SELF-DETERMINATION THEORY AS A FRAMEWORK FOR EVALUATING WITHIN-PERSON EFFECTS OF PERSONALIZED NORMATIVE FEEDBACK ON DRINKING

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A Dissertation

Presented to

The Faculty of the Department

of Psychology

University of Houston

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In Partial Fulfillment

Of the Requirements for the Degree of

Doctor of Philosophy

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By

Zachary G. Baker

August, 2019

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ABSTRACT

Academic consequences, alcohol use disorders, assaults, and death are real and present dangers for college students problematically consuming alcohol. A number of theories exist that aid in the understanding of problematic alcohol consumption. These theories have been used to create particularly effective interventions to reduce problematic alcohol consumption. Still, these interventions do not reduce problematic drinking for all people, all of the time. Through empirical and theoretical means, this work aimed to answer questions about why problematic alcohol consumption endures. Empirically, problematic alcohol consumption, its predictors, and interventions to reduce it were examined at the within-person level where the majority of variance resides. Theoretically, self-determination was employed to explain why people may be more or less inclined to drink following interventions both situationally and across situations. The present study tested the utility of within-person measurement and self-determination theory as moderators of a personalized normative feedback intervention and injunctive norms among heavy-drinking college students. Participants completed baseline assessments, received personalized normative feedback or a control intervention, completed daily assessments for 17 days, and completed a follow-up assessment. Analyses were conducted using structural equation modeling and multilevel modeling. Due to time constraints, the final intended sample of 300 participants was not successfully collected. Instead, 156 were included in the daily analyses, while 136 were included in the baseline-follow-up analyses. Results provided little compelling evidence of the moderating effect of self-determination on either a personalized normative feedback intervention or naturally occurring injunctive norms in predicting alcohol consumption. This lack of compelling

evidence was largely due to an insufficient sample size to detect the effect sizes estimated by this study using conventional heuristics of statistical significance. The results do suggest that some of the most detectable interaction effect sizes may be at the within-person level, thus future research may benefit from focusing on within-person, as opposed to between-person effects. The effect sizes also suggest that the injunctive norms by self-determination interaction may be particularly fruitful for future research if future research confirms these findings in more powerful studies. Specifically, those that are less self-determined may be particularly susceptible to injunctive norms. Given past evidence of difficulty manipulating injunctive norms, this may suggest that altering people's feelings of self-determination may be a useful route to reducing problematic alcohol consumption. Improvements for the study design are also suggested.

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Self-Determination Theory as A Framework For Evaluating Within-Person Effects Of Personalized Normative Feedback On Drinking

Among college students aged 18-24, deaths and assaults are often related to alcohol consumption (Hingson, Heeren, Winter, & Wechsler, 2005). Moreover, 1/4 college students experience academic consequences from drinking alcohol (Hingson, Zha, & Weitzman, 2009) and 1/5 have alcohol use disorders (Blanco et al., 2008). A major focus of the NIAAA is the College Alcohol Intervention Matrix ("CollegeAIM NIAAA's Alcohol Intervention Matrix," 2018), which helps schools address harmful and underage student drinking with individual and environmental strategies. Many brief and effective interventions exist and are reported in CollegeAIM, but many are not effective for all people, all the time. For example, an often-used method that can limit costs is alcohol skills training, but it is not effective at reducing alcohol consumption on its own ("CollegeAIM NIAAA's Alcohol Intervention Matrix," 2018). Another intervention that similarly limits costs but is far more effective at reducing drinking is personalize normative feedback (PNF) ("CollegeAIM NIAAA's Alcohol Intervention Matrix," 2018). Even though individuals reduce their drinking, evidence seems to suggest that they are still binge drinking (Lewis, Neighbors, Oster-Aaland, Kirkeby, & Larimer, 2007) and experiencing alcohol-related problems (Neighbors, Lewis, Bergstrom, & Larimer, 2006). In the present work, we propose that self-determination theory (Deci & Ryan, 1985a, 2002; Ryan & Deci, 2017a) may offer greater understanding of why and when interventions and normative predictors of drinking are more or less impactful to college student drinking.

Self-Determination Theory

Less self-determined people drink more and have more alcohol-related problems (Hove, Parkhill, Neighbors, McConchie, & Fossos, 2010a; Steers et al., 2016). Self-determination in the context of motivation concerns the reasons people perceive for enacting their behavior and is measured along a continuum of regulation from the most internal sources to the least internal (Howard, Gagné, & Bureau, 2017; Sheldon, Osin, Gordeeva, Suchkov, & Sychev, 2017).

Motivation explains a great deal of the variance in actual drinking behavior (Cronin, 1997) and is thought to be the most proximal means by which behavior can be predicted (Cooper, 1994; Cox & Klinger, 1988). Perhaps the most well-studied conceptualization of motivation as it applies to alcohol consumption describes two categories that might interact to form different kinds of motivation (Kuntsche, Knibbe, Gmel, & Engels, 2005). Kuntsche et al.,'s (2005) categories include internal-external and positive-negative. Internal, positive motivation targets the enhancement of positive mood or well-being through drinking. Internal, negative motivation focuses on avoiding negative emotions. External, negative motivation focuses on avoiding social rejection. External, positive motivation focuses on obtaining social rewards. Interestingly, items used in this and other scales of motivation for drinking have been placed in different categories by different researchers (Kuntsche et al., 2005). For instance, some have placed items like "I like the feeling of drunkenness" into scales focused on enhancement, while others have placed that same item into labels of social camaraderie or social facilitation. This portrays the importance of having a priori theoretical reasons for categorization of items (Kuntsche et al., 2005). For instance, self-determination theory would refer to drinking because you "like the feeling." as a form of intrinsic

motivation (Hagger et al., 2012).[1]

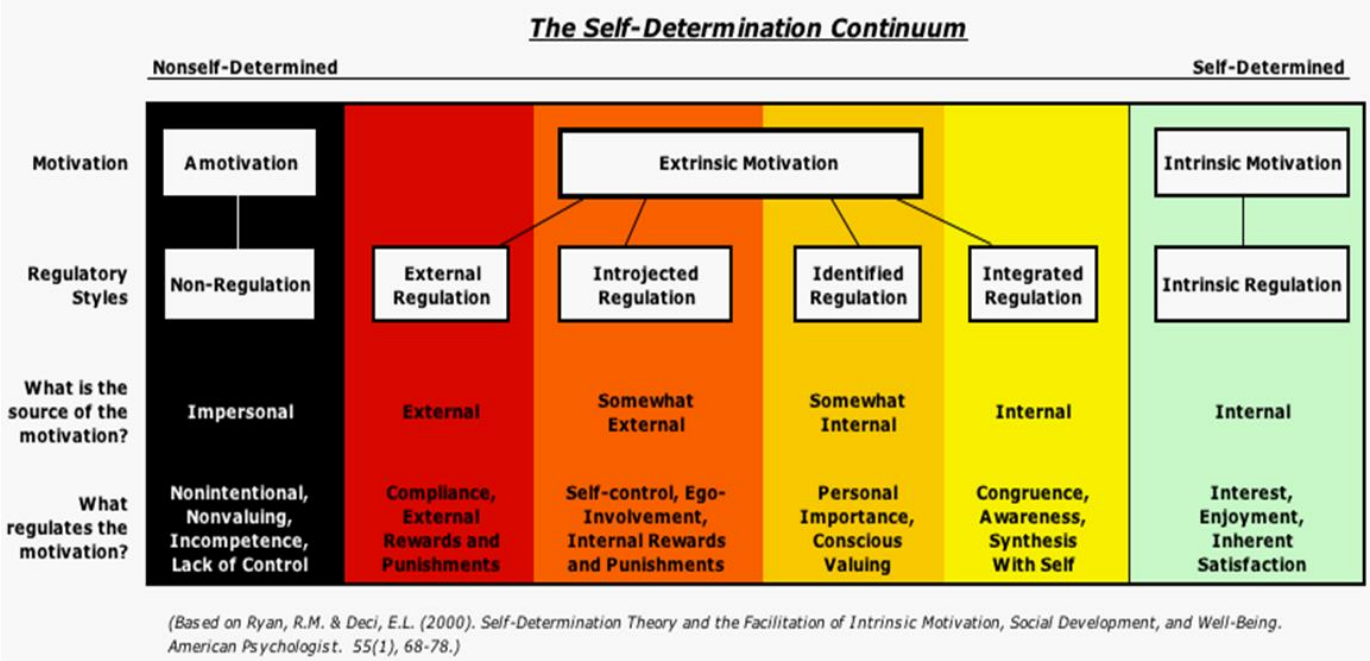

Figure 1. The Self-Determination Continuum (Reprinted from "What is Self-Determination Theory?," 2018).

Intrinsic motivation lies on the most internal end of a continuum of self-determination (For an overview of the continuum, please see Figure 1). This is a continuum of internalization in which the most self-determined reasons for drinking are the result of liking drinking in its various forms, for no reasons other than the spontaneous feelings, sensations, and experiences that are involved and inseparable from the behavior itself. Rather than liking the results that drinking produces, intrinsic motivation for problematic drinking is about enjoying the drinking experience itself. Surveys suggest that this intrinsic motivation for

[1] The present discussion focuses on alcohol consumption motivation for problematic drinkers specifically, but it is worth noting that those who have a general orientation that is characteristic of more external motivation across a range of domains (Deci & Ryan, 1985c; Vallerand, 1997, 2000) tend to drink more (Chawla, Neighbors, Logan, Lewis, & Fossos, 2009; Hove, Parkhill, Neighbors, McConchie, & Fossos, 2010b; Knee & Neighbors, 2002a; Rodriguez et al., 2018), though this may be the case more so for whites than Asians (Nguyen & Neighbors, 2013).

drinking is a major motivation for drinking with estimates of individuals drinking because they enjoy it ranging from 16% (Feldman, Harvey, Holowaty, & Shortt, 1999) to 94.4% (Jerez & Coviello, 1998).

Like intrinsic incentives, extrinsic incentives, including enhancement and social motives, are commonly endorsed by drinkers (Kuntsche et al., 2005). The next step along the continuum, according to self-determination theory, describes the next most internal kind of incentives and involves drinking because it is coherent with one's sense of self and higher-order identities (i.e., integrated regulation). This draws strong parallels with elements of theories on authenticity (Kernis & Goldman, 2006; Wood, Linley, Maltby, Baliousis, & Joseph, 2008). For instance, if one engages in problematic drinking because they are a fun-loving person, a social butterfly, or a party animal, this may be thought of as being done because of integrated regulation. Notably, to be purely integrated regulation, one is drinking solely as an expression of that identity, not to prove that identity true or to portray oneself in a particular light to others.

Identified regulation is next on the continuum and is less completely internalized into one's true self than is integrated regulation. Identified regulation is about recognizing the importance of the behavior, while not enjoying the behavior for its own sake. The behavior is thus congruent with one's identity in that it is valued and facilitates important goals. Like integrated regulation, identified regulation is still somewhat internal to the self, but the task in question (in this case, problematic drinkers consuming alcohol) is meaningful. For instance, if one wishes to be a healthy person and acknowledges NIAAA's guidelines for healthy drinking, as a female (male) they might ensure that they consume 1 (2) drinks per day because of the reduction in mortality, heart failure/stroke, or vascular dementia

(Griswold et al., 2018; cf. Gunzerath, Faden, Zakhari, & Warren, 2004), though this would be a less fitting example for problematic drinking. If people wish to be more social, they might engage in problematic alcohol consumption for its social lubrication effects (Kuntsche et al., 2005). In identified regulation there is more focus on the outcomes associated with alcohol than there is in intrinsic or integrated regulation, which is why identified regulation is viewed as more external to the true self.

The next step along the continuum, introjection, is rather unique to self-determination theory. Introjected motivation concerns regulation that tends to come from within the person, but not from the true self. Rather than focusing on benefits of internalization (e.g., synthesis with the sense of self or conscious valuing because of goal alignment) it is focused on more internal pressures. In introjected regulation, the pressures for problematic drinking are coming from within a person, but self-determination considers them to be relatively external to the true self (Deci, Eghrari, Patrick, & Leone, 1994; Stone, Deci, & Ryan, 2009). Introjected regulation may lead people to engage in problematic drinking because of expectations they have about what appears cool. The behavior in this example reflects introjection because it is derived not from actual experiences with others, but instead internal pressures and expectations that one holds.

Beyond introjection, at the most external end of the spectrum, is external regulation. External regulation is characterized by a focus on external rewards and punishments. Here the behavior is considered so external because none of the forces that serve as catalysts for it come from the self. Instead, forces outside the self entirely drive the behavior. In external regulation, people might engage in problematic drinking because of the acceptance that accompanies it, or because of rejection associated with not drinking that way.

The last form of described regulation that lies along the self-determination continuum at the far end as the least self-determined is known as amotivation. Amotivated regulation is characterized by neither intrinsic nor extrinsic motivation. Instead, people at this far end of the continuum cannot identify reasons for why they drink. Calling this a form of regulation is somewhat paradoxical because it really represents a lack of regulation. People who exhibit amotivated problematic drinking regulation simply do not have clear reasons for drinking. Sometimes they drink, sometimes they do not, and they are not aware of why it happens.

The careful reader might take a few exceptions with the above explanations. First, some of the lines between these forms of regulation may be blurry and hard to distinguish in actual behavior. These distinctions are primarily pedagogical and are an imperfect representation of what should be thought of as a truly unbroken continuum (Deci & Ryan, 1985b; Ryan & Deci, 2017b). Rather than being discreet categories that stand far separated from one another, they are notable sections along a spectrum and understanding each of them helps to paint a better picture of that spectrum overall (cf. Chemolli & Gagné, 2014).

Additionally, many or even all of these types of extrinsic motivation (i.e., integrated, identified, introjected, and external) might operate in concert. Self-determination theorizing might suggest that all of these motivations operating in concert is unlikely when also considering intrinsic motivation and amotivation. Still, this can theoretically – and does empirically – happen with each kind of extrinsic motivation (Sheldon et al., 2017).[2] Indeed, above examples of each form of extrinsic motivation (from integrated through external) included social elements for problematic drinking, demonstrating conceptual overlap. It is

[2] Empirically, there has also been a great deal of evidence for people endorsing both intrinsic and amotivated responses while also endorsing extrinsic responses simultaneously (Howard, Gagné, & Bureau, 2017; Sheldon, Osin, Gordeeva, Suchkov, & Sychev, 2017), though this breaks somewhat from original theorizing.

completely reasonable that a person might drink problematically because it is coherent with their sense of self (integrated), aligns with their goals of wanting to be an effective social actor (identified), to avoid feeling lame (introjected), *and* because of the acceptance they might receive for drinking to excess (external). Indeed, various forms of motivation in the SDT continuum are consistently associated with one another, often in a simplex pattern of correlations wherein the more positive correlations are observed among the types of regulation that are closer on the continuum (Blais, Sabourin, Boucher, & Vallerand, 1990; Sheldon et al., 2017). Likewise, many motives assessed in the realm of drinking that have been developed without the theoretical lens of SDT are highly correlated (Kuntsche et al., 2005). While people may attribute their problematic drinking to many or even all of these motives, it is unlikely that they will attribute their problematic drinking to all of these motives equally (Howard et al., 2017; Howard, Gagné, Morin, & Forest, 2016). Therefore, when asking about these motives, questions should try to tap each of the types of regulation described. Typically, those questions assess the extent to which each type of regulation is responsible for the behavior of interest. Then, by combining them into an overall index (known as the *relative autonomy index*, see also *relative autonomy continuum*), we may come to understand where along the self-determination continuum the regulation for a behavior like problematic drinking stands, overall.[3]

[3] It should be noted that the relative autonomy index has been researched extensively but that there is currently active debate regarding whether it is best to look at an overall index or examine the contributions of each step along the continuum individually. Strong evidence has been put forth to suggest that some information is lost in examining a relative autonomy index versus examining each step on its own (Chemolli & Gagné, 2014). Still, it seems likely that some information will nearly always be lost when engaging in any form of averaging and that more explanation is possible with more predictors (Sheldon et al., 2017). Moreover one recent meta-analysis suggests that a continuum structure does well-represent the data (Howard et al., 2017). Therefore, a useful way to engage in this debate for one's own research is to think of what questions one has. There are situations where introjection might be of particular interest (Deci, Eghrari, Patrick, & Leone, 1994; Stone, Deci, & Ryan, 2009); perhaps because an intervention has been designed to specifically address introjection. In that case, examining

More self-determination leads to greater self-regulation, goal-setting and attainment, and overall well-being (Deci & Ryan, 1985b, 2002; Ryan & Deci, 2017b). Self-determination is fundamental to well-being across people and cultures (Chen et al., 2014; Chirkov, Ryan, Kim, & Kaplan, 2003; Ryan et al., 1999; Sheldon et al., 2004; cf. Tripathi, Cervone, & Savani, 2018) and deficits in it lead to suboptimal outcomes (Deci & Ryan, 2000; Moller & Deci, 2009; van Egmond, Navarrete Berges, Omarshah, & Benton, 2017). At least one research team has explored self-determination in concert with one particularly effective form of alcohol intervention: personalized normative feedback (Neighbors et al., 2006).

Personalized Normative Feedback and Social Norms

Personalized Normative Feedback (PNF) interventions confront people with discrepancies between own drinking, perceptions of others' drinking, and realities of others' drinking. Students then reduce drinking and alcohol-related problems to align their behavior with others' behavior (e.g., Neighbors et al., 2004). PNF Interventions arise out of social norms theories and refer to two types of perceived social norms: descriptive norms and injunctive norms (Cialdini, Reno, & Kallgren, 1990).

Social norms and drinking. Early conceptualizations of social norms viewed them as a more-or-less unitary construct that reflected our perception of others, especially with regard to relevant tasks (Shaffer, 1983). It is worth noting that some theories that originally

introjection (and other specific components of the continuum) is essential. In other situations, examining the overall continuum is more appropriate (Hadden, Baker, & Knee, 2018; Hadden, Knee, DiBello, & Rodriguez, 2015), because the continuum is of interest rather than a single element. Unfortunately, I tend to see researchers (and I am not innocent of this crime) examining the whole continuum or individual elements atheoretically. For my questions, the continuum is typically more apropos and therefore that is what I tend to examine. In the present work I am describing the overall continuum because I believe it to be more reflective of the larger ideas and that the extra explanation provided by individual components does not buy enough to offset the cost of the added complexity. Still, if future researchers propose a compelling theoretical reason for examining the individual components, I would not begrudge them, nor would I consider it a violation of my model.

explored norms as an individual construct continue to do so today (e.g., Chatzisarantis, Hagger, & Brickell, 2008). One such example is the Theory of Planned Behavior, which views norms as essential to understanding intentions and, in turn, behavior. While current thinking on the Theory of Planned Behavior does understand and advocate the importance of understanding multiple kinds of norms (Ajzen, 2002), as more than a unitary construct, many researchers do not introduce such complexity (e.g., Hagger et al., 2012).

Social norms, however, rather compellingly consist of more than one construct (Cialdini, Kallgren, & Reno, 1991; Cialdini, Reno, & Kallgren, 1990; Nolan, Schultz, Cialdini, Goldstein, & Griskevicius, 2008). Specifically, there are descriptive and injunctive norms.[4][5] Cialdini and colleagues went to great lengths to explain these different types of norms and how they might differentially impact behavior. Descriptive norms consist of what people are perceived to do. For instance, in the context of drinking, one might ask how many drinks the average college student of their sex consumes each night of an average week. The

[4] In addition to descriptive and injunctive norms there is a new kind of norm that has been described. Different research teams have called this norm by names including trending norms and dynamic norms. Both names are appropriate as they are used to describe a type of norm that is changing and (at least in applications so far) represents a minority, or counter-normative, behavior. Counter-normative investigations of this type of norm include water conservation behaviors, donations to conservancy organizations, and reduction of meat consumption (Mortensen et al., 2017; Sparkman & Walton, 2017). In each of these cases, the behaviors chosen did not represent something that the majority of people were doing, thus traditional conceptualizations of descriptive norms may have been counterproductive in attempts to upregulate these behaviors. This type of norm might be particularly useful in the realm of drinking when talking about things like reducing drinking. For instance, it is unlikely that a majority of students are trying to reduce their drinking at a given university, but it is likely that some are. Thus, a descriptive norm for drinking reduction may not be particularly useful as there is not a motivation to conform. Perhaps a trending norm could be used in which participants are informed that the number of students who are trying to reduce their drinking has increased over a specified period (e.g., the past two years). The literature on trending/dynamic norms is still particularly young, though, thus the focus of the present work will remain on the relatively more established descriptive and injunctive norms.

[5] In addition to the different kinds of norms, both perceived and actual norms have been described and studied. In interventions like personalized normative feedback, discrepencies between perceived and actual are highlighted and corrected to alter drinking behavior.

resulting mean of those days represents the descriptive norm for weekly drinking (Borsari & Carey, 2003; Neighbors et al., 2016).

Whereas descriptive norms reflect perceptions of behavior, injunctive norms reflect perceptions of approval (Lac & Donaldson, 2018; Neighbors et al., 2008). For instance, in the context of drinking, one might ask how many drinks the average college student of their sex *approves of* consuming each night of an average week. The resulting mean of those days represents the injunctive norm for weekly drinking (Krieger et al., 2016). Across several domains, people's injunctive and descriptive norms have been shown to uniquely contribute to their own behavior (Etcheverry & Le, 2014; Perkins, Craig, & Perkins, 2011).

Unfortunately, at least until recently, the alcohol literature has not provided consistent evidence that perceptions of what others drink and approve of drinking uniquely impact our own drinking. Instead, when descriptive and injunctive norms have been entered simultaneously as predictors of drinking behavior, positive associations have been observed for descriptive norms, while negative associations have been observed with injunctive norms in several kinds of relationships, though this is more often the case with relatively distal reference groups (Krieger et al., 2016; Lac & Donaldson, 2018). Put another way, the more others approve of drinking, the less individuals drink, controlling for descriptive norms (Larimer, Turner, Mallett, & Geisner, 2004). One explanation for these paradoxical findings is that there has been a rather common deficiency in measurement of injunctive norms that resulted in these associations. Indeed, when Krieger and colleagues (2016) measured injunctive norms with scales analogous to the measurement of descriptive norms and behavior, they found that injunctive norms were positively, uniquely related to drinking behavior, while more traditionally used measures of injunctive norms were not related to

drinking behavior ($rs < .015$). That is to say, both perceiving others to drink more and perceiving others to approve of drinking more, predicted more drinking (Krieger et al., 2016) when using comparable measurement methodology.

The majority of alcohol research on injunctive and descriptive norms has been in college students and, as such, the reference group used for injunctive and descriptive norms has often been other college students (Cooke, Dahdah, Norman, & French, 2014). Theorizing suggests that the more relevant a reference group is perceived to be, the more relevant those norms will be to behavior (Cialdini, 2011; Neighbors et al., 2008). The thinking goes then, that college students' fellow college students (especially same-sex ones) are a particularly relevant reference group since they are the ones with whom most drinking will occur (Lewis et al., 2007).

Some recent work has explored the importance of other relevant reference groups in the context of drinking (e.g., Baker, Krieger, Rodriguez, Derrick, Knee, & Neighbors, in prep). Lac and Donaldson (2018) showed that typical injunctive and descriptive norms from friends, parents, and typical students may each uniquely contribute to drinking attitudes and behavior. Similarly, the approval of friends (i.e., injunctive norms) appears to be a better predictor of drinking for heavy drinkers than approval of parents (Chawla, Neighbors, Logan, Lewis, & Fossos, 2009), although these same associations may operate differently in Asian, as opposed to white, heavy drinkers (Nguyen & Neighbors, 2013).

Baker and colleagues (in prep) examined the independent roles of both individuals in a romantic dyad in predicting drinking behavior based on extensive evidence of the importance of romantic partners in patterns of alcohol abuse (Derrick & Leonard, 2016; Rodriguez & Derrick, 2017). Their work suggested that when norms are measured in line

with the guidelines of Krieger et al. (2016), people's injunctive norms for their romantic partner (i.e., perceptions of how much the partner approves of drinking) are indirectly associated with behavior through attitudes toward drinking. Moreover, people's descriptive norms for their romantic partner (i.e., perceptions of how much the partner drinks) are directly associated with drinking behavior. Interestingly these associations extend beyond people's partner's injunctive and descriptive norms, which are quite highly related to the actor attitudes and behavior.

Interventions to reduce drinking using social norms theory have been among the most effective strategies available when targeting descriptive norms (Riper et al., 2009; Rodriguez et al., 2015). People tend to overestimate the drinking of others (Borsari & Carey, 2003) and correcting these perceptions is a rapid process that appears to reduce drinking months and even years later (Mostardinha & Pereira, 2017; Rooke, Thorsteinsson, Karpin, Copeland, & Allsop, 2010). Interestingly, at least one investigation even found that descriptive norms interventions are particularly effective among heavy drinkers who are less self-determined (Neighbors et al., 2006). Unfortunately, interventions incorporating injunctive norms messages with descriptive norms have not been shown to provide the same benefits in the alcohol literature (Steers et al., 2016). Perhaps this issue of effectiveness is attributable to defensiveness that is experienced when people feel that their autonomy is threatened as it might be when confronted by disparities between their behavior and others' approval. Evidence in line with this supposition was found in a study demonstrating that social norms may be particularly relevant for those exhibiting more controlled, as opposed to more autonomous, regulation for their behavior (Chatzisarantis & Biddle, 1998).

Integrating Self-Determination and Social Norms

There is relatively little research on the integration of self-determination and social norms. The majority of the research that could be located came from the labs of one UK team, predominantly examining these associations in the context of exercise science (Brickell, Chatzisarantis, & Pretty, 2006; Chan & Hagger, 2012; Chatzisarantis & Biddle, 1998; Chatzisarantis, Biddle, & Meek, 1997; Chatzisarantis et al., 2008; Chatzisarantis, Hagger, & Smith, 2007; Chatzisarantis, Hagger, Smith, & Sage, 2006; Chatzisarantis, Hagger, Wang, & Thøgersen-Ntoumani, 2009; Hagger & Chatzisarantis, 2009; Hagger, Chatzisarantis, & Biddle, 2002; Hagger, Rentzelas, & Chatzisarantis, 2014) although we were able to locate two instances of examination of alcohol specifically (Hagger et al., 2012) and health behavior more broadly (Hagger, Hardcastle, et al., 2014). Unfortunately, the majority of these investigations suffer from a unitary perspective on social norms or a collapse of social norms into a single construct (discussed above). Moreover, the majority of these investigations examine elements of self-determination theory as a predictor (as opposed to a moderator) of the social norm-health behavior association.

At least one additional research team has investigated the integration of self-determination and social norms in the context of alcohol consumption (Chawla et al., 2009; Knee & Neighbors, 2002; Neighbors, Larimer, Markman Geisner, & Knee, 2004; Neighbors et al., 2006). Although the literature from this group is considerably more limited, it does have the twin benefits of examining alcohol consumption as an outcome and sometimes examining self-determination as a moderator of social norms.

Self-determination and injunctive norms. Lower levels of person-level self-determination predict greater drinking and alcohol-related problems (Chawla et al., 2009;

Neighbors, Larimer, Markman Geisner, et al., 2004). Less self-determined individuals drink, in part, for social approval (Knee & Neighbors, 2002). Therefore, stronger associations between injunctive norms and problematic drinking are expected among people lower in self-determination.

Self-determination and PNF. Neighbors et al. (2006) employed a descriptive norm PNF intervention and found that less self-determined students reported reductions in alcohol-related problems compared to their more self-determined counterparts. This same pattern of effects did not appear for descriptive norms or drinking. The authors argue that this may be because "consequences are more likely to be experienced following heavy drinking on a given occasion…it is possible that [less self-determined] participants in the intervention condition reduced how much they drank on specific occasions. In future research, more specific assessment…would illuminate this issue." (p. 9). Here the authors raise a call for investigation of the PNF - alcohol association as it is moderated by self-determination at the within-person level.

Within-Person, Drinking-Event Specific Variation.

Self-determination at the level of a particular drinking event should be more closely related to actual drinking and problems at that event than general feelings of self-determination in one's life. The hierarchical model of motivation (Vallerand, 1997, 2000; Vallerand & Ratelle, 2002), suggests that self-determination may be conceptualized from distal dispositional levels (i.e., personality-level; between-persons) through proximal situational levels (e.g., drinking-event-level; within-persons). Similar models have been supported in close relationships (Knee, Lonsbary, Canevello, & Patrick, 2005), sport/physical exercise (Vallerand, 2007), and schooling (Guay, Mageau, & Vallerand, 2003). Thus, it

seems likely to also apply in the context of problematic alcohol consumption. Personality-level self-determination does predict drinking behavior (Chawla et al., 2009; Neighbors, Larimer, Markman Geisner, et al., 2004), but this is likely mediated by drinking-event-level self-determination. Thus, event-level self-determination is a more proximal motivation in shaping drinking behavior. By this logic, similar predictions may be made for personality-level self-determination and drinking-event-level self-determination.

Most of the variance (see Figure 2) in descriptive norms and actual drinking occurs at the drinking-event-level (i.e., within-persons; 66% and 81%, respectively) as opposed to the person-level (i.e., between-persons; 24% and 17% respectively) (Cullum, Armeli, & Tennen, 2010; Lau-Barraco, Braitman, Stamates, & Linden-Carmichael, 2016; O'Grady, Cullum, Tennen, & Armeli, 2011).

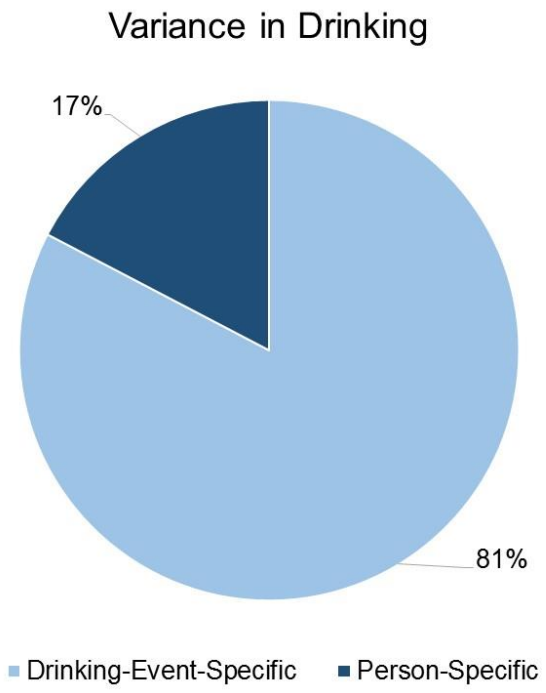

Figure 2. Breakdown of drinking variance between the person-level and the drinking-event-specific level.

Promising results from PNF interventions have targeted drinking behaviors at the person-level (i.e., between people) (Neighbors, Larimer, & Lewis, 2004; Rodriguez et al., 2015) but not in the context of individual drinking events. Similarly, investigation of the roles of self-determination (Chawla et al., 2009; Knee & Neighbors, 2002; Neighbors, Larimer, Markman Geisner, et al., 2004) and injunctive norms (Krieger et al., 2016) in heavy drinking is commonly conducted at the person level. Mohr, Arpin, and McCabe (2015) suggested that, "much of the focus is on individual differences. Yet, within-person variability contributes at least as much to drinking as between-person variability" (p. 586). Some researchers are beginning to investigate interventions to reduce drinking by way of daily processes (e.g., Suffoletto et al., 2012; Witkiewitz et al., 2014), but this is not yet the standard practice, nor have PNF interventions been studied this way. Moreover, I was unable to find investigations of injunctive norms at the within-person level. Thus, the focus of the majority of social norms research has found powerful effects when studying individual differences, but further understanding of day-to-day processes seem to hold a great deal of potential benefit for understanding and improving interventions.

The temporal proximity to events that daily diary methodology allows will help to clarify the independent roles of self-determination, PNF, and injunctive norms as well as their interactions in problematic drinking. In addition to the ability to capture drinking-event-specific variation and processes, a daily diary design can remove many issues associated with recalling one's drinking behavior over weeks or months (Reis, Gable, & Maniaci, 2014; Shiffman, 2009). While not measuring objective drinking behaviors and consequences directly, daily assessment is a step closer to that gold-standard.

Present Study.

I investigated self-determination as a moderator of the effect of a PNF intervention for problematic drinking. I also investigated self-determination as a moderator of the association between injunctive norms and problematic drinking. I hope to reveal the ways in which heavy drinking students' self-determination, descriptive norms, injunctive norms, and problematic drinking change from drinking event to drinking event, within-persons. This analysis facilitated better understanding of current interventions (i.e., through the understanding that self-determination and drinking-event-specific explanations can bring to them) and to modify these interventions for continued to improvements (i.e., by applying this understanding).

Specific Aims and Hypotheses

Aim 1. Evaluate self-determination as a moderator of the association between a descriptive norm PNF intervention and drinking.

Hypothesis 1a. Participants who have received a PNF intervention and who are less self-determined (between-persons) would reduce consumption more than those who are more self-determined and/or have received a control intervention.

Hypothesis 1b. Participants who have received a PNF intervention and who are less self-determined (between-persons) would reduce alcohol-related problems more than those who are more self-determined and/or have received a control intervention.

Hypothesis 2a. When participants who have received a PNF intervention are less self-determined (within-persons), they would reduce consumption more than when they are more self-determined and more than those who received a control intervention.

Hypothesis 2b. When participants who have received a PNF intervention are less self-determined (within-persons), they would reduce alcohol-related problems more than when they are more self-determined and more than those who received a control intervention.

Aim 2. Evaluate self-determination as a moderator of the association between injunctive norms and drinking.

Hypothesis 3a. Participants who perceive more approval for drinking and who are less self-determined (between-persons) would exhibit more consumption than those who are more self-determined and/or perceive less approval for drinking.

Hypothesis 3b. Participants who perceive more approval for drinking and who are less self-determined (between-persons) would exhibit more alcohol-related problems than those who are more self-determined and/or perceive less approval for drinking.

Hypothesis 4a. When participants perceive more approval for drinking and are less self-determined (within-persons), they would exhibit more consumption than when they are more self-determined and and/or perceive less approval for drinking.

Hypothesis 4b. When participants perceive more approval for drinking and are less self-determined (within-persons), they would exhibit more alcohol-related problems than when they are more self-determined and and/or perceive less approval for drinking.

Method

Participants

Of the 3823 college students from the University of Houston (UH) who participated in the screening survey, 579 (15%) were deemed to be heavy drinkers and qualified to participate in the study. Participants were deemed heavy drinkers if they a) had at least 1 heavy-drinking episode in the past 2.5 weeks (i.e., 4+ drinks for women and 5+ drinks for

men on a single occasion) and b) reported drinking at least once per week on average. These criteria are similar to those used in past studies (e.g., Young et al., 2016) to screen for heavy drinkers. Students had to have at least 1 heavy-drinking episode in the past 2.5 weeks and to report drinking at least once per week on average to increase the likelihood that they will encounter both heavy and regular drinking sessions during the diary reporting period. Of those who qualified, 425 (73%) accessed the baseline survey. UH possesses a campus of 36,088 undergraduates with an even spread of male (51%) and female students, but the reported sex was not even with 129 (30.35%) participants reporting that they were male and 294 (68.53) participants reporting that they were female, and 2 participants (.47%) not reporting their sex. A collegiate sample was ideal for the present work in line with NIAAA's CollegeAIM focus. I also elected against an online sample (e.g., MTurk) because of suggestions that remote, online feedback is not an efficacious way to deliver PNF (Rodriguez et al., 2015) and because of UH's remarkably diverse population. Unfortunately, the racial makeup of participants, likewise, did not represent UH's diversity with participants reporting being 56.97% White, 15.60% Asian, 8.51% Black/African American, 7.80% Multi-Racial, 7.80% Other 2.60% Native American/American Indian, and .71% Native Hawaiian/Pacific Islander. Average age was 23.44 (*SD* = 4.69) years and 33.49% of participants reported being Hispanic/Latino. Still, it should be noted that these figures may reflect more diversity than is observed at first glance because many Hispanic/latino participants likely endorsed being "white" in the question about race.

Of those who accessed the baseline survey, 156 (36.71%) attended the intervention/orientation session and completed at least one daily survey while 136 (32.00%) participated in the follow-up survey. The study was discontinued due to time constraints and

thus the final sample was considerably smaller than the originally proposed 300 participants who completed baseline, intervention, 13/17 daily surveys, and follow-up. This was despite having run the study for four months longer than was originally proposed and significantly increasing compensation opportunities (see below).

Measures

Screening measures.

Demographic exclusion variables. Age (in years), status as a student at the University of Houston, and gender were assessed to determine whether potential participants met study criteria.

Standard drink conversion chart. This chart presented standard drink conversions and examples to standardize the number of drinks participants indicated they consumed (e.g., "5oz wine, 12 oz beer).

Greatest number of drinks consumed in a single occasion in the last 17 days. This question allowed us to establish whether or not participants meet the 4+/5+ drinks in a single occasion problematic drinker criterion for females/males.

Days consumed over the last month. This question allowed us to screen drinkers for having consumed alcohol, on average, once per week.

Filler media use. Questions about the number of hours spent texting, using social media, and playing video games were used to make study hypotheses less clear and to increase logical coherence in case participants were assigned to the social media control condition.

Baseline/follow-up measures.[6]

Demographics. Demographics included age, biological sex, gender identity, height, weight, student status, class standing, current GPA, sexual orientation, racial background, ethnicity, religious affiliation, number of hours worked as an employee, whether or not someone is currently in a committed romantic relationship, relationship status, relationship start date, exclusivity of the relationship, number of previous romantic partners, relational involvement, and sexual activity.

Index of autonomous functioning. This 15-item Likert scale (1 "Not at all true" to 5 "Completely true") assessed personality-level autonomy as a unitary construct but also may be investigated using its individual subscales: susceptibility to control (e.g., "I believe certain things so that other will like me."), authorship/self-congruence (e.g., "My decisions represent my most important values and feelings."), and interest-taking (e.g., "I am interested in understanding the reasons for my actions") (Weinstein, Przybylski, & Ryan, 2012) $\boldsymbol{\alpha} = .\mathbf{72}$.

Injunctive norms. After being presented with the standard drink conversion chart, participants were asked to estimate what drinking the typical [gender piped] UH student would consider acceptable versus unacceptable. Items included approval of a number of drinks on each day of the week (adapted from the DDQ), number of days consuming alcohol per week, drinks on a given occasion, and traditional injunctive norms items assessing a number of behaviors from 1 (unacceptable) to 7 (acceptable) (Krieger et al., 2016) $\boldsymbol{\alpha} = .\mathbf{85}$.

[6] While only measures germane to the present hypotheses are presented here, the reader may consult the supplemental materials for a full list of measures included in the study.

Daily drinking questionnaire (DDQ). After being presented with the standard drink conversion chart, participants were asked to estimate their own drinking. Questions included number of drinks on each day of a typical week in the last 2.5 weeks, over how many hours those drinks were consumed on each day, how often alcohol was consumed during the last 2.5 weeks, and how many drinks were consumed on an average occasion during the last 2.5 weeks (Collins, Parks, & Marlatt, 1985).

Quantity/Frequency-Peak Alcohol Use Index (QFP). After being presented with the standard drink conversion chart, participants were asked to estimate their own drinking. Questions include how many drinks were consumed on the occasion they drank the most in the past 2.5 weeks, how many hours were spent drinking on that occasion, how many drinks were consumed on a typical weekend evening in the past 2.5 weeks, how many hours were spent drinking those drinks, and how many days of the week alcohol was consumed in the last 2.5 weeks (Baer, 1993; Marlatt, Baer, & Larimer, 1995).

Alcohol Consumption Index (ACI). After being presented with the standard drink conversion chart, participants were asked to estimate their own drinking. Participants were asked how many times during the last 2.5 weeks they had 5+ drinks in one sitting, how many times per week they have 5+ drinks in one sitting, how many times per month they have 5+ drinks in one sitting, during the last 2.5 weeks how many drinks they consumed, how many drinks per week they consume, how many drinks they consume on weekends (Friday-Sunday), how many drinks they consume during the week (Monday-Thursday). Two questions also assessed how much participants perceive themselves to drink compared to their friends and other college students from 1 (much less) to 5 (much more) (Knee & Neighbors, 2002) $\boldsymbol{\alpha = .91}$.

Young adult alcohol consequences questionnaire (YAACQ). Participants selected from a 24-item list, consequences that may have happened to them during the past 2.5 weeks including, "While drinking, I have said or done embarrassing things." and "I have felt sick to my stomach or thrown up after drinking." (Read, Kahler, Strong, & Colder, 2006; Read, Merrill, Kahler, & Strong, 2007).

Rutgers alcohol problem index (RAPI). Participants indicated on a scale of 0=none, 1=1-2 times, 3=3-5 times, 3=5+ times how many times each of 24 problems happened to them while they were drinking during the last 2.5 weeks (e.g., "Not able to do homework or study for a test" and "Had a bad time") (White & Labouvie, 1989).

Electronic usage. Electronic usage was assessed so that it could be used if participants were randomized to the control condition. Participants were asked to provide both their own and their perceptions of other college students use of several technologies. For both self and average [gender-piped] college students, participants rated the number of hours spent "surfing the internet," "in social media sites (snapchat, facebook, instagram, etc)," "emailing," "text messaging/IM/chat," "downloading music," and playing video games."

Daily measures. Participants were first asked whether they drank the day before (Y [34.57%] /N [65.43%]) and whether other people they were with drank yesterday (Y [31.36%] / N [68.64%).

Alcohol-related problems/consequences. These items included those from the brief version of the YAACQ and the RAPI with checklist responses. Items were deleted if they had redundant content or did not seem likely to vary at the day level. Thirty-eight items were retained in the final scale used and participants were asked to select them if they experienced the consequence "yesterday while drinking alcohol or as a result of drinking alcohol."

Non-alcohol-related problems/consequences. If participants selected that they did not drink the day before, they saw a similar list that asked them to "select any of the following that you experienced yesterday." Whenever possible, identical items were presented with the context of drinking removed (e.g., the alcohol problem of "I became very rude, obnoxious or insulting after drinking" became "I became very rude, obnoxious or insulting" in the non-drinking context). There were 29 items. Items were deleted if removing the context of alcohol rendered the item meaningless (e.g., "I drank when I had not planned to drink").

Alcohol consumption. After being presented with the standard drink conversion chart, participants were asked to indicate the number of drinks they consumed yesterday.

Injunctive norms. After being presented with the standard drink conversion chart, if participants indicated that others they were with drank yesterday, they then reported how many drinks they believe others they were with approved of consuming yesterday. If participants reported that others they were with were not drinking yesterday, the were asked to report their perception of how many drinks the average [gender piped] UH student approved of drinking yesterday.

Self-determination. Participants answered 11 questions assessing the reasons why they consumed alcohol the previous day. This measure was adapted from the Self-Regulation Questionnaire (SRQ) (Weinstein, Hodgins, & Ryan, 2010) and the SRQ-E (Nurmi et al., 2016). It included 5 items assessing the internal end of the continuum and 6 items to assess the external end of the continuum. The external items were subtracted from the internal items in line with recent recommendations (Sheldon et al., 2017). Items were rated by participants from 1 "Not at all true" to 7 "Very true" ($\boldsymbol{\alpha_{WI} = .65}$; $\boldsymbol{\alpha_{BN} = .70}$).

Procedure

Recruitment. All students from the University of Houston Registrar's list were emailed to invite them to take part in a screening questionnaire to see if they qualify for a study to earn them $20. We also retrieved lists of the classes at the University of Houston to reach out to the professors of those classes to request the opportunity to conduct in-class recruitment. Specifically, spreadsheets were requested from the College of Liberal Arts and Social Sciences, CT Bauer College of Business, College of Natural Science and Math, College of Social Work, and College of Technology because of their uniquely large enrollments. While this is a non-ideal sampling method because it is biased compared to a sample from the wider university, it was intended to serve for more expedient recruitment.

On 1/22/2019, we also increased our incentive for participants based upon informal feedback such that participants would receive $20 for participation as well as entry into a lottery to win one of four $500 gift cards. All participants who had already participated at the time of this change were also contacted, informed of this change, and entered into the raffle. Throughout the study, we also contacted participants who qualified but did not complete the baseline, participants who completed the baseline but did not attend the

orientation/intervention, and participants who missed a daily survey to remind them to participate and attempt to schedule as-yet uncompleted surveys/sessions.

Screening. Participants answered the items from the screening questionnaire. At the end of this questionnaire, if they did not meet minimum criteria they saw the message: "Thank you for your response. Unfortunately, you are not eligible for our study. We thank you for your time. Research would not be possible without participants like you." If they did meet minimum criteria, they received the message: "Thank you for your response. You are eligible for our study. We thank you for your time. Research would not be possible without participants like you. So that we may provide you with additional study information, which will allow you to earn the $20 gift card for participating, please provide your email address and telephone number:" followed by three questions asking whether we may email, text, and call participants. If they were deemed eligible and provided their email address, they were then automatically emailed a link to the baseline survey.

Baseline. After clicking the link to the baseline survey, participants answered the questions in the baseline survey. The relevant data from their baseline survey (i.e., electronic use and alcohol consumption) was then saved in a Qualtrics contact sheet so that it could be referenced later for their personalized normative feedback in lab. Finally, participants were given a study-specific link to the program Calendly, through which they were able to sign up for an in-lab session. Items within measures and measures within surveys had their orders randomized.

In-lab orientation and personalized normative feedback. Upon entering the laboratory, participants were escorted to an individual desk where they put on headphones and received an orientation for the study explaining how payment works, how they would receive and complete daily reports over the next 17 days, and how they would receive the follow-up survey. Participants were then given the opportunity to ask any questions in case there were any procedures they did not understand.

After completing the orientation, participants clicked a link on the home screen of the computer they were sitting at (as directed by the end of the orientation video), which opened a Qualtrics survey that was designed to provide personalized normative feedback or control feedback. This link randomly assigned participants to the alcohol-based feedback (53.75%) or the control, media-based feedback (46.25%). In the alcohol-based feedback condition, participants viewed graphs comparing their own, their perception of other [gender-piped] UH student, and actual [gender-piped] UH student days drinking per week, drinks per occasion, and drinks per week. Those in the control condition received analogous feedback on the number of hours texting, on social media sites, and playing video games each week. Each piece of feedback (e.g., days drinking per week) was followed by a question to ensure participant attention. Participants were notified whether they got each attention question correct before moving to the next page of feedback. After receiving the feedback, participant information was piped into a new sheet to be read by Qualtrics. Participants were then directed to speak to the research assistant in the room with them. This research assistant then asked for their email, which linked to the feedback the participant just received so that it could be printed, reviewed, and taken home by the participant.

Daily surveys. Daily surveys were sent out every morning for 17 days starting the first Friday following in-lab orientation and feedback. These surveys began on Fridays because each survey is a report on the previous day and this allows for the capture of 3 sets of weekends during the diary period (i.e., Thursday, Friday, and Saturday). Given that these are the days on which drinking occurs the most (Neal & Fromme, 2007), we hoped this would allow for maximal capture of meaningful drinking variation. There were 2149 daily surveys accessed by participants, resulting in a mean of 13.78 surveys per participant.

Follow-up survey. The final survey was the follow-up survey, which directly paralleled the baseline survey for all measures pertinent to the present work. For measures that differ between the baseline and follow-up surveys, please view the full list of measures presented in the appendix. Following completion of this survey, participants were compensated with a $20 Amazon gift card code emailed to them.

Results

Analysis Plan.

Between-person hypotheses. Hypotheses 1a, 1b, 3a, and 3b were between-person hypotheses that concerned baseline and follow-up variables, but no daily variables. Because these data have only 2 time points but multiple indicators for each outcome of interest, they were analyzed using structural equation modeling software (i.e., Mplus). The non-normal indicators of the outcomes of interest were indicators of latent variables and thus were specified as non-normal. It is still possible, though, that this coule be a misspecification and that the residuals of those indicators remained non-normally distributed, though that is not necessarily the case, nor is it necessarily likely that the latent variable was nonnormally distributed (see “Mplus Discussion >> Non-normal distribution,” n.d. for a discussion).

Predictors were grand-mean centered with the exception of the intervention condition variable. For all analyses, intervention condition was dummy coded such that 1 = descriptive norm alcohol PNF and 0 = control social media PNF.

Within-person hypotheses. Hypotheses 2a, 2b, 4a, and 4b were within-person hypotheses that concerned several daily variables as well as baseline by daily interactions, therefore they were analyzed using multilevel modeling software (i.e., SAS Proc Mixed).[7] Time was modeled as both a fixed and random effect, given experience that this model tends to have a superior fit to more traditional diary estimation methods (e.g., autoregressive covariance structures) whenever possible (i.e., when such a complex model successfully converged). All daily predictors were person-mean centered, while all between-person predictors were grand-mean centered, with the exception of the intervention condition variable. For all analyses, intervention condition was dummy coded such that 1 = descriptive norm alcohol PNF and 0 = control social media PNF.

Aim 1. Evaluate self-determination as a moderator of the association between a descriptive norm PNF intervention and drinking.

Hypothesis 1a. Participants who have received a PNF intervention and who are less self-determined (between-persons) would reduce consumption more than those who are more self-determined and/or have received a control intervention.

Measurement model.

[7] The original plan for these analyses was to run all models with a negative binomial specification. However, it was not possible to get any of the models to converge while using a random estimate of day. Moreover, even the simplest model using exclusively fixed slopes would not converge for H4a when specifying a negative binomial distribution. When residuals were examined, they appeared normal, suggesting that negative binomial specifications may have been unnecessary for these models. Additionally, the more complex models did converge when assuming normality of residuals. Finally, the normal estimation offers the benefit of allowing fixed estimates to be in a meaningful metric. Therefore, the present results reflect the normality of residuals assumption, but estimates for these models specifying a negative binomial distribution are presented in the supplement. The results were largely similar regardless of analysis method.

Consum by DDQ@1 (lamb41);
Consum by QFP (lamb51);
Consum by ACI (lamb61);

Structural model.

Consum on SelfD (beta11);
Consum on Int (beta12);
Consum on SelfDInt (beta13);

Latent variable residual variances.

Consum;

Observed variable variances.

SelfD (thet11);
Int (thet22);
SelfDInt (thet33);

Observed variable covariances.

SelfD with Int (thet12);
SelfD with SelfDInt (thet13);
Int with SelfDInt (thet23);

Observed variable residual variances.

DDQ (thet44);
QFP (thet55);
ACI (thet66);

Figure 3. Hypothesis 1a: Standardized Estimates for the Interaction Between PNF and Person-Level Self-Determination Predicting Alcohol Consumption

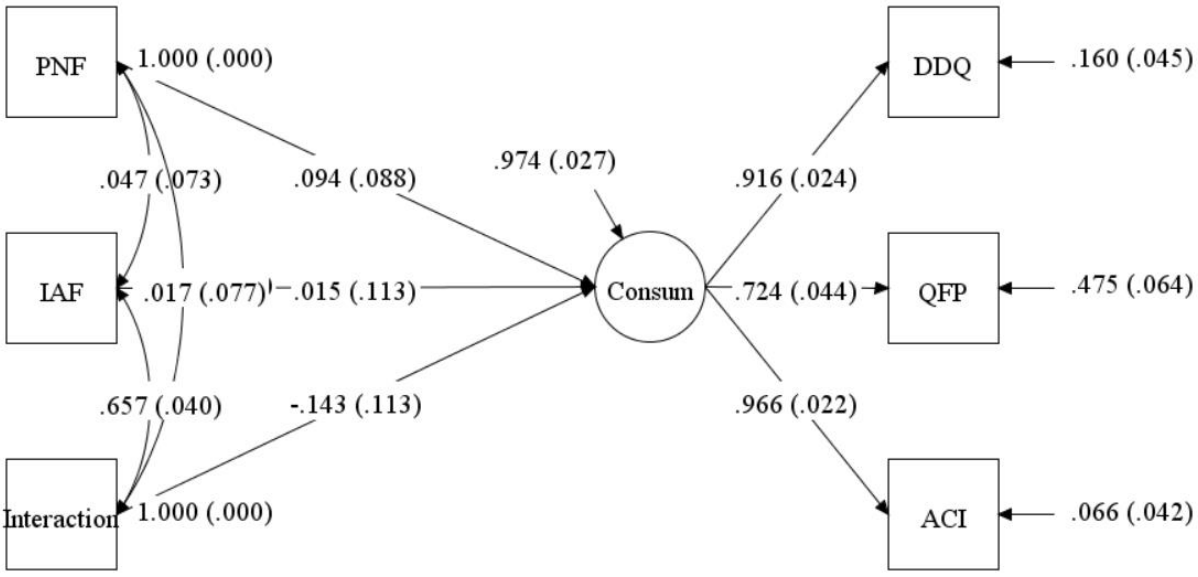

Table 1. Hypothesis 1a: Interaction Between PNF and Person-Level Self-Determination Predicting Alcohol Consumption

Effect	Estimate	Standard Error	*t*-value	*p*-value	95% CI		Standardized Estimate
					Lower	Upper	
IAF	.26	1.90	.13	.893	-3.46	3.97	.02
PNF	1.55	1.45	1.07	.286	-1.30	4.39	.09
IAF X PNF	-3.37	2.68	-1.26	.209	-8.63	1.89	-.14

Note. This model was estimated using Mplus version 8.3. IAF = Index of Autonomous Functioning; PNF = Personalized Normative Feedback

The fit of this model was good ($RMSEA < .001; CFI = 1.00; SRMR = .01$). Regressing the alcohol consumption latent variable (see Figure 3 and Table 1) onto self-determination ($\beta = .02, p = .893$), PNF ($\beta = .09, p = .285$), and the PNF by self-determination interaction ($\beta = -.14, p = .207$) revealed no significant associations. This finding did not support hypothesis 1a.

Hypothesis 1b. Participants who have received a PNF intervention and who are less self-determined (between-persons) will reduce alcohol-related problems more than those who are more self-determined and/or have received a control intervention.

Measurement model.
Probs by YAACQ1* (lamb41);
Probs by YAACQ2 (lamb51);
Probs by RAPI1 (lamb61);
Probs by RAPI2 (lamb71);
Structural model.
Probs on SelfD (beta11);
Probs on Int (beta12);
Probs on SelfDInt (beta13);
Latent variable residual variances.
Probs@1;
Observed variable variances.
SelfD (thet11);
Int (thet22);
SelfDInt (thet33);

Observed variable covariances.
SelfD with Int (thet12);
SelfD with SelfDInt (thet13);
Int with SelfDInt (thet23);
Observed variable residual variances.
YAACQ1 (thet44);
YAACQ2 (thet55);
RAPI1 (thet66);
RAPI2 (thet77);

Figure 4. Hypothesis 1b: Standardized Estimates for the Interaction Between PNF and Person-Level Self-Determination Predicting Alcohol-Related Problems

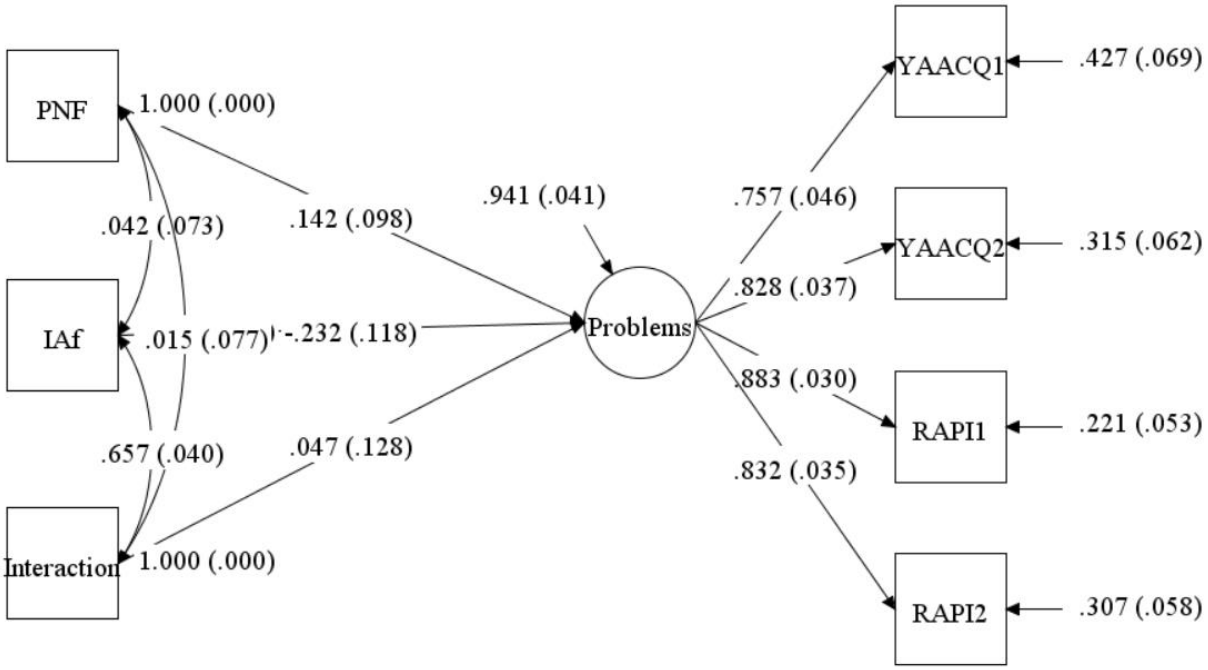

Table 2. Hypothesis 1b: Interaction Between PNF and Person-Level Self-Determination Predicting Alcohol-Related Problems

Effect	Estimate	Standard Error	*t*-value	*p*-value	95% CI Lower	95% CI Upper	Standardized Estimate
IAF	-.90	.47	-1.93	.054	-1.81	.02	-.23
PNF	.54	.38	1.42	.154	-.20	1.27	.14
IAF X PNF	.25	.69	.37	.715	-1.10	1.61	.05

Note. This model was estimated using Mplus version 8.3. IAF = Index of Autonomous Functioning; PNF = Personalized Normative Feedback

The fit of this model was also good ($RMSEA = .065; CFI = .948; SRMR = .03$). Regressing the alcohol-related problems latent variable (see Figure 4 and Table 2) onto self-determination ($\beta = -.23, p = .049$), PNF ($\beta = .14, p = .149$), and the PNF by self-determination interaction ($\beta = .05, p = .715$) only revealed a significant association for the self-determination main effect such that being more self-determined was associated with fewer alcohol-related problems. This did not support hypothesis 1b.

Hypothesis 2a. When participants who have received a PNF intervention are less self-determined (within-persons), they would reduce consumption more than when they are more self-determined and more than those who received a control intervention.

Level 1.

$$Drinks_{ij} = b_{0j} + b_{1j} * selfdetermination_{ij} + b_{2j} * jdate_{ij} + e_{ij}$$

Level 2.

$$b_{0j} = \gamma_{00} + \gamma_{01} * intervention_j + \gamma_{02} * \overline{selfdetermination_{.j}} + u_{0j}$$
$$b_{1j} = \gamma_{10} + \gamma_{11} * intervention_j$$
$$b_{2j} = \gamma_{20} + u_{2j}$$

This model (see Table 3) revealed that PNF ($\beta = .05, p = .694$) and self-determined motivation for drinking at the person level ($\beta = .01, p = .435$) were not statistically significant predictors of alcohol consumption. Likewise, self-determined motivation for drinking at the day level ($\beta = .09, p = .065$) and the interaction between PNF and self-determined motivation at the day level ($\beta = -.09, p = .069$) were not statistically significant predictors of alcohol-related problems. This did not support hypothesis 2a.

Table 3. Hypothesis 2a: Interaction Between PNF and Daily Motivation for Alcohol Consumption Predicting Alcohol Consumption

Effect	Estimate	Standard Error	*t*-value	*p*-value	95% CI Lower	95% CI Upper	Standardized Estimate
Intercept	3.23	.31	10.32	<.001	2.61	3.85	-.14
Daily Motivation	.44	.24	1.85	.065	-.03	.90	.09
PNF	.16	.40	.39	.694	-.62	.93	.05
Person Motivation	.17	.22	.78	.435	-.26	.60	.01
PNF by Daily Motivation Interaction	-.56	.31	-1.82	.069	-1.16	.04	-.09

Note. This model was estimated using SAS Proc Mixed with fixed and random effects of daily reports included in the model. Standardized estimates include standardized predictors and outcomes for all non-categorical measures.

Hypothesis 2b. When participants who have receive a PNF intervention are less self-determined (within-persons), they will reduce alcohol-related problems more than when they are more self-determined and more than those who received a control intervention.

Level 1.

$$Problems_{ij} = b_{0j} + b_{1j} * selfdetermination_{ij} + b_{2j} * jdate_{ij} + e_{ij}$$

Level 2.

$$b_{0j} = \gamma_{00} + \gamma_{01} * intervention_j + \gamma_{02} * \overline{selfdetermination_{.j}} + u_{0j}$$
$$b_{1j} = \gamma_{10} + \gamma_{11} * intervention_j$$
$$b_{2j} = \gamma_{20} + u_{2j}$$

This model (see Table 4) revealed no statistically significant associations between any variables. Person level PNF ($\beta = -.03, p = .871$) and motivation ($\beta = -.06, p = .420$) as well as day level motivation ($b = -.14, p = .328$) and the interaction between day level motivation and PNF ($b = -.08, p = .381$) did not significantly predict alcohol-related problems. This did not support hypothesis 2b.

Table 4. Hypothesis 2b: Interaction Between PNF and Daily Motivation for Alcohol Consumption Predicting Alcohol-Related Problems

Effect	Estimate	Standard Error	*t*-value	*p*-value	95% CI Lower	95% CI Upper	Standardized Estimate
Intercept	1.56	.27	5.76	<.001	1.03	2.10	.63
Daily Motivation	-.16	.17	-.98	.328	-.50	.17	-.14
PNF	-.05	.34	-.16	.871	-.71	.61	-.03
Person Motivation	-.15	.19	-.81	.420	-.52	.22	.06
PNF by Daily Motivation Interaction	-.19	.22	-.88	.381	-.62	.24	-.08

Note. This model was estimated using SAS Proc Mixed with fixed and random effects of daily reports included in the model. Standardized estimates include standardized predictors and outcomes for all non-categorical measures.

Aim 2. Evaluate self-determination as a moderator of the association between injunctive norms and drinking.

Hypothesis 3a. Participants who perceive more approval for drinking and who are less self-determined (between-persons) would exhibit more consumption than those who are more self-determined and/or perceive less approval for drinking.

Measurement model.
Consum by DDQ@1 (lamb41);
Consum by QFP (lamb51);
Consum by ACI (lamb61);

Structural model.
Consum on SelfD (beta11);
Consum on Int (beta12);
Consum on SelfDInt (beta13);
Latent variable residual variances.
Consum;
Observed variable variances.

SelfD (thet11);
Inorms (thet22);
SelfDIno (thet33);

Observed variable covariances.

SelfD with Inorms (thet12);
SelfD with SelfDIno (thet13);
Inorms with SelfDIno (thet23);

Observed variable residual variances.

DDQ (thet44);
QFP (thet55);
ACI (thet66);

Figure 5. Standardized Estimates for the Interaction Between Injunctive Norms and Person-Level Self-Determination Predicting Alcohol Consumption

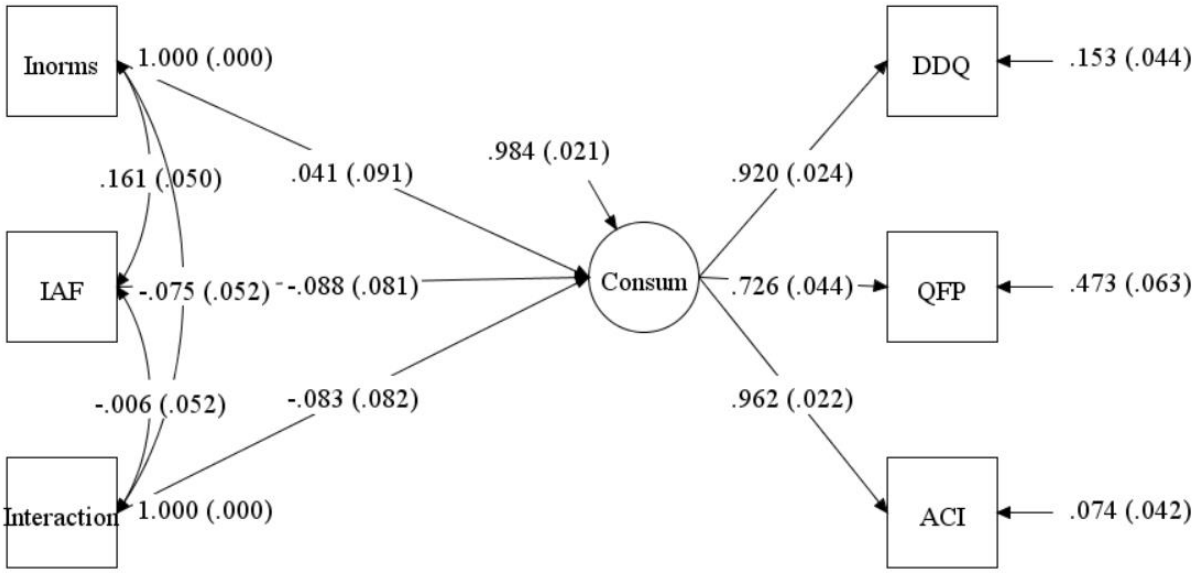

Table 5. Hypothesis 3a: Interaction Between Injunctive Norms and Person-Level Self-Determination Predicting Alcohol Consumption

Effect	Estimate	Standard Error	*t*-value	*p*-value	95% CI Lower	95% CI Upper	Standardized Estimate
IAF	-1.48	1.38	-1.08	.282	-4.19	1.22	-.09
Inorms	.43	.96	.45	.654	-1.46	2.32	.04
Inorms X IAF	-1.70	1.69	-1.01	.313	-5.01	1.61	-.08

Note. This model was estimated using Mplus version 8.3. IAF = Index of Autonomous Functioning; Inorms = Injunctive Norms

The fit of this model was good ($RMSEA < .01; CFI = 1.00; SRMR = .02$). Regressing the alcohol consumption latent variable (see Figure 5 and Table 5) onto self-determination ($\beta = -.09, p = .279$), injunctive norms ($\beta = .04, p = .654$), and the injunctive norms by self-determination interaction ($\beta = -.08, p = .311$) none of these predictors were statistically significantly associated with alcohol consumption. This did not support hypothesis 3a.

Hypothesis 3b. Participants who perceive more approval for drinking and who are less self-determined (between-persons) would exhibit more alcohol-related problems than those who are more self-determined and/or perceive less approval for drinking.

Measurement model.
Probs by YAACQ1* (lamb41);
Probs by YAACQ2 (lamb51);
Probs by RAPI1 (lamb61);
Probs by RAPI2 (lamb71);
Structural model.
Probs on SelfD (beta11);
Probs on Inorms (beta12);
Probs on SelfDIno (beta13);
Latent variable residual variances.
Probs@1;
Observed variable variances.
SelfD (thet11);
Inorms (thet22);
SelfDIno (thet33);
Observed variable covariances.
SelfD with Ino (thet12);
SelfD with SelfDIno (thet13);
Inorms with SelfDIno (thet23);
Observed variable residual variances.
YAACQ1 (thet44);
YAACQ2 (thet55);
RAPI1 (thet66);
RAPI2 (thet77);

Figure 6. Standardized Estimates for the Interaction Between Injunctive Norms and Person-Level Self-Determination Predicting Alcohol-Related Problems

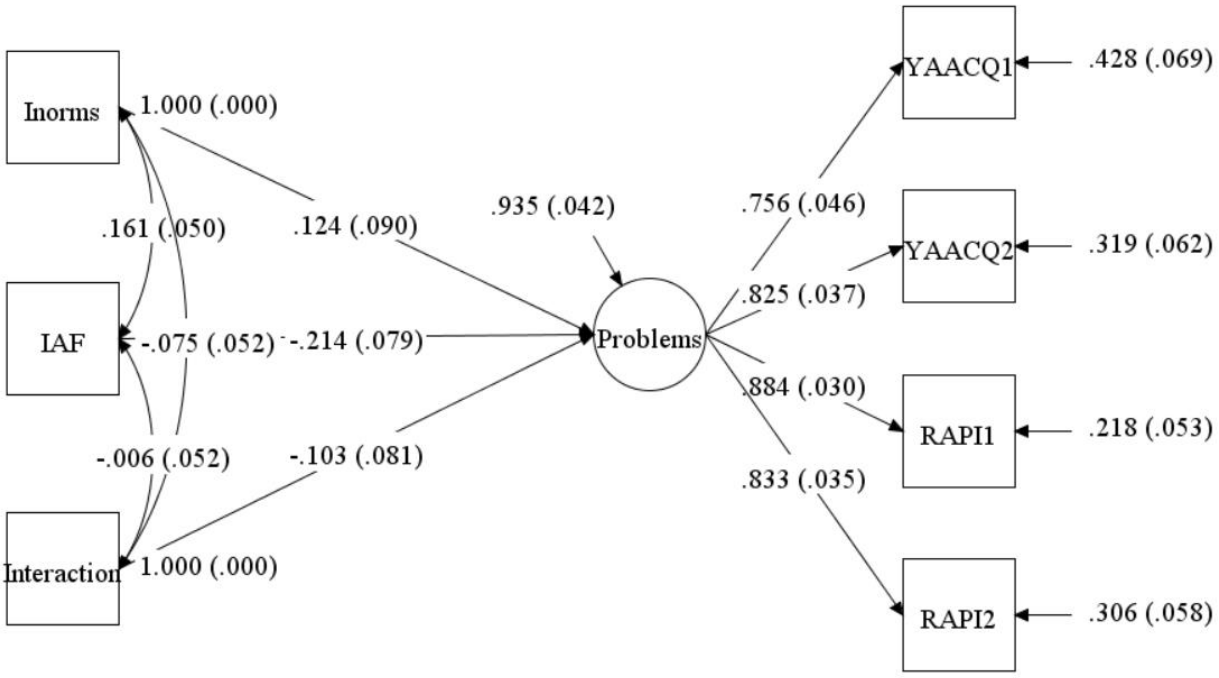

Table 6. Hypothesis 3b: Interaction Between Injunctive Norms and Person-Level Self-Determination Predicting Alcohol-Related Problems

Effect	Estimate	Standard Error	*t*-value	*p*-value	95% CI Lower	95% CI Upper	Standardized Estimate
IAF	-.83	.32	-2.57	.010	-1.46	-.20	-.21
Inorms	.30	.22	1.36	.175	-.13	.73	.12
Inorms X IAF	-.48	.39	-1.25	.213	-1.24	.28	-.10

Note. This model was estimated using Mplus version 8.3. IAF = Index of Autonomous Functioning; Inorms = Injunctive Norms

The fit of this model was also good ($RMSEA = .06; CFI = .95; SRMR = .03$). Regressing the alcohol-related problems latent variable (see Figure 6 and Table 6) onto self-determination ($\beta = -.21, p = .010$), injunctive norms ($\beta = .12, p = .168$), and the injunctive norms by self-determination interaction ($\beta = -.10, p = .207$) revealed that greater self-determination was a negative predictor of alcohol-related problems. This did not support hypothesis 3b.

Hypothesis 4a. When participants perceive more approval for drinking and are less self-determined (within-persons), they would exhibit more consumption than when they are more self-determined and and/or perceive less approval for drinking.

Level 1.

$$Drinks_{ij} = b_{0j} + b_{1j} * selfdetermination_{ij} + b_{2j} * inorms_{ij} + b_{3j} * selfdetermination_{ij} * inorms_{ij} + b_{4j} * jdate_{ij} + e_{ij}$$

Level 2.

$$b_{0j} = \gamma_{00} + \gamma_{01} * \overline{selfdetermination_{.j}} + \gamma_{02} * \overline{inorms_{.j}} + u_{0j}$$
$$b_{1j} = \gamma_{10}$$
$$b_{2j} = \gamma_{20}$$
$$b_{3j} = \gamma_{30}$$
$$b_{4j} = \gamma_{40} + u_{4j}$$

This model (see Table 7) revealed that person level injunctive norms were a significant positive predictor of more drinks consumed ($\beta = -.08, p < .001$) but motivation was not ($\beta = .03, p = .294$). Day level motivation ($\beta = .11, p = .010$) and day level injunctive norms were both positively predictive of more drinks consumed ($\beta = .52, p < .001$) while the interaction between day level motivation and injunctive norms ($\beta = -.13, p < .001$) suggesting that the positive association between injunctive norms and alcohol consumption became weaker when people were higher in self-determined motivation for drinking. This did support hypothesis 4a.

Table 7. Hypothesis 4a: Interaction Between Daily Injunctive Norms and Daily Motivation for Alcohol Consumption Predicting Alcohol Consumption

Effect	Estimate	Standard Error	*t*-value	*p*-value	95% CI Lower	95% CI Upper	Standardized Estimate
Intercept	2.87	.20	14.58	<.001	2.48	3.26	-.27
Daily Motivation	.34	.13	2.59	.010	.08	.60	.11
Daily Injunctive Norms	.49	.03	19.04	<.001	.44	.55	.52
Person Motivation	.18	.17	1.05	.294	-.16	.53	.03
Person Injunctive Norms	.38	.10	3.69	<.001	.18	.59	-.08
Daily Injunctive Norms by Daily Motivation Interaction	-.16	.03	-4.75	<.001	-.23	-.10	-.13

Note. This model was estimated using SAS Proc Mixed with fixed and random effects of daily reports included in the model. Standardized estimates include standardized predictors and outcomes for all non-categorical measures.

Hypothesis 4b. When participants perceive more approval for drinking and are less self-determined (within-persons), they will exhibit more alcohol-related problems than when they are more self-determined and and/or perceive less approval for drinking.

Level 1.

$$Problems_{ij} = b_{0j} + b_{1j} * selfdetermination_{ij} + b_{2j} * inorms_{ij} + b_{3j} * selfdetermination_{ij} * inorms_{ij} + b_{4j} * jdate_{ij} + e_{ij}$$

Level 2.

$$b_{0j} = \gamma_{00} + \gamma_{01} * \overline{selfdetermination_{.j}} + \gamma_{02} * \overline{inorms_{.j}} + u_{0j}$$
$$b_{1j} = \gamma_{10}$$
$$b_{2j} = \gamma_{20}$$
$$b_{3j} = \gamma_{30}$$

$$b_{4j} = \gamma_{40} + u_{4j}$$

This model (see Table 8) revealed that person level injunctive norms ($\beta = .04, p = .108$) and motivation were not ($\beta = .06, p = .269$) significant predictors of alcohol-related problems. Day level motivation ($\beta = -.14, p = .072$) was also not a significant predictor but day level injunctive norms ($\beta = .25, p < .001$) was a positive predictor of more alcohol-related problems. Finally, the interaction between self-determined motivation and injunctive norms predicting alcohol-related problems was not statistically significant ($\beta = -.10, p = .085$). This did not support hypothesis 4b.

Table 8. Hypothesis 4b: Interaction Between Daily Injunctive Norms and Daily Motivation for Alcohol Consumption Predicting Alcohol-Related Problems

Effect	Estimate	Standard Error	*t*-value	*p*-value	95% CI Lower	95% CI Upper	Standardized Estimate
Intercept	1.44	.20	7.07	<.001	1.04	1.84	.54
Daily Motivation	-.21	.12	-1.81	.072	-.43	.02	-.14
Daily Injunctive Norms	.12	.02	5.20	<.001	.07	.16	.25
Person Motivation	-.20	.18	-1.11	.269	-.54	.15	.06
Person Injunctive Norms	.17	.10	1.61	.108	-.04	.37	.04
Daily Injunctive Norms by Daily Motivation Interaction	-.05	.03	-1.73	.085	-.11	.01	-.10

Note. This model was estimated using SAS Proc Mixed with fixed and random effects of daily reports included in the model. Standardized estimates include standardized predictors and outcomes for all non-categorical measures.

Discussion

What We Found – A Strict Interpretation

The present research set out with a primary focus to examine the moderating effects of self-determination on a personalized normative feedback intervention and naturally occurring injunctive norms. Four attempts were made to measure each of these interactions for a total of eight tests of primary interest. If one were to make decisions purely on the basis of statistical significance, they would find that in 0/4 tests, the PNF by self-determination interaction was significant and in 1/4 tests, the injunctive norms by self-determination

interaction was significant. This seems to provide little evidence that self-determination moderates either the effects of PNF or injunctive norms in the context of problematic alcohol consumption. While many recent arguments suggest that we should look beyond mere "$p <$ .05" thresholds (e.g., Benjamin et al., 2017; Daniel Lakens, 2019; Daniël Lakens et al., 2017; McShane, Gal, Gelman, Robert, & Tackett, 2017; Quatto, Ripamonti, & Marasini, 2019), the original intent of this dissertation and the power analysis for the grant that supported this research were conducted with that threshold in mind.

What We Found – A Nuanced Interpretation

Of course, alternative statistical practices present a number of other ways to examine our results. For instance, some might also be inclined to examine "marginal" and "trending" findings (often referred to as those that have *p*-values between .05-.10 and .10-.15, respectively). By this standard, we might conclude that 2/4 injunctive norms by self-determination interactions were evidenced by the data. Likewise, 1/4 PNF by self-determination interactions were evidenced by the data. Notably, each of these three interactions of interest were within-person assessments. One good reason to examine the data this way is that data collection was terminated well in advance of the final intended sample. Although the sample size was not particularly small for the within-person findings, it was still approximately half the size of what the originally proposed sample would be, and this may be especially relevant for the between-person findings given their lower power in the best of circumstances. Still, the findings do not seem to change drastically when using this interpretation strategy. A similar conclusion is likely to be drawn if one focuses on the effect sizes observed in the present work. It is still worth cautioning that these effect sizes may be

somewhat unstable given the sample size, but they may be particularly useful as a pilot for future work.

Perhaps a more data-driven approach would be to estimate what would have been found had the full 300 participant sample been collected. Power analyses were thus conducted using the observed effect sizes of the between-person analyses. These power analyses suggest that H1a would have approximately .678 power, H1b would have approximately .152 power, H3a would have approximately .286 power, and H3b would have approximately .417 power. This does not seem to provide good evidence that examining these effects at the between person level will be a particularly good use of resources (i.e., if our estimates are accurate, even 300 participants would not provide .8 power to test any of the interactions of interest). Notably, this is the third strategy for interpretation that comes to, more-or-less, the same conclusion about the findings. Perhaps the effects are there, but they are rather small and therefore may have minor practical utility.

Examining within-person effects may offer a more efficient maximization of resources. Indeed, with the possible exception of H2b, all of the moderation effects would have been statistically significant given the observed effect sizes in a sample of 300 participants with a similar number of entries per participant (indeed, these estimates would also be statistically significant with far fewer than 300 participants). In the case of H2a and H2b (moderation of a PNF intervention), this leads to a similar conclusion as the earlier interpretation strategies because we still have just one test that would be statistically significant. Perhaps more importantly, that effect was in the opposite of the predicted direction. That is to say, the PNF intervention seemed to reduce drinking more on days when

people reported feeling higher in self-determination than it did for those who were lower in self-determination, but evidence for alcohol-related problems would still be lacking.

Self-determination as a moderator of injunctive norms, however, did exhibit two interactions in the predicted direction. That is to say, injunctive norms may be less strongly associated with drinking and alcohol-related problems on days when people feel more self-determined. This seems to suggest that in addition to within-person measurement, resources might be maximized by examining self-determination by injunctive norms interactions in predicting problematic alcohol consumption. Again, though, these results should be interpreted with caution, especially given the alternative interpretation strategies outlined above. Ultimately, the safest conclusion to draw from these results is that more data need to be collected.

PNF in this Versus Other Studies

It is worth noting that the effects of our PNF intervention were somewhat smaller than has been seen in past literature. One possible reason for this is that our implementation of the manipulation was somehow flawed. While we attempted to follow the methodology of past work as closely as possible, including using original grant applications, publications, measures binders, and discussions with original researchers, it is still possible that our manipulation failed to employ some component key to the efficacy of PNF. Likewise, it is possible that we did something additional or made certain decisions that undermined the intervention's efficacy. One recent paper suggested that replicator degrees of freedom are an underexamined source of failed replications and smaller effect sizes (Bryan, Yeager, & O'Brien, 2019). If so, it will be important for future researchers to determine what exactly

those key elements might be so that PNF can be more effectively employed by a wide range of researchers in the future.

Another possibility is that the true effect size of PNF interventions is somewhat smaller than what may be seen in the extant literature. A great deal of recent work suggests that replication attempts systematically find effects 33%-77% smaller than those of original reports (Camerer et al., 2018). The majority of these replication attempts have been in the context of more basic research, however, and there may be reason to believe that applied literature is less susceptible to issues of replication (e.g., because of mandates from NIH "Enhancing Reproducibility through Rigor and Transparency | grants.nih.gov," n.d.). Still, other perspectives suggest that more applied research is at least equally susceptible to many of the issues that are hypothesized to have caused these replication issues (Hardwicke & Ioannidis, 2018; Ioannidis & Trikalinos, 2007).

Part of the impetus for this study was a call from past researchers (Neighbors et al., 2006) to explore whether less self-determined people reduced how they drank on specific occasions. We found a pattern representing the opposite direction of effect, though, this pattern did not reach statistical significance. Moreover, we failed to replicate the effect observed in that study (that less self-determined individuals experience fewer alcohol-related problems following a PNF intervention). It is possible that this effect failed to replicate because our sample size was smaller (by nearly 100 participants), because we employed a different measure of self-determination, or even because our follow-up (two weeks) was much shorter than that study (two months) and the effects take longer to manifest[8]. It is also

[8] This length to manifestation possibility is somewhat unlikely given past empirical findings an current theory on the processes of social norms.

possible that we failed to replicate this effect because it is not a replicable effect but given the many shortcomings of our study and the fact that this represents only one failed replication, we think it would be beneficial to explore the other explanations in additional studies before contemplating the explanation that the effect may not be replicable.

Implications if our Self-Determination by Injunctive Norms Interactions Prove Reliable

If follow-up work does confirm the within-person injunctive norms by self-determination estimates to be stable, it may suggest a novel way of intervening with participants to reduce problematic drinking. Specifically, attempts to manipulate injunctive norms in the context of problematic alcohol consumption have not been particularly successful (e.g., Steers et al., 2016), but manipulating self-determination might be a way to reduce the problematic implications of injunctive norms. There have been several lab studies that have successfully manipulated self-determination in-the-moment (Hodgins et al., 2010; Weinstein et al., 2010), which might be used to good effect to study these effects in the laboratory. Still, we encourage caution given anecdotal experience of difficulty replicating that paradigm and original author suggestions that this manipulation may have trouble affecting self-report measures (H. Hodgins, personal communication, June 10, 2014). Perhaps a more fruitful, long-lasting strategy could be to provide autonomy-support to drinkers (please see Kayser, Cossette, & Alderson, 2014 for a review of autonomy-support interventions in the context of health behavior). This autonomy support could come from a wide range of sources including school officials (e.g., resident advisors, faculty, administrators, health professionals), friends or romantic partner who were trained how to

provide this support and its benefits, or even outside individuals in students' lives like parents and religious leaders.[9]

Another implication of the present work is that within-person effects are deserving of a great deal of additional study. Indeed, between-person variance accounted for a minority of the variance in injunctive norms, alcohol consumption, and alcohol-related problems (please see supplemental materials), supporting Mohr et al.'s contention that, "much of the focus is on individual differences. Yet, within-person variability contributes at least as much to drinking as between-person variability" (p. 586). Indeed, it seems that evidence is mounting that "within-person variability contributes at least as much to drinking as between-person variability." may be a considerable understatement. The only measure for which between-person variance exceeded within-person variance was motivation for drinking and even for that variable 40% of the variance was at the within-person level. This work complements that of several authors who have noted the importance of within-person measurement and interventions at that level (Cullum et al., 2010; Lau-Barraco et al., 2016; Mohr, Arpin, & McCabe, 2015; O'Grady et al., 2011; Suffoletto, Callaway, Kristan, Kraemer, & Clark, 2012; Witkiewitz et al., 2014). It seems ironic that the majority of investigations are at the person level when the majority of variance is within-persons. There are compelling arguments that between-person investigations and interventions can have great effectiveness and can be very cost-efficient ("CollegeAIM NIAAA's Alcohol Intervention Matrix," 2018), but the fact remains that within-person studies are underutilized given their massive potential.

[9] While autonomy support has a massive body of literature supporting it, once recent report suggested that its benefits were not cross-culturally universal (Tripathi, Cervone, & Savani, 2018). This study is directly in contrast to a great deal of literature suggesting that autonomy-support is universal (see Ryan & Deci, 2017b for a review) and has undergone a great deal of criticism on methodological and theoretical grounds, but it should be noted that there remains some active debate on the topic.

A third implication is continued support for a large body of literature demonstrating the importance of considering the interplay between social norms and self-determination in the context of health behaviors. While this is not a new topic of study (Brickell et al., 2006; Chan & Hagger, 2012; Chatzisarantis & Biddle, 1998; Chatzisarantis et al., 1997, 2008, 2007, 2006, 2009; Hagger & Chatzisarantis, 2009; Hagger et al., 2002; Hagger, Rentzelas, et al., 2014), it certainly supports the utility of continued research (Chawla et al., 2009; Hagger et al., 2012; Knee & Neighbors, 2002; Neighbors, Larimer, Markman Geisner, et al., 2004) in this vein insofar as it has implications for problematic alcohol consumption. Given the differences in effect sizes observed (i.e., in the contexts of PNF and injunctive norms), this work also suggests that continued examination of the unique implications of different kinds of social norms and their associations with constructs from self-determination theory is warranted.

Self-Determination and Alcohol Consumption More Broadly

In many of the partial analyses presented here, on days when participants were more internally motivated to drink, they tended to drink more. Despite this, they tended toward fewer alcohol-related problems. These results might suggest that more self-determined people drink more but do it in less harmful ways. Unfortunately, drawing strong conclusions about this are unwarranted for at least two reasons. First, past research suggests that those who are less self-determined both generally and in various domains tend to drink more (Chawla et al., 2009; Hove, Parkhill, Neighbors, McConchie, & Fossos, 2010b; Knee & Neighbors, 2002; Rodriguez et al., 2018). Thus, our findings appear to be directly in contrast with that work. Second, these same patterns did not consistently appear in the baseline-follow-up analyses nor in the zero order correlations (please see supplementary materials). It

is therefore possible that these positive associations between self-determination and alcohol consumption were simply spurious. Still, if more self-determined people are able to drink more without causing as much harm to themselves or others, this is likely a finding the field would be interested in learning and we encourage future research to investigate it.

Limitations and Future Directions

We have tried to be transparent in outlining the flaws of the present work and the implications of those flaws for the understanding and advancement that might be gleaned from this work. Chief among those flaws is a small sample size both because a larger sample was pre-registered and because it appears to have limited the ability of the present work to draw firm conclusions. In addition to sample size, there are several other opportunities to improve upon the present work.

One opportunity for improvement is in the realm of measurement. While the majority of our measures have been directly validated in the past or have been adapted from past validated measures, they were still not perfect for both theoretical and methodological reasons. For instance, measurement is likely one contributor to our underestimated effect sizes in the baseline-follow-up analyses (i.e., H1a, H1b, H3a, and H3b). Indeed, in the pre-registered analysis plan, the index of autonomous functioning was the chosen measure of self-determination, but a more domain-specific measure would be likely to be much more strongly associated with alcohol-related outcomes. This supposition fits with theory and research in line with the hierarchical model of motivation (Vallerand, 1997, 2000; Vallerand & Ratelle, 2002) as well as similar models in other domains including school (Guay et al., 2003), close relationships (Blais et al., 1990), and physical exercise (Vallerand, 2007). Evidence for this can be seen in the findings of hypotheses 2a 2b, 4a, and 4b wherein a

domain-specific measurement was used, and consistently stronger associations were found between the outcomes of interest and domain-specific self-determination. Additionally, such a measure was included in the baseline assessment and supplementary analyses do suggest that these findings are more in line with hypotheses. Although, *p*-values tended to remain larger than set thresholds, suggesting additional recruitment would still be beneficial. Additionally, when examining individual items, endorsement of two internally-focused items was quite low: "I drink because it helps me to achieve my goals." and "I drink because it allows me to improve myself." Perhaps this suggests that certain elements of the self-determination continuum (in this case, identified regulation) are less relevant to problematic drinking than others. On the other hand, given the large body of research demonstrating the utility and theoretical importance of identified regulation (e.g., Chemolli & Gagné, 2014) in such a wide range of behaviors, perhaps this merely suggests that it was assessed in with sub-optimal items.

There is already a large body of work examining motivation in the context of alcohol consumption that can be drawn upon to a greater extent in future research. Some of the extant work on motivation and alcohol consumption has, at times, been disorganized and contradictory (Kuntsche et al., 2005), but at other times it has provided great utility in understanding problematic alcohol consumption (Cooper, Kuntsche, Levitt, Barber, & Wolf, 2016). Future researchers might benefit from trying to integrate the better validated conceptualizations of motivation with that of self-determination to a greater extent than was done here.

While investigating alternative conceptualizations, we encourage future research to take race, culture, and ethnicity carefully into consideration. The need to examine culture is

an often repeated flaw of much research, but we think it is a particularly poignant point in the study of self-determination and social norms research. Recent research suggests that norms and self-determination outside of (Tripathi et al., 2018) and within (Nguyen & Neighbors, 2013) the context of alcohol consumption may operate in different ways, especially for Asian participants. Our sample was diverse, but unfortunately, given our lack of power to find effects of primary interest, it seemed particularly inappropriate to begin exploratory analyses examining the implications of race, culture, or ethnicity.

Conclusion

Problematic alcohol consumption creates less extreme (i.e., academic consequences) and more extreme (i.e., assaults and death) tribulations for college students (Hingson et al., 2005, 2009). A great deal of progress has been made in the development of interventions to reduce problematic consumption and curb its consequences ("CollegeAIM NIAAA's Alcohol Intervention Matrix," 2018), but there remains room for improvement. In particular, the research reported here suggests two major avenues for improvement. First and most compellingly, measurement and interventions at the within-person level should be a major focus of strategies to reduce problematic alcohol consumption because it is where most of the variance in problematic alcohol consumption and its most proximally related variables lies. Second, self-determination may be a useful theoretical lens through which to derive future interventions to reduce problematic consumption, in part because of the way self-determination may interact with injunctive norms, but much more data will need to be collected to definitely answer this question.

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