.71	1,19	−0.22	0.17	1.53	.23	.27

Note: Data are parameter estimates for the effect of Assessment type on study measures (see text for details), PE = (unstandardized) parameter estimate; SE = standard error; F = F value from LMM, r = Effect Size measure computed using methods of Kashdan and Steger (2006); n_2 = number of subjects. Two participants were designated as "controlled drinkers" and were excluded from analyses involving lapse. Bolded p values reflect findings that are both statistically significant and are deemed 'discoveries' using the Benjamini-Hochberg $Q < .05$ threshold (see text for details).

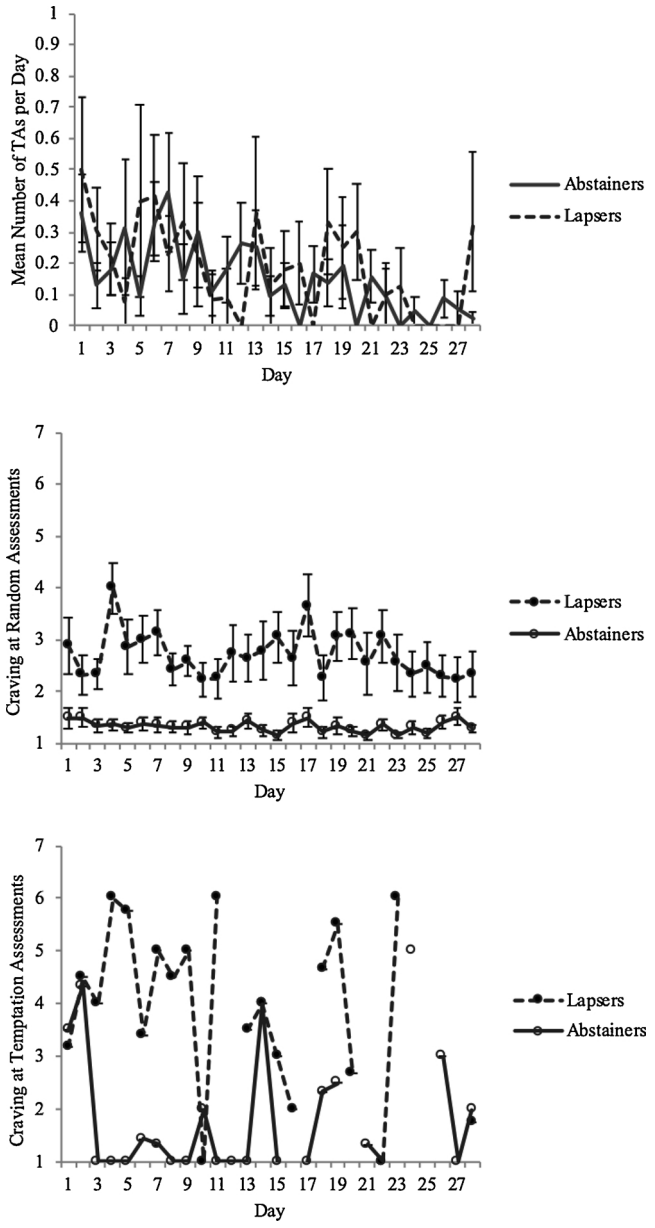

Fig. 1. Pattern of temptation assessments (upper graph) and Craving (lower two graphs) over time. Data are means (± 1 S.E.). Data for temptation assessments show mean number of temptation assessments per day. Data for middle graph show craving at random assessments and data for bottom graph show craving at temptation assessments. Error bars are removed from bottom graph to aid clarity. Missing data in bottom graph reflect the absence of temptation assessments on that day.

affect and stress, and lower levels of abstinence motivation, at temptation assessments than at random assessments. Third, there was evidence that higher levels of negative affect prospectively predicted entry of temptation assessments later that day, but entry of temptation assessments did not prospectively predict higher levels of negative affect later that day. Fourth, differences in abstinence motivation between temptation assessments and random assessments were larger in lapsers than in abstainers.

The frequency of temptation episodes in our sample was comparable to the frequency of alcohol craving reported previously in alcohol-dependent samples (Cooney et al., 2007; Krahn et al., 2005; Litt et al., 2000; Tiffany, 1990). Additionally, craving ratings at temptation assessments were comparable to craving ratings at temptation assessments in a heroin-dependent sample (Marhe et al., 2013), while craving ratings in temptation assessments of the abstainers were comparable to those reported by abstinent alcohol-dependent patients (Litt et al., 1998). Craving ratings reported at random assessments in lapsers in the current study were comparable to craving ratings reported in another EMA study involving alcoholic outpatients (Serre et al., 2018). Consistent with the idea that temptation assessments capture moments of higher craving, at temptation assessments lapsers had higher craving ratings than those reported in that study (Serre et al., 2018).

As noted above, patients reported higher levels of stress and negative affect at temptation assessments than at random assessments. For negative affect, the between-assessment difference was a large effect. These results are consistent with data from other EMA studies involving heroin-dependent and cocaine-dependent patients (Epstein et al., 2009; Marhe et al., 2013; Preston and Epstein, 2011). Stress/negative affect may have preceded the temptation to drink, or the temptation to drink may have preceded elevated stress/negative affect. That is, it may be that stress/negative affect was already higher before the temptation episode and aided in precipitating a temptation assessment, as suggested by the Affective Processing Model of Negative Reinforcement (Baker et al., 2004). This model states that the accumulation of negative affect can result in craving (and presumably a temptation). Alternatively, the experience of temptation may result in higher levels of stress/negative affect, either because access to the substance is blocked, or because one feels guilty or anxious for being tempted while trying to remain abstinent (Kavanagh et al., 2005; Tiffany, 1990). Finally, there may be no causal relationship between temptations and elevated stress/negative affect, with the association being caused by a third, unseen, momentary variable.

Results of lagged analyses provided more support for the notion that stress/negative affect precipitates temptation episodes than the notion that temptation episodes precipitate stress/negative affect. One should note the magnitude of parameter estimates (and *OR*s) for prospective associations was smaller than those for cross-sectional associations, even for the significant prospective associations (Table 3). Results apply to time intervals between EMA assessments used in the current study (average of ~5 h), and different results may be obtained if data from different time intervals were collected. For example, temptation episodes may increase stress/negative affect during, or for a short time after, a temptation assessment.

In common with other studies, frequency of temptation episodes was not associated with lapse (Marhe et al., 2013). However, craving was higher in lapsers (vs. abstainers). The causal direction between craving and relapse cannot be established from our study. However, Serre et al. (2018) reported that craving predicted subsequent alcohol use, but not vice versa. In addition, lapsers (vs. abstainers) reported lower abstinence motivation at temptation assessments (vs. random assessments). Thus, alcohol-dependent patients who report generally high craving ratings, and larger decreases of abstinence motivation, at temptation assessments (vs. random assessments), could be at risk for poor outcomes (although, in a study on smoking, no difference was found in temptation assessments between lapsers and abstainers (Shiffman et al., 1996a). However, we cannot be sure about the causal direction of these relations (see Supplementary Materials).

The study had several strengths. To our knowledge, the time course of temptation assessments in alcohol-dependent patients over a 4-week period has not been assessed using electronic devices. We also obtained a relatively large number of temptation assessments, which bolsters confidence in results of analyses involving assessment type, and which yielded new information about real-world experiences of alcohol-dependent patients trying to maintain abstinence. We aimed at strong clinical relevance and limited the number of exclusion criteria to avoid obtention of a homogeneous sample that lacked generalizability. Therefore, we included patients who used anti-craving medication, which potentially affected motivational factors for drinking. However, there was no difference in the use of medications between the lapsers and abstainers, and there was no evidence that use of medication

Table 3
Results of lagged analyses for the association between NA/stress/motivation and assessment type.

Analysis Type	IV ↓	*DV* ↓	Assessment Type						NA/Stress/Abstinence Motivation					
			df	*PE*	*SE*	*F*	*p*	*OR*	*df*	*PE*	*SE*	*F*	*p*	*r*
Cross-Sectional	*Negative Affect* (*t*)	Assessment Type (*t*)	1, 40	1.52	0.32	22.22	< **.001**	4.58	n/a	n/a	n/a	n/a	n/a	
Cross-Sectional	*Stress Now* (*t*)	Assessment Type (*t*)	1, 37	0.76	0.21	12.48	**.001**	2.13	n/a	n/a	n/a	n/a	n/a	
Cross-Sectional	*Stress Past Hour* (*t*)	Assessment Type (*t*)	1, 36	0.89	0.21	18.78	**.001**	2.45	n/a	n/a	n/a	n/a	n/a	
Cross-Sectional	*Motivation* (*t*)	Assessment Type (*t*)	1, 25	−0.64	0.16	15.49	< **.001**	0.53	n/a	n/a	n/a	n/a	n/a	
Prospective	Lagged *Negative Affect* (*t*)	Assessment Type (t_{+1})	1, 39	0.71	0.29	6.08	**.02**	2.03	n/a	n/a	n/a	n/a	n/a	
Prospective	Lagged *Stress Now* (*t*)	Assessment Type (t_{+1})	1, 33	0.35	0.23	2.47	.13	1.43	n/a	n/a	n/a	n/a	n/a	
Prospective	Lagged *Stress Past Hour* (*t*)*	Assessment Type (t_{+1})	1, 1048	0.39	0.19	4.23	.04	1.48	n/a	n/a	n/a	n/a	n/a	
Prospective	Lagged *Motivation* (*t*)*	Assessment Type (t_{+1})	1, 1049	−0.11	0.16	0.46	.50	0.90	n/a	n/a	n/a	n/a	n/a	
Prospective	Lagged Assessment Type (*t*)	*Negative Affect* (t_{+1})	n/a	n/a	n/a	n/a	n/a		1, 28	0.13	0.09	2.42	.13	.28
Prospective	Lagged Assessment Type (*t*)	*Stress Now* (t_{+1})	n/a	n/a	n/a	n/a	n/a		1, 27	0.13	0.11	1.47	.24	.23
Prospective	Lagged Assessment Type (*t*)	*Stress Past Hour* (t_{+1})	n/a	n/a	n/a	n/a	n/a		1, 27	0.17	0.10	2.51	.12	.24
Prospective	Lagged Assessment Type (*t*)	*Motivation* (t_{+1})	n/a	n/a	n/a	n/a	n/a		1, 27	−0.21	0.21	0.99	.33	.19

Note: Data are parameter estimates for mixed models (SAS PROC MIXED for continuous outcomes, SAS PROC GLIMMIX for binary outcomes) for the association between NA/Stress/Motivation and Assessment Type (see text for details); *PE* = parameter estimate; *SE* = standard error; *OR* = Odds Ratio; *r* = Effect Size measure computed using methods of Kashdan and Steger (2006). Only assessments on the same day as the previous assessment were included in prospective analyses. Lagged variables are Lagged *Deviation* scores. *Mean* scores are included in all models, along with lagged *Deviation* scores of the DV. Day in study is also included in all models. *Treated as fixed coefficients due to failure to converge when treated as random coefficients. Bolded *p* values reflect findings that are both statistically significant and are deemed 'discoveries' using the Benjamini-Hochberg $Q < .05$ threshold (see text for details).

exerted a strong influence of results (Supplementary Materials). Patients were instructed to continue to complete assessments even after a lapse, permitting an exploratory analysis of differences in variables before and after a lapse, though those results require replication in a larger sample.

The study had limitations. First, to reduce participant burden, participants were not required to indicate the “start time” and “end time” of temptations. Therefore, it is not clear when a temptation episode actually “started”, so that the start could have occurred before the subject entry, complicating interpretation. Moreover, duration of temptation episodes in the current study is not known. Note that Shiffman et al. (1996b) reported that the median temptation duration was relatively brief (11 min) in a sample of smokers. Second, a relatively high number of patients reported drinking at the outset of the study, diminishing enthusiasm for analyses on the association between Drinking Status and EMA variables prior to first lapse. Notably, as noted above, there is uncertainty as to what extent the reported differences in temptation assessments vs. random assessments between lapsers and abstainers are a cause or consequence of lapsing.

The use of single-item scales for several measures (e.g., craving, motivation) was also a limitation, because reliability cannot be directly assessed, and because validity would be expected to be lower than for measures derived from multiple-item scales. However, regarding single-item craving measures, several researchers have argued that reliability (Drobes and Thomas, 1999) and predictive validity (Berlin et al., 2013; Kozlowski et al., 1996) may be adequate. Moreover, in EMA studies multiple-item scales may induce reactivity (e.g., craving decreases or increases as a result of answering questions about it) and the time required to answer questions may potentially decrease validity in the sense that psychological states fluctuate and are different after some time (Sayette et al., 2000). Last, there are limitations with the use of participant-initiated temptation assessments. For example, it is difficult to validate reports of self-initiated temptation assessments. It is not known whether the temptation assessments entered are representative of tempted moments, or how many times the participants felt tempted but did not enter a temptation assessment (e.g., due to fatigue in completing assessments) (Supplementary Materials).

Knowledge of whether negative affect precedes or follows temptation episodes could be useful in making treatment decisions and should be investigated in future studies. Clinically, professionals working with outpatients should be watchful of patients who report generally strong cravings, and who report feeling more negative affect and a lower motivation to remain abstinent during temptation episodes.

Contributors

AW performed analyses and wrote the final draft manuscript. TS conceptualized and designed the study. MS and TS wrote the initial drafts; DM and IF reviewed multiple drafts. Data were principally collected by MS. ES assisted with design and implementation of EMA assessments, and VH contributed to data collection and reviewed draft manuscripts. All authors have approved the manuscript. All authors have contributed to the article preparation and have approved the final article.

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Content

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Declaration of Competing Interest

None.

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Appendix A. Supplementary data

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