# Emphasizing interpersonal factors: an extension of the Witkiewitz and Marlatt relapse model

## Dorian Hunter-Reel<sup>1</sup>, Barbara McCrady<sup>1</sup> & Thomas Hildebrandt<sup>2</sup>

Center of Alcohol Studies, Rutgers University, Piscataway, NJ, USA<sup>1</sup> and Eating and Weight Disorders Program, Mount Sinai School of Medicine, New York, NY, USA<sup>2</sup>

## ABSTRACT

Aim Recently, Witkiewitz & Marlatt reformulated the Marlatt & Gordon relapse model to account for current research findings. The present paper aims to extend this model further to incorporate social variables more fully. Methods The social-factors and alcohol-relapse literatures were reviewed within the framework of the reformulated relapse model. Results The literature review found that the number of social network members, investment of the individual in the social network, levels of general and alcohol-specific support available within the social network and specific behaviors of network members all predict drinking outcomes. However, little is known about the mechanisms by which these social variables influence outcomes. The authors postulate that social variables influence outcomes by affecting intra-individual factors central to the reformulated relapse prevention model, including processes (e.g. self-efficacy, outcome expectancies, craving, motivation, negative affective states) and behaviors (e.g. coping and substance use). The authors suggest specific hypotheses and discuss methods that can be used to study the impact of social factors on the intra-individual phenomena that contribute to relapse. Conclusion The proposed extension of the relapse model provides testable hypotheses that may guide future alcohol-relapse research.

**Keywords** Alcohol expectancies, coping, craving, interpersonal behavior, motivation, negative affect, non-linear modelling, relapse, self-efficacy, social factors.

Correspondence to: Dorian Hunter-Reel, Center of Alcohol Studies, Rutgers University, 607 Allison Road, Piscataway, NJ 08854, USA. E-mail: dorianhr@eden.rutgers.edu

Submitted 29 August 2007; initial review completed 28 December 2007; final version accepted 11 March 2009

## INTRODUCTION

Both individual factors and the social environment play key roles in the treatment outcomes of people with alcohol use disorders (AUDs) [1]. However, the interactions between individual and social factors in AUD treatment are poorly understood. This paper addresses this interface by (i) providing a focused review of the literature on social factors and their influence on AUD treatment outcomes; and (ii) integrating findings from the review with Witkiewitz & Marlatt's reformulated relapse model.

#### The interpersonal relapse model

For people with AUDs, several aspects of social support relate to treatment outcomes. For example, higher levels of general social support correlate with less drinking after treatment [2,3]. Among social variables, the degree of social support available from the most supportive person in the network may be the best predictor of reducing drinking [4], and the number of supportive relationships also predicts abstinence strongly [5–10]. Further, the more non-drinking friends a person with an AUD has, the better the outcomes tend to be [10,11].

#### Social investment

Some studies have found a weak relationship between social support and drinking outcomes [2,12]. One reason may be that social investment (indicated by the size of the social network, amount of contact with network members and subjective value of network members) moderates the relationship between alcohol-specific support (support for abstinence and support for drinking) and drinking outcomes [12]. Although social support for abstinence predicts better drinking outcomes among those highly invested in others [3,10,13], social support may be unrelated or even detrimental to subsequent abstinence for those with low investment in the network [12,14].

## Type of support offered

Alcohol-specific support is a more robust predictor of drinking outcomes than general support [3,15]. More support for abstinence from family, friends and work colleagues is associated with lower relapse rates [3,14,16]. However, the evidence with regard to support for drinking is mixed. Using the Project MATCH sample, Longabaugh et al. [17] found that support for drinking, as measured by the percentage of members of the social network who were supportive of drinking, was associated with poorer outcomes. However, using the same data set, Zywiak, Longabaugh & Wirtz [10] found that support for drinking from the four most important people in the network was not related to drinking. In terms of support for drinking, it may be that the impact of the social network as a whole is more important than that of the individuals closest to the drinker, who are perhaps least likely to encourage drinking.

General and alcohol-specific support interact with one another in contributing to positive outcomes. Support for abstinence is correlated with abstinence whether general support is high or low, but when general support is high, the association is even stronger [16]. Alternatively, general social support is associated more strongly with abstinence when encouragement for abstinence is low [16].

## Sources of support

A family's encouragement for abstinence is associated with significantly more abstinent days [13]. Having a family that provides support and assurance of worth is associated with less relapse [5–9], whereas negative family behaviors (e.g. withdrawing from the drinker, avoiding dealing with drinking and tolerating drinking) are associated with more drinking [18]. Good family adjustment and functioning also are associated with better drinking outcomes [2,19,20].

Being married generally predicts positive drinking outcomes [3], although results in this area have been mixed: being married is associated with both the best and the worst outcomes, and the positive effects of marriage are more pronounced for men [2]. Marital happiness is associated with a lower intensity of drinking [18], and greater marital dissatisfaction predicts poorer drinking outcomes [21-23]. Furthermore, having a betterfunctioning marriage before treatment predicts less relapse [18], and marital happiness and abstinence are correlated positively after treatment [24]. Marital events and spousal factors are the reasons cited most frequently by male alcoholics for relapse [22]. Although certain positive spousal behaviors are associated with less drinking [21,25], certain negative spousal behaviors are associated with more drinking [18,26].

Friendships may also play an important role in drinking outcomes. Encouragement from friends for abstinence is associated with better drinking outcomes [13]. While the more non-drinking friends a person has the more positive the outcomes tend to be [10,11], the more drinking friends in the network, the poorer the outcomes tend to be [3,11]. In fact, having even a single person in the social network who uses the same drug of abuse is predictive of poorer outcomes [3]. Furthermore, higher levels of stress from friends predict poorer outcome [6]. General social support from friends and extended family has been shown to be associated with better drinking outcomes (i.e. less drinking), particularly outcomes among people who are both unemployed and unmarried [5–9].

The best outcomes occur when support for abstinence comes from all members of the network. Having more abstinence-specific support from family, friends and work associates is associated with lower risk of relapse [3,16]. Strangely, the number of non-drinking co-workers (but not non-drinking friends or family) participating in treatment predicts positive drinking outcomes [6]. Also, perceived support from family and co-workers, but not from friends, predicts positive drinking outcomes [5–9].

## Gender differences

A number of studies have suggested that social networks have a stronger influence on women than on men. Women are more likely to drink in response to interpersonal stressors [27], report conflict with their partners as precipitants of relapse [28,29] and relapse when with other people, particularly romantic partners [30]. However, some studies have found no such gender differences in the relationships between drinking outcomes and social support [2,11].

## Age differences

Younger alcoholics tend to have fewer non-drinking friends [11], and those who cite relationships as primary motivators for changing their drinking tend to be older and to have begun their drinking careers later [29].

## Relationships among social support variables

Alcohol-specific variables, such as encouragement from important others for abstinence, drinking status of important others and embeddedness in an abstinent life-style, are moderately intercorrelated (*rs* ranging from 0.38 to 0.53) [14]. General qualities of the social network, such as perceived social support, social network size and family dysfunction, are also moderately intercorrelated (*rs* ranging from 0.32 to 0.45) [13]. However, alcohol-specific social support and general qualities of the social network are not correlated with each other [13].

## Interpersonal functioning

The relationships between the individual and social support factors may be bidirectional: the social support system influences an individual's functioning, but the individual's interpersonal skills and functioning also are likely to affect the social network. There is a significant body of research on the role of interpersonal functioning in Axis I disorders, such as post-traumatic stress disorder, eating disorders and depression (see [31–33]), but there is no similar body of research on the role of interpersonal functioning in substance use disorders. Future research should examine the influence of the drinker's interpersonal functioning on the key behaviors of the social network known to influence outcomes.

In summary, many social network characteristics are associated with drinking outcomes, including the size of the network, types of relationships in the network, certain behaviors of social network members and the drinking status of network members. Some individual characteristics may moderate the relationship between social support and outcome, including social investment, age and gender. What we do not know, however, is by what mechanisms these social network characteristics translate into changes in an individual's behavior. Social network members' behavior toward the drinker and the drinker's perceptions of such actions may lead to changes in the psychological processes that underlie the relapse and recovery process. Witkiewitz & Marlatt's [1] expanded model of relapse provides a comprehensive description of these individual psychological processes.

#### The intra-individual relapse model

In 2004, Witkiewitz & Marlatt [1] proposed a reconceptualization of the cognitive-behavioral relapse model that had dominated the field ([34]; see Fig. 1). The new model proposes that determinants of relapse include self-efficacy, outcome expectancies, craving, motivation, coping, negative affect and, more distally, family history, social support and degree of dependence on alcohol. The new model presents a comprehensive theory of relapse as a complex system, and proposes that multiple elements operate within high-risk situations and influence the functioning of the system. The new model allows for several configurations of distal (solid lines in Fig. 1) and proximal (dotted lines) relapse risks, the former representing chronic vulnerabilities for relapse and the latter representing immediate precipitants. These precipitants are organized as phasic (or situational) and tonic (long-term) processes. The phasic response is characterized as the turning point, where behavioral responses may lead to sudden changes in substance use.

This reconceptualized model improves upon the previous model by incorporating new research findings on the importance of affect and background variables in understanding vulnerability to relapse. However, given that research has shown the importance of social factors in predicting relapse, it is surprising that interpersonal processes are characterized only as distal risk factors. In a commentary on the new relapse model, Stanton [35] stated, 'Missing in this reconceptualization is a more thorough shift from an individual psychology of relapse to a systemic psychology of relapse' (p. 340). The behavior of individuals with AUDs does not occur in a vacuum and may be understood as a result of interactions between intra-individual processes and contextual factors.



Witkiewitz & Marlatt clearly agree that intraindividual and interpersonal factors interact. In responding to Stanton's critique, they [36] referred to processes within their model as occurring within context, and stated 'relapse should be conceptualized as a feedback loop, whereby changes in intrapersonal factors (e.g. negative affect) interact with changes in interpersonal factors (e.g. marital happiness) until a steady state of drinking or not drinking is achieved' (p. 342).

However, the mechanisms by which interpersonal factors may influence intra-individual factors are not specified in the model. There is a large body of research suggesting that both interpersonal and intra-individual factors are related to multiple types of psychopathology, such as depression, eating disorders and schizophrenia [37–41], and emerging research suggests that there may be a dynamic relationship between interpersonal and intra-individual factors. For example, it has been reported that as much as 75% of the variance in interpersonal problems among college students could be explained by measures of attachment, emotional reactivity and emotional isolation (intra-individual processes), suggesting that interpersonal and intrapersonal factors map onto one another [42]. Also, it should be noted that individuals have some choice in the construction and maintenance of their social networks. As McCrady [43] stated, 'Social networks are better viewed as dynamic systems, with members of the networks acting on each other and in turn being influenced by each other ... the construction of a social network is not a passive process'.

## Extension of the revised relapse model

We are proposing an extension of the Witkiewitz & Marlatt [1] model to articulate specific mechanisms by which social factors might influence the intra-individual factors at the core of the relapse model. In the following sections, we delineate a series of hypotheses about intraindividual and interpersonal processes. In addition, we posit ways in which an individual's interpersonal behaviors may influence the social network. Within the proposed extension of the relapse model, we differentiate between social support and interpersonal functioning. We conceptualize social support as both a tonic and phasic factor that includes the structure, function and quality of the social environment. Interpersonal functioning refers to an individual's social network investment as well the individual's ability to effectively build and use their network. 'Social support' is a largely environmental factor, and 'interpersonal functioning' is largely an individual characteristic. However, these variables are linked inextricably, such that modifications in one are very likely to lead to changes in the other.

We posit a feedback loop between the social support environment and the individual functioning within that environment.

## Cognitive processes

Witkiewitz & Marlatt [1] described several cognitive processes related to relapse, including self-efficacy, outcome expectancies, craving, motivation and affective states. Social support and interpersonal functioning may be involved in each or all of these processes, as described in the following paragraphs.

*Self-efficacy.* Members of the network may serve to bolster self-efficacy by communicating their confidence in the drinker's ability to achieve and maintain abstinence. Alternatively, the social network may reduce self-efficacy by supporting drinking or communicating lack of confidence in the drinker's ability to succeed in maintaining abstinence. Further, interpersonal functioning may play a role in that individuals may vary in their ability or like-lihood to (i) seek out people who support either abstinence or drinking; and (ii) elicit support from the network and reinforce the support they receive.

*Outcome expectancies.* Social outcomes expected by an individual may have a significant effect on drinking outcomes. If drinkers believe they will suffer interpersonal consequences when they drink, the probability that they will drink may decrease. Further, if drinkers expect better social support as a result of abstinence, they may be more likely to abstain. Alternatively, individuals may have positive social expectancies about re-initiating drinking, thus making relapse more likely. Interpersonal functioning may play a role in whether an individual is able to build and maintain a social network that will reinforce abstinence, thereby improving the drinker's positive expectancies about abstinence.

*Craving.* Craving may be cue-driven and, therefore, highly related to the environment [44–50]. Social network members may provide cues for drinking, either by their own drinking or because the drinker associates them with past drinking. In addition, social events in which drinking takes place may also serve as cues. Conversely, interacting with members of the network who do not provide drinking cues may lower craving. Furthermore, interpersonal functioning may play a role in that drinkers may be more or less skilled in their ability to avoid people or situations that induce craving.

*Motivation.* Social network members may provide motivation to resist drinking, and motivation may change as a function of these relationships. Social network members

may create an unpleasant environment for the abstinent individual, thereby lowering the drinker's motivation for abstinence [51]. Alternatively, the social environment may provide encouragement, support or specific positive reinforcers when the drinker is sober, thereby increasing the drinker's motivation to remain abstinent. A supportive environment may provide the only source of motivation when other sources of motivation wane. Interpersonal functioning may play a role in that individuals may vary in their ability to seek motivationenhancing social experiences, or to behave in ways that will foster such experiences.

Affective states. Of all the intra-individual factors in the Witkiewitz & Marlatt model, negative affect is perhaps the most important in the prediction of relapse. In retrospective accounts, negative affect is a frequently reported antecedent to relapse and is also a principal factor in the prospective prediction of relapse. Negative mood states (as well as social isolation and family factors) are more likely to be reported repeatedly as precursors to multiple relapses [52]. Difficulties in the social network may be particularly powerful in producing negative affect, putting individuals at greater risk for relapse, and individuals whose social networks frequently induce negative affect may be particularly vulnerable. Further, interpersonal functioning may contribute to negative affect in that individuals with more chaotic or off-putting interpersonal styles may elicit behavior from others that increases the individuals' own negative feelings.

#### Behavior

*Coping behavior.* Coping may involve both overt acts and cognitive strategies. Thinking about the potential impact of relapse on people in the social network may provide a powerful form of cognitive coping, although this form of coping may be related to outcome expectancies. If social outcome expectancies of sobriety are positive, the effectiveness of cognitive coping may be higher. Further, the quality of an individual's interpersonal functioning may moderate the effect of social coping efforts—the more an individual is invested in the social network, the more effective cognitive coping is likely to be. Alternatively, if individuals have low investment in social relationships or if they do not believe relapse would cause harm to network members, cognitive coping is likely to be a less effective and less-used strategy.

Reaching out to network members may be a skillful and powerful form of behavioral coping. The likelihood of an individual using this type of coping could be influenced by the composition of the social network, because there may not be network members available to provide help. An individual's interpersonal skills also potentially affect their use of social support, because an individual could be more or less likely (or able) to go to their social network, create an appropriate social network, recall or recognize people who are able and willing to provide support, or behave in ways that elicit support.

Substance use. Environmental cues may elicit physiological responses to prepare the body for drinking, independent of the subjective experience of craving or cognitive processes related to drinking [53,54]. Such physiological processes are known to occur when environmental stimuli are paired repeatedly with drinking and thus become conditioned stimuli [55]. The presence of these stimuli elicits responses that protect the body from the effects of the drug and preserve homeostasis. For example, in rats tolerant to the body temperaturelowering effects of alcohol, the administration of alcoholplacebo in the presence of conditioned alcohol cues results in a compensatory rise in body temperature [56]. Such compensatory responses are thought to be one mechanism by which tolerance develops [56,57]. We propose further that conditioned cue-reactivity is one mechanism by which automatic drinking (i.e. drinking with limited or no planning to do so) may occur and that social network members and social situations may serve as conditioned cues for automatic substance use.

#### Perceived effects

The social network may react positively or negatively to drinking. The ability of individuals to use their social network (i.e. their interpersonal functioning) may be compromised by their drinking, thereby leading them to have less social support in the future. Thus, there may be a direct feedback loop from perceived social network effects to outcome expectancies, so that outcome expectancies are altered as individuals learn how the network responds to relapse.

## **METHODS OF ASSESSMENT**

In the previous section, we set forth a series of postulates about relationships among social support, intraindividual variables and drinking outcomes. These postulates suggest an abundance of potential methodologies to assess these relationships. Preliminary research, using existing self-report measures, could test concurrent correlations between dimensions of social support and intraindividual variables and between interpersonal behaviors and social support variables. Additional analyses could test the degree to which interactions between these variables contribute to the prediction of drinking outcomes.

A second level of analysis could use similar self-report methods to test time-lagged relationships between social support variables and intra-individual variables, examining whether specific aspects of social support at one observation point predict specific intra-individual variables at a second or later observation point. Similarly, time-lagged models could test the degree to which interpersonal behaviors predict later social network variables. More complex models that incorporate feedback loops and successive changes in the variables of interest could be built and tested based on initial findings from these more basic analyses.

An important question is whether the postulated relationships between social and intra-individual variables fluctuate in response to specific events, or if the relationships develop over time through repeated experiences and interactions and are relatively immutable to short-term experiences. Several research methodologies could be applied to study this question. For example, behavioral tasks could be presented in simulated drinking settings that incorporate repeated measurement of variables (e.g. affective arousal, self-efficacy, craving) in response to specific supportive or negative cues from a confederate. Existing methods to study interpersonal interactions, such as those developed by Gottman and his associates [58] or Jacob & Leonard [59], could be modified to incorporate intra-individual measures along with interactional variables such as partner support, concern or contempt.

Research on intimate relationships points to the psychophysiological and neurocognitive sequelae of positive and negative social interactions [60]. Interactional studies conducted in laboratory settings could incorporate psychophysiological measures to determine under what circumstances interactions influence arousal in a positive or negative way. Similarly, functional neuroimaging techniques could be used to understand more clearly the impact of the presence of supportive others (actual or imaginal) on arousal and craving.

More naturalistic designs using ecological momentary assessment [61] could be used to test the impact of specific events in the life of the drinker on intra-individual and social network variables. Participants could record intra-individual variables (such as self-efficacy, craving or negative affect), specific social network events (such as provision of positive support) or the drinking of a social network member. Time–series analytical techniques (see the following section) could be applied to the data to test the inter-relationships among these variables over relatively short periods.

Narrative analysis also could be used in exploratory studies to generate new hypotheses about how drinkers and members of the social network understand the interrelationships among intra-individual behavior, interpersonal behaviors and actions of the social network. It is possible that narrative analysis would identify new variables or major themes that are more important than discrete events. The literature on intimate relationships points to the importance of variables such as commitment [62] and attachment [63], but the relationship of such variables to drinking outcomes remains untested.

#### Statistical methodology

In addition to the abundance of design methodologies that may be used to understand the relationships among the social network, the individual and drinking outcomes, a number of novel statistical techniques may be valuable in evaluating these relationships. Standard statistical techniques (e.g. correlation, regression) may answer many of the questions about the proposed relationships among variables. However, recent advances in quantitative techniques to study change over time, as well as approaches to modeling relapse, are central to testing our proposed hypotheses. Because contemporary research now targets important process outcomes, researchers must rely upon a new set of statistical and methodological tools. This methodological shift is particularly relevant to testing hypotheses where variation in relevant outcomes (e.g. lapse or relapse) is explained by both intra-individual (e.g. motivation) and interpersonal (e.g. social support) variables and where these variables are likely to be related to each other in a reciprocal relationship.

Central to the model extension is the reciprocal nature of interpersonal and intrapersonal variables. The study of such reciprocal relationships can be explored using nonrecursive models that allow for the incorporation of feedback loops into the pattern of hypothesized relationships [64]. For example, the contribution of potential reciprocal relationships between social support and motivation on drinking outcomes could be tested in this type of model, thus reflecting the effect of a dynamic process on a specific outcome. Alternative extensions of this model could test for autoregressive cross-lagged effects to determine the contribution of one variable to another over time. These are designed specifically for repeatedmeasures or time-series models where two variables (e.g. negative affect and drinking) can contribute uniquely to changes in the other at successive time-points while accounting for the repeated measurement and allowing both variables to change as a function of time [65]. These models accommodate more directly the types of hypotheses embedded in the expanded model where the individual's interaction with his/her environment has both interpersonal and intra-individual consequences likely to contribute to drinking.

A further extension of these time–series models uses repeated nominal variables, which fall under the framework of Markov chain modeling (see [66]). These methods allow for the estimation of transition probabilities between categories that are relevant to existing of hypothesis testing of process variables, such as motivation (e.g. contemplation, action), relationship status (e.g. single, divorced, married) or diagnostic status (e.g. abuse, dependence). As with other time–series models, the effects of time-varying covariates can be used to evaluate process level outcomes, such as whether changes in relationship status predict drinking levels (or whether drinking levels predict change in relationship status) over time,

problem drinkers. Because variability in outcomes involves both an event occurrence (e.g. first drink or break from a period of abstinence) and a process or pattern of drinking (i.e. relapse to regular pattern of drinking), the methodologies employed must be flexible enough to handle a number of analytical complexities associated with these drinking outcomes. For example, percentage of days abstinent (PDA) often skews towards abstinence (i.e. 100% PDA) during interventions or skews towards daily drinking (i.e. 0% PDA) in populations with high relapse rates. Zeroinflated (or negative binomial) Poisson regression models are now becoming more commonplace in the analysis of alcohol use, because these methods account for the nonnormal distributions often found in behavioral data such as drinking (e.g. [67]).

and to assess the reciprocal nature of these variables in

In addition to dealing with non-normal distributions, statistical methodologies to test this expanded relapse model must account for individual differences in the patterns and processes of change. Most existing statistical models (e.g. hierarchical linear models, latent growth curve models, mixed effects models) assume a common, typically linear, process of change for the entire population, where variation around this common pattern of change is modeled by observed covariates (e.g. differences in drinking over time as a function of treatment) [68]). More recent extensions of these models have incorporated the identification of unobserved (latent) subgroups, where processes of change can differ between groups (e.g. [69,70]), and advances in modeling are now able to account for violations of the measurement invariance assumptions between unobserved groups (see [71] for a review). The ability to identify unobserved groups with different trajectories allows researchers to evaluate the presence of different patterns of change (e.g. a group that moves quickly from abstinence to heavy drinking versus a group that has gradual, steady increases in drinking after treatment), as well as predictors of group membership (e.g. degree of social support or self-efficacy).

Many aspects of the model extension also suggest that change is discontinuous rather than linear. Some advances in statistical methodology have particular relevance to modeling change processes posited as discrete changes (e.g. abstinence to relapse) or believed to be part of a larger dynamic process [72]. In an interesting example of this type of modeling, Hufford et al. [73] presented preliminary data suggesting that relapse is predicted most accurately using the cusp catastrophe model developed from non-linear dynamical systems theory. In this type of model, change is conceptualized as a complex system, wherein variation in certain parameters can be used to predict or explain an observed pattern of relapse. However, the parameters considered in a cusp catastrophe model seek to explain the states where minor shifts in either parameter yield a wide range of instability in the relevant outcome. Thus, behavioral outcomes such as drinking are modeled as an increasing likelihood of a wide range of drinking levels (i.e. degree of instability within the system) rather than as an increased likelihood of a specific level of drinking, as in traditional linear modeling approaches [74].

#### FUTURE DIRECTIONS

We have reviewed literature on the role of the social network in understanding drinking, changes in drinking behavior and maintenance of such changes in those with AUDs. There is, however, a lack of understanding of the mechanisms by which social networks influence behavior change. We propose that social network variables and interpersonal functioning are probable moderators of treatment outcomes (variables that precede treatment that determine for whom and under which circumstances change can occur) [75]) and that Witkiewitz & Marlatt's intra-individual variables are potential mechanisms of change (variables that covary with change and are found to have a causal effect upon the outcome variable) [75]. However, these mediators may also feed back and influence moderators, thus also functioning as moderators.

We propose that social networks influence the underlying cognitive, affective and behavioral processes described in Witkiewitz & Marlatt's [1] relapse model and have proposed ways in which such influence may occur. We have also proposed a feedback loop, in that individual functioning may influence the social network which, in turn, may influence the individual. We have also articulated a series of testable hypotheses and have suggested possible methodological and statistical tools to evaluate them.

These suggested modifications are not intended to displace the model proposed by Witkiewitz & Marlatt, but rather to place the model within a social context and to delineate factors that may interact with intra-individual characteristics and processes to produce outcomes. As Witkiewitz & Marlatt [36] noted, it is difficult to justify large and expensive treatment trials when we do not understand the basic processes underlying outcomes. To develop more efficacious treatments, we must understand the 'systemic relapse processes, and the individual dynamics of treatment failure, as well as the protective factors that are predictive of treatment success' ([36], p. 342). We hope that this model extension will help to spur research to this end and will, in turn, lead to more efficacious treatments for individuals with AUDs.

## Acknowledgements

The authors appreciate the thoughtful feedback on previous versions of the manuscript provided by Drs Katie Witkiewitz and Alan Marlatt. The authors also appreciate the help of Mr Paul Candon and Ms Samantha Farris in the preparation of this manuscript. Preparation of this paper was supported in part by National Institute on Alcohol Abuse and Alcoholism grant no. T32 AA07569.

## Declarations of interest

None.

## References

- 1. Witkiewitz K., Marlatt G. A. Relapse prevention for alcohol and drug problems: that was Zen, this is Tao. *Am Psychol* 2004; **59**: 224–35.
- Beattie M. C. Meta-analysis of social relationships and posttreatment drinking outcomes: comparison of relationship structure, function and quality. *J Stud Alcohol* 2001; 62: 518–27.
- Havassy B. E., Hall S. M., Wasserman D. A. Social support and relapse: commonalities among alcoholics, opiate users and cigarette smokers. *Addict Behav* 1991; 61: 235–46.
- Barber J. G., Crisp B. R. Social support and prevention of relapse following treatment for alcohol abuse. *Res Soc Work Pract* 1995; 5: 283–96.
- Booth B. M., Russell D. W., Soucek S., Laughlin P. R. Social support and outcome of alcoholism treatment: an exploratory analysis. *Am J Drug Alcohol Abuse* 1992; 18: 87–101.
- Gordon A. J., Zrull M. Social networks and recovery: one year after inpatient treatment. *J Subst Abuse Treat* 1991; 8: 143–52.
- Humphreys K., Moos R. H., Finney J. W. Life domains, Alcoholics Anonymous, and role incumbency in the 3-year course of problem drinking. *J Nerv Ment Dis* 1996; 184: 475–81.
- MacDonald J. G. Predictors of treatment outcome for alcoholic women. Int J Addict 1987; 22: 235–48.
- 9. Rosenberg H. Relapsed versus non-relapsed alcohol abusers: coping skills, life events, and social support. *Addict Behav* 1983; **8**: 183–6.
- Zywiak W. H., Longabaugh R., Wirtz P. W. Decomposing the relationship between pretreatment social network characteristics and alcohol treatment outcome. *J Stud Alcohol* 2002; 63: 114–21.
- Mohr C. D., Averna S., Kenny D. A., Delboca F. 'Getting by (or getting high) with a little help from my friends': an examination of adult alcoholics' friendships. *J Stud Alcohol* 2001; 62: 637–45.

- 12. Longabaugh R., Beattie M. C., Noel N., Stout R., Malloy P. The effect of social investment on treatment outcome. *J Stud Alcohol* 1993; **54**: 465–78.
- Beattie M. C., Longabaugh R. Interpersonal factors and post-treatment drinking and subjective well being. *Addiction* 1997; 92: 1507–21.
- Longabaugh R., Wirtz P. W., Beattie M. C., Noel N., Stout R. Matching treatment focus to patient social investment and support: 18-month follow-up results. *J Consult Clin Psychol* 1995; 63: 296–307.
- Beattie M. C., Longabaugh R., Fava J. Assessment of alcohol-related workplace activities: development and testing 'your workplaces'. J Stud Alcohol 1992; 53: 469–75.
- Beattie M. C., Longabaugh R. General and alcohol-specific social support following treatment. *Addict Behav* 1999; 24: 593–606.
- 17. Longabaugh R., Wirtz P. W., Zweben A., Stout R. L. Network support for drinking, Alcoholics Anonymous and long-term matching effects. *Addiction* 1998; **93**: 1313–33.
- McCrady B. S., Hayaki J., Epstein E. E., Hirsch L. S. Testing hypothesized predictors of change in conjoint behavioral alcoholism treatment for men. *Alcohol Clin Exp Res* 2002; 26: 463–70.
- Moos R. H., Bromet E., Tsu V., Moos B. Family characteristics and the outcome of treatment for alcoholism. *J Stud Alcohol* 1979; 40: 78–88.
- O'Farrell T. J., Hooley J., Fals-Stewart W., Cotter H. L. Expressed emotion and relapse in alcoholic patients. J Consult Clin Psychol 1998; 66: 744–52.
- 21. McCrady B. S., Epstein E. E., Sell R. D. Theoretical bases of family approaches to substance abuse treatment. In: Rotgers F., Keller D. S., Morgenstern J., editors. *Treatment of Substance Abusers: Theory and Technique*, 2nd edn. New York: Guilford Press; 2003, p. 112–39.
- 22. Maisto S. A., O'Farrell T. J., Connors G. J., McKay J., Pelcovits M. A. Alcoholics attributions of factors affecting their relapse to drinking and reasons for terminating relapse events. *Addict Behav* 1998; 13: 79–82.
- 23. Fals-Stewart W., O'Farrell T. J., Birchler G. R., Cordova J., Kelley M. L. Behavioral couples therapy for alcoholism and drug abuse: where we've been, where we are, and where we're going. *J Cogn Psychother Int Q* 2005; **19**: 229–46.
- McCrady B. S., Epstein E. E., Kahler C. W. Alcoholics Anonymous and relapse prevention as maintenance strategies after conjoint behavioral alcohol treatment for men: 18-month outcomes. *J Consult Clin Psychol* 2004; 72: 870–8.
- Dunn N. J., Jacob T., Hummon N., Seilhamer R. A. Marital stability in alcoholic–spouse relationships as a function of drinking pattern and location. *J Abnorm Psychol* 1987; 96: 99–107.
- Orford J., Guthrie S., Nicholls P., Oppenhemer E., Egert S., Hensman C. Self-reported coping behavior of wives of alcoholics and its association with drinking outcome. *J Stud Alcohol* 1975; 36: 1254–67.
- Allan C. A., Cooke D. J. Stressful life events and alcohol misuse in women: a critical review. *J Stud Alcohol* 1985; 43: 147–52.
- Conner G. J., Maisto S. A., Zywiak W. H. Male and female alcoholics attributions regarding the onset and termination of relapses and the maintenance of abstinence. J Subst Abuse 1998; 10: 27–42.
- 29. Lutz M. E. Sobering decisions: are there gender differences? *Alcohol Treat Q* 1991; **8**: 51–64.

- Rubin A., Stout R. L., Longabaugh R. Gender differences in relapse situations. *Addiction* 1996; 91: S111–20.
- MacDonald C., Chamberlain K., Long N., Flett R. Posttraumatic stress disorder and interpersonal functioning in Vietnam War veterans: a mediational model. *J Trauma Stress* 1999; 4: 701–7.
- O'Mahony J. F., Hollwey S. Eating problems and interpersonal functioning among several groups of women. *J Clin Psychol* 1995; **51**: 345–51.
- Joiner T., Coyne J. C. The Interactional Nature of Depression: Advances in Interpersonal Approaches. Washington, DC: American Psychological Association; 1999.
- Marlatt G. A., Gordon J. R., editors. Replace Prevention: Maintenance Strategies in the Treatment of Addictive Behaviors. New York: Guilford Press; 2003.
- Stanton M. Relapse prevention needs more emphasis on interpersonal factors. *Am Psychol* 2005; 60: 340–1.
- Witkiewitz K., Marlatt G. A. Emphasis on interpersonal factors in a dynamic model of relapse. *Am Psychol* 2005; 60: 341–2.
- 37. Coyne J. C. Thinking interactionally about depression: a radical restatement. In: Joiner T., Coyne J. C., editors. *The Interactional Nature of Depression: Advances in Interpersonal Approaches*. Washington, DC: American Psychological Association; 1999, p. 365–92.
- De Decker B., Van de Craen P. Towards an interpersonal theory of schizophrenia. In: Wodak R., Van de Craen P., editors. *Neurotic and Psychotic Language Behaviour*. Clevedon: Multilingual Matters; 1987, p. 249–65.
- Haworth-Hoeppner S. The critical shapes of body image: the role of culture and family in the production of eating disorders. J Marriage Fam 2000; 62: 212–27.
- Whitehouse P. J., Harris G. The inter-generational transmission of eating disorders. *Eur Eat Disord Rev* 1998; 6: 238–54.
- 41. van Furth E. F., van Strien D. C., Martina L. M. L., van Son M. J. M., Hendrickx J. J. P., van Engeland H. Expressed emotion and the prediction of outcome in adolescent eating disorders. *Int J Eat Disord* 1996; 20: 19–31.
- 42. Wei M., Vogel D. L., Ku T. Y., Zakalik R. A. Adult attachment, affect regulation, negative mood, and interpersonal problems: the mediating roles of emotional reactivity and emotional cutoff. *J Couns Psychol* 2005; **52**: 14–24.
- 43. McCrady B. S. To have but one true friend: implications for practice of research on alcohol use disorders and social networks. *Psychol Addict Behav* 2004; 18: 113–21.
- Baumann S. B., Sayette M. A. Smoking cues in a virtual world provoke craving in cigarette smokers. *Psychol Addict Behav* 2006; 20: 484–9.
- 45. Cooney N., Litt M. D., Morse P. A., Bauer L. O. Alcohol cue reactivity, negative-mood reactivity, and relapse in treated alcoholic men. *J Abnorm Psychol* 1997; **106**: 243–50.
- 46. Franken I. H. A., de Haan H. A., van der Meer C. W., Haffmans P. M. J., Hendriks V. M. Cue reactivity and effects of cue exposure in abstinent posttreatment drug users. *J Subst Abuse Treat* 1999; 16: 81–5.
- Hutchison K. E., Niaura R., Swift R. Smoking cues decrease prepulse inhibition of the startle response and increase subjective craving in humans. *Exp Clin Psychopharmacol* 1999; 7: 250–6.
- McCusker C. G., Brown K. Cue-exposure to alcoholassociated stimuli reduces autonomic reactivity, but not craving and anxiety, in dependent drinkers. *Alcohol Alcohol* 1995; **30**: 319–27.

- 49. Myrick H., Anton R. F., Li X., Henderson S., Drobes D., Voronin K. *et al.* Differential brain activity in alcoholics and social drinkers to alcohol cues: relationship to craving. *Neuropsychopharmacology* 2004; 29: 393–402.
- Volkow N. D., Wang G. J., Telang F., Fowler J. S., Logan J., Childress A. *et al.* Cocaine cues and dopamine in dorsal striatum: mechanism of craving in cocaine addiction. *J Neurosci* 2006; 26: 6583–8.
- Steinglass P. The impact of alcoholism on the family: relationship between degree of alcoholism and psychiatric symptomatology. J Stud Alcohol 1981; 42: 288–303.
- Connors J. P., Longabaugh R., Miller W. R. Looking forward and back to relapse: implications for research and practice. *Addiction* 1996; **91**: 191–6.
- Ramos B. M. C., Siegel S., Bueno J. L. O. Occasion setting and drug tolerance. *Integr Physiol Behav Sci* 2002; 37: 165–77.
- 54. Siegel S. Pavlovian conditioning and drug overdose: when tolerance fails. *Addict Res Theory* 2001; **9**: 503–13.
- Siegel S. The inside story of conditioning. *PsycCRITIQUES* 1970; 15(5).
- Siegel S., Baptista M. A. S., Kim J. A., McDonald R. V., Weise-Kelly L. Pavlovian psychopharmacology: the associative basis of tolerance. *Exp Clin Psychopharmacol* 2000; 8: 276– 93.
- Siegel S. Drug tolerance, drug addiction, and drug anticipation. *Curr Dir Psychol Sci* 2005; 14: 296–300.
- Gottman J. M., Notarius C. I. Decade review: observing marital interaction. J Marriage Fam 2000; 62: 927–47.
- Jacob T., Leonard K. Sequential analysis of marital interactions involving alcoholic, depressed, and nondistressed men. J Abnorm Psychol 1992; 101: 647–56.
- Coan J. A., Schaefer H. S., Davidson R. J. Lending a hand: social regulation of the neural response to threat. *Psychol Sci* 2006; 17: 1032–9.
- Stone A. A., Shiffman S. Ecological momentary assessment (EMA) in behavorial medicine. *Ann Behav Med* 1994; 16: 199–202.
- Stanley S. M., Markman H. J. Assessing commitment in personal relationships. J Marriage Fam 1992; 54: 595– 608.
- Epstein N. B., Baucom D. H. Enhanced Cognitive-Behavioral Therapy for Couples. A Contextual Approach. Washington, DC: American Psychological Association; 2003.
- 64. Kline R. Reverse arrow dynamics: formative measurement and feedback loops. In: Hanckock G. R., Mueller R. O., editors. *Structural Equation Modeling: a Second Course*. Greenwich, CT: Information Age Publishing; 2006, p. 43–68.
- Bollen K. A., Curran P. J. Autoregressive latent trajectory models: a synthesis of two traditions. *Sociol Methods Res* 2004; 32: 336–88.
- 66. Xiaowei Y., Shoptaw S., Kun N., Juanmei L., Belin T. R. Markov transition models for binary repeated measures with ignorable and nonignorable missing values. *Stat Methods Med Res* 2007; 16: 347–64.
- Hernandez-Avila C. A., Song C., Kuo L., Tennen H., Armeli S., Kranzler H. R. Targeted versus daily naltrexone: secondary analysis of effects on average daily drinking. *Alcohol Clin Exp Res* 2006; 30: 860–5.
- Laurenceau J., Hayes A. M., Feldman G. C. Some methodological and statistical issues in the study of change processes in psychotherapy. *Clin Psychol Rev* 2007; 27: 682–95.
- 69. Muthen B., Muthen L. K. Integrating person-centered and variable-centered analyses: growth mixture modeling with

latent trajectory classes. Alcohol Clin Exp Res 2000; 24: 882–91.

- Clark D. B., Jones B. L., Wood D. S., Cornelius J. R. Substance use disorder trajectory classes: diachronic integration of onset age, severity, and course. *Addict Behav* 2006; 31: 995– 1009.
- Muthen B. O. Latent variable hybrids: an overview of old and new methods. In: Hancock G. R., Samuelsen K. M., editors. *Latent Variable Mixture Models*. Charlotte, NC: Information Age Publishing; 2008, p. 1–24.
- 72. Hayes A. M., Laurenceau J. P., Feldman G., Strauss J. L., Cardaciotto L. Change is not always linear: the study of

nonlinear and discontinuous patterns of change in psychotherapy. *Clin Psychol Rev* 2007; **27**: 715–23.

- Hufford M. R., Witkiewitz K., Shields A. L., Kodya S., Caruso J. C. Relapse as a nonlinear dynamic system: application to patients with alcohol use disorders. *J Abnorm Psychol* 2003; 112: 219–22.
- Witkiewitz K., Marlatt G. A. Modeling the complexity of post-treatment drinking: it's a rocky road to relapse. *Clin Psychol Rev* 2007; 27: 724–38.
- Kraemer H. C., Wilson G. T., Fairburn C. G., Agras W. S. Mediators and moderators of treatment effects in randomized clinical trials. *Arch Gen Psychiatry* 2002; 59: 877–83.