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Bayesian Analysis of Parental Drinking Motives and Children's Adjustment

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BAYESIAN ANALYSIS OF
PARENTAL DRINKING MOTIVES
AND CHILDREN'S ADJUSTMENT

DISSERTATION

A dissertation submitted in partial fulfillment of the
requirements for the degree of Doctor of Philosophy in the
College of Arts and Sciences
at the University of Kentucky

By

Aaron Adriel Duke

Lexington, Kentucky

Director: Dr. Peggy Keller, Assistant Professor of Psychology

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ABSTRACT OF DISSERTATION

BAYESIAN ANALYSIS OF PARENTAL DRINKING MOTIVES AND CHILDREN'S ADJUSTMENT

Harm reduction strategies can mitigate against some of the deleterious effects of alcohol on families. These strategies are most feasible and cost-effective when they can be targeted at those who are most at risk. Previous studies examining the relation between parents' alcohol use and their children's psychological adjustment have failed to consider important contextual questions such as drinking motives. The current investigation set out to identify the extent to which parents' drinking motives predict internalizing and externalizing psychopathology in their children. The investigation consisted of cross sectional analysis of parents' drinking motives and their children's adjustment using data from 154 families recruited from the local community. Utilizing Bayesian data analytic techniques, we examined the role of parents' drinking motives along with possible mediating variables including familial conflict, parental depression, and parenting style. Results showed that maternal social drinking motives were better predictors of children's maladjustment than either coping or enhancement drinking motives. Unexpectedly, maternal enhancement drinking motives were associated with fewer adjustment problems. Maternal enhancement drinking motives also predicted higher levels of collaborative conflict resolution and lower levels of parental depression, both of which were associated with reduced levels of children's externalizing problems. Paternal alcohol consumption and drinking motives were not associated with children's internalizing or externalizing problems. Clinical implications and directions for future research are discussed.

KEYWORDS: Drinking Motives; Parental Drinking; Child Psychopathology; Internalizing and Externalizing Problems; Bayesian Analysis

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May 15, 2013

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BAYESIAN ANALYSIS OF
PARENTAL DRINKING MOTIVES
AND CHILDREN'S ADJUSTMENT

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DEDICATION

I lovingly dedicate this dissertation to my wife, Amanda, who bravely faced many nights alone with three young children while I worked on my research, and whose job, despite being unquestionably more important than mine, lacks the glory and praise it rightfully deserves.

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Finally, this acknowledgement section would not be complete without recognizing the most important people in my life, my beautiful and inspiring wife Amanda, my little kinchins — Eli, Noah, and Sarah — and the best babysitters in the world, my wonderful parents. Thank you all.

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Chapter 1: Introduction

Parents wonder why the streams are bitter,
when they themselves have poisoned the
fountain.

JOHN LOCKE

Alcohol consumption in the U.S. is at a 25-year high, and 30 percent of Americans admit that drinking has caused trouble in their families (Gallup, 2010, 2011). While “family trouble” caused by alcohol use can come in many forms, perhaps the most pernicious is the negative impact it can have on children. Recent estimates suggest that more than 1 in 10 children in the United States under the age of 18 (between 7.5 and 10 million children) *currently live* with a parent who has qualified for an alcohol use disorder within the past year (B. F. Grant, 2000; SAMHSA, 2012). Children of parents with alcohol problems are more likely to experience a range of adverse childhood experiences including neglect and emotional, physical, and sexual abuse (De Bellis et al., 2001; Dube et al., 2001; D. K. Smith, Johnson, Pears, Fisher, & DeGarmo, 2007; West & Prinz, 1987; Young, Boles, & Otero, 2007). These adverse childhood experiences have been associated with poorer life outcomes and higher rates of internalizing and externalizing psychopathology (e.g., Connell & S. H. Goodman, 2002; McLaughlin et al., 2012).

Despite the negative impact that parental alcohol use can have on children, most children of parents who drink are not abused or neglected, nor do they necessarily have significant internalizing and/or externalizing problems; in an early review of the literature on parental alcoholism and childhood psychopathology, West and Prinz emphasized that “neither all nor a major portion of the population of children from alcoholic homes are inevitably doomed to psychological disorder” (1987, p. 214). Many important mediators and moderators of parental alcohol use and child psychopathology have been the subject of previous research including *resilience* (H. H. Lee & Cranford, 2008; Werner, 1986), *anxiety sensitivity* (MacPherson, Stewart, & McWilliams, 2001), *attachment* (El-Sheikh & Buckhalt, 2003), *parent-child communication* (Jacob, Krahn, & Leonard, 1991; Jones & Houts, 1992), *parental depression* (El-Sheikh & Flanagan, 2001), *parenting* (Reich, Earls, & Powell, 1988; Roosa, Tein, Groppenbacher, Michaels, & Dumka, 1993), *family conflict/cohesion* (Farrell, Barnes, & Banerjee, 1995; El-Sheikh & Flanagan, 2001; El-Sheikh & Buckhalt, 2003), *child personality* (A. Berkowitz & Perkins, 1988), and *punishment/abuse* (e.g., Reich et al., 1988). However, many important contextual questions have yet to be addressed that could shed light on why all parental alcohol use is

not equally damaging to children. One such question is *how do parents' motivations for drinking fit into the picture?*

Drinking Motives

Individuals who choose to consume alcohol do so for diverse reasons including to “fit in” (*conformity motives*), because they enjoy how it feels (*enhancement motives*), because it makes them “loosen up” and behave more sociably (*social motives*), and to cope with stress and other negative emotions (*coping motives*; M. L. Cooper, 1994). Of these different drinking motives, drinking to cope with negative affect has been shown to be particularly hazardous (V. V. Grant, Stewart, & Mohr, 2009), and may prove to have the most detrimental impact on children.

Wills and Shiffman (1985) posited that people use alcohol to regulate both their positive and negative affective experiences. According to this *affective regulation hypothesis*, alcohol is used to reduce negative affect when one is overaroused and to augment positive affect when one is underaroused. These two drinking motives are argued to map onto the two major biological motivational systems proposed by Gray (1970) in his original physiological theory of personality (i.e., the behavioral activation and behavioral inhibition systems; see also Willem, Bijttebier, Claes, & Uytterhaegen, 2012). In this model, drinking for enhancement is thought to reflect positive-valenced, appetitive motives, while drinking to cope is thought to represent negative, avoidant, threat-focused motives. Cooper et al.'s originally hypothesized model is reproduced in Figure 1.1; this model was largely supported by the results of two large samples—one with adults and one with adolescents (M. L. Cooper, Frone, Russell, & Mudar, 1995).

Motivations for drinking alcohol are not restricted to emotion regulation. Cox and Klinger (1988, 2011) outlined a four-factor motivational model of alcohol use where each factor was defined by the valence of the affective change and whether the change is direct or indirect. Thus, the four categories are 1) direct enhancement of positive affect, 2) indirect enhancement of positive affect, 3) direct reduction of negative affect, and 4) indirect reduction of negative affect. M. L. Cooper (1994) tested Cox and Klinger's theory by revising their three-factor questionnaire of drinking motives (M. L. Cooper, Russell, Skinner, & Windle, 1992) to include a fourth factor corresponding to *conformity* motives. Thus, enhancement and coping motives were conceptualized as direct pharmacological motivations while social and conformity motives were conceptualized as indirect motivations. The results of their study were interpreted as supporting Cox and Klinger's theory.

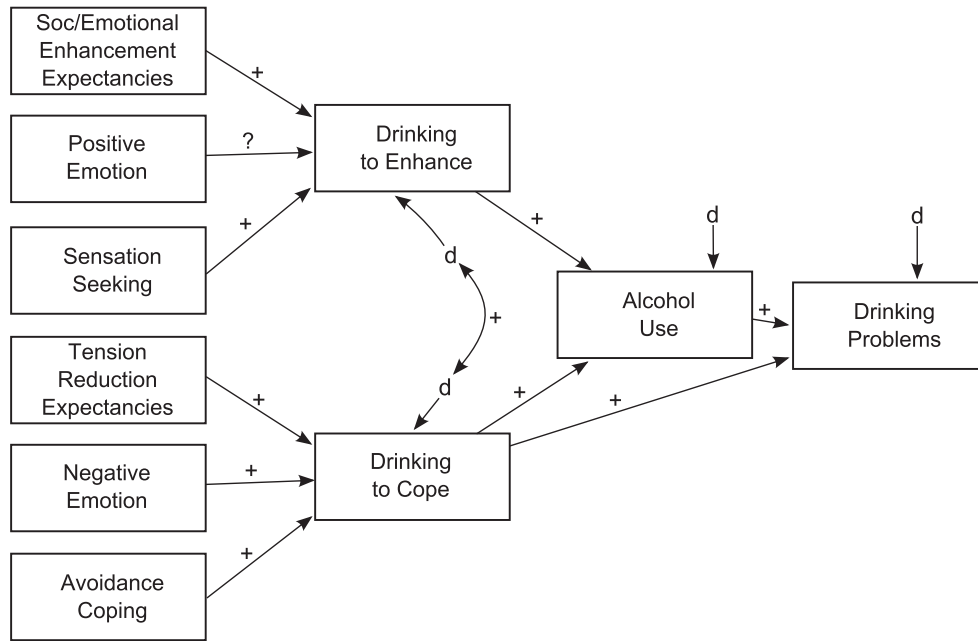


Figure 1.1: Hypothesized model of alcohol use as an emotion management strategy. Reproduced from “Drinking to Regulate Positive and Negative Emotions: A Motivational Model of Alcohol Use,” by M. L. Cooper, M. R. Frone, M. Russell, and P. Mudar, 1995, *Journal of Personality and Social Psychology*, 69, p. 992. Copyright 1995 by the American Psychological Association.

Over the past decade, numerous studies have tested the factor structure of drinking motives. They have been found to be mostly invariant across large-scale surveys conducted in Switzerland, Canada, and the United States, with social motives being the most prevalent, followed by enhancement, coping, and then conformity motives (E. Kuntsche, Stewart, & Cooper, 2008). Smaller studies ($N < 1,000$) have reported similar findings in Spain, Hungary, Italy, and Brazil (Hauck-Filho, Teixeira, & Cooper, 2012; Mazzardis, Vieno, Kuntsche, & Santinello, 2010; Németh, Urbán, et al., 2011). However, it is worth noting that some studies have found coping motives to be more common than enhancement motives (e.g., in the U.S. and Nigeria; Gire, 2002).

Drinking motives are not mutually exclusive—they can both coexist and vary over time. In-depth interviews with South Korean women undergoing treatment for alcohol dependence revealed a series of motivational transitions from drinking for pleasure (i.e., enhancement), to drinking in order to cope with negative emotions, and finally, to needing alcohol to function (Kim, Wiechelt, & Kim, 2010). Drinking motives have also been shown to vary from moment to moment depending upon positive and negative affect (Arbeau, Kuiken, & Wild, 2011). Drinking motives are also thought to undergo a

developmental transition from adolescence to adulthood. For example, it has been argued that true *social* drinking motives do not exist for adolescents, but rather are subsumed within conformity motives; this was the case in a study of First Nations (Mi'kmaq) adolescents in Nova Scotia (Mushquash, Stewart, Comeau, & McGrath, 2008).

Predicting Intoxicated Behavior

Drinking motives are of clinical relevance not just because they influence alcohol consumption, but also because they provide insight into *drinking context*, which is critical in predicting harmful drinking-related behaviors. It is well documented that alcohol intoxication can have widely discrepant effects ranging from prosocial behaviors (e.g., conviviality, helping, and social bonding; see Sayette et al., 2012) on one extreme to antisocial behaviors (e.g., aggression, withdrawal, and risk-taking) on the other (see Steele & Josephs, 1990). It makes little sense to aggregate across individuals with strong tendencies on opposite ends of the pro-vs-antisocial spectrum. The determinants of where someone will be on this continuum include both environmental and personality factors. For example, very few people are naturally aggressive under alcohol unless provoked (Giancola, Helton, et al., 2002). Provocation represents one of a number of important environmental influences to harmful drinking behavior. However, provocation alone is not sufficient to predict aggression. Individuals who tend to aggress while under the influence of alcohol typically have aggressive personalities (Denson, Aviles, et al., 2008; Giancola, 2002a, 2002b; Giancola, Godlaski, & Parrott, 2005; Giancola, Parrott, et al., 2012). Importantly, drinking motives are able to capture both environmental and personality-level variance important in predicting intoxicated behavior.

From Parents to Children

Studies have shown that parental problem drinking influences children's adjustment by way of numerous environmental and behavioral mediators (e.g., Eiden, Edwards, & Leonard, 2007; Keller, Cummings, & Davies, 2005; Keller, Cummings, Davies, & Mitchell, 2008; Keller, Gilbert, Koss, Cummings, & Davies, 2011; Rafferty & Hartley, 2006; Reich et al., 1988; Roosa et al., 1993; El-Sheikh & Flanagan, 2001). In order to expand upon this literature, we propose to go one step further by treating drinking behavior as a multidimensional construct and examining how different parental drinking motives might predict children's adjustment. A useful place to begin in testing this postulate is to look at established mediators of parental problem drinking and children's adjustment. Below we argue that different drinking motives may differentially predict the

mechanisms by which parental drinking affects adjustment problems in children. Specifically, we examine the role of *conflict* (parent-parent and parent-child), *parental depression*, and *parenting behavior* and argue that coping drinking motives have the strongest theoretical link to children's maladjustment, followed by enhancement, and then social drinking motives.

Conflict

One of the ways in which parental problem drinking negatively impacts children is by engendering conflict both between parents (i.e., parental conflict) and between parent and child (i.e., parent-child conflict; see Keller, Cummings, & Davies, 2005, Keller, Gilbert, et al., 2011, Rafferty & Hartley, 2006, Reich et al., 1988, El-Sheikh & Flanagan, 2001). Alcohol intoxication is one of the most reliable general risk factors for aggression (Bushman, H. M. Cooper, et al., 1990; Exum, 2006; Ito, N. Miller, Pollock, et al., 1996) and has been repeatedly linked to intimate partner violence (Foran, O'Leary, et al., 2008) and child abuse (Widom & Hiller-Sturmhöfel, 2001). Drinking motives, as contextual moderators of drinking behavior, are likely linked to drinking-related conflict. There are reasons to believe that both coping and enhancement motives may be predictive of alcohol-related conflict, but for different reasons. On the other hand, social drinking motives may be inversely related to conflict given evidence that social drinking may facilitate social bonding and helping behaviors (e.g., Sayette et al., 2012).

Drinking to cope may result in particularly salient frustration cues capable of instigating aggression. The frustration-aggression hypothesis argues that frustration (or more generally, negative affect; see L. Berkowitz et al., 1989) leads to aggressive inclinations that are often displaced (i.e., not directed at the source of one's frustration; N. E. Miller, 1941). Further, displaced aggression is most pronounced when coupled with alcohol consumption (e.g., Aviles, Earleywine, Pollock, Stratton, & Miller, 2005; Denson, Aviles, et al., 2008; Denson, White, & Warburton, 2009). A meta-analysis of displaced aggression revealed a relatively robust effect size (mean Cohen's $d = 0.54$) and found that displaced aggression was stronger when there were similarities between the source of one's frustration and the target of the displaced aggression (Marcus-Newhall, Pedersen, Carlson, & Miller, 2000). It is not difficult to imagine a situation where coping drinking motives are clearly linked to increased familial conflict via displaced aggression. For example, imagine a father of two who loses a child and turns to alcohol in order to cope with his loss, and each time he looks at his surviving child he is reminded of the child he lost. Such a father may be more likely to create conflict with his surviving child due to frustration and generalized negative affect coupled with the disinhibitory effects of

alcohol.

Enhancement drinking motives may also increase the likelihood of conflict through increased exposure to salient sensation-seeking/cues. Sensation-seeking can be defined as “the seeking of varied, novel, complex, and intense sensations and experiences, and the willingness to take physical, social, legal, and financial risk for the sake of such experience” (Zuckerman, 1994, p. 27). A meta-analytic review including a total of over 32,000 participants revealed a positive relation between sensation-seeking and aggression (Cohen’s $d = 0.20$; Wilson & Scarpa, 2011). Underarousal Theory posits that individuals who are chronically underaroused seek out intense sensations *including conflict* in order to alleviate the dysphoria associated with their underaroused state (Zuckerman, 1990). This hypothesis has been supported by at least two meta-analyses of physiological arousal and aggressive behavior (Lorber, 2004; Ortiz & Raine, 2004). Thus, enhancement drinking motives may increase conflict via increased levels of disinhibited sensation-seeking.

Depression

The impact of parental problem drinking has also been shown to be mediated by parental depression in at least one study (El-Sheikh & Flanagan, 2001). A comprehensive meta-analytic review identified maternal depression as being particularly salient to children’s adjustment, especially when coupled with paternal alcoholism (S. H. Goodman et al., 2011). We propose that parental depression may be a potential mediator between coping drinking motives and children’s adjustment problems given coping drinking motives relation to depression (Armeli, Conner, Cullum, & Tennen, 2010; V. V. Grant, Stewart, & Mohr, 2009; M. Windle & R. Windle, 2012) and the ability of alcohol use to increase depressive symptoms (e.g., Gilman & Abraham, 2001). Whether parental depression consistently mediates the relation between parental drinking and children’s adjustment has been highlighted as an important area in need of further research (S. H. Goodman, 2007).

Parenting Behavior

Finally, an important mechanistic link between parental drinking motives and children’s adjustment may be parenting behavior. The negative impact of parental problem drinking has been shown to be mediated by less effective parenting, lax discipline, and less parental support (Eiden et al., 2007; Keller, Cummings, Davies, & Mitchell, 2008; Roosa et al., 1993). Coping drinking motives, being more strongly associated with negative emotionality and the depressive effects of alcohol, likely facilitate these negative

parenting styles (i.e., decreased parental involvement and less consistent discipline). This hypothesis is supported by a meta-analytic study linking maternal depression to maladaptive parenting behaviors (Lovejoy, Graczyk, O'Hare, & Neuman, 2000). More generally, there is ample evidence linking maternal personality to parenting behaviors (e.g., Belsky & Barends, 2002; Clark, Kochanska, & Ready, 2000; McKee, Colletti, Rakow, Jones, & Forehand, 2008) and a correspondingly expansive literature linking parenting behaviors to children's adjustment (e.g., Galambos, Barker, & Almeida, 2003; Scaramella, Conger, & Simons, 1999). Given previous research demonstrating unique personality correlates of different drinking motives (e.g., Arbeau et al., 2011; Hussong, 2003; Littlefield, Agrawal, et al., 2011; Mezquita, Stewart, & Ruipérez, 2010; Stewart & Devine, 2000; Stewart, Loughlin, & Rhyno, 2001; Theakston, Stewart, Dawson, Knowlden-Loewen, & Lehman, 2004), it is reasonable to expect a similar pattern of different effects on parenting behavior of different parental drinking motives.

Current Study

There is a pronounced clinical need to better understand which families are most at risk for negative consequences associated with parental drinking. We have identified reasons why parents' drinking motivations may be related to internalizing and externalizing problems in their offspring. The primary aim of the current study was to test whether phenomenologically distinct drinking motives can help explain the widely disparate effects of parents' alcohol use on their children's emotional well-being.

We formulated three hypotheses on the relation between parents' drinking motives and their children's psychological adjustment. *First*, we hypothesized that measurement of parents' drinking motives will provide meaningful gains in our ability to predict children's adjustment when compared with only taking into account parents' problematic drinking. *Second*, we hypothesized that parents' coping drinking motives would have the strongest association with children's maladjustment, followed by enhancement motives, and finally, social motives. *Third*, we predicted that the relation between parental drinking motives and children's adjustment would be mediated by partner conflict, parent-child conflict, parental warmth, parental psychological and behavioral control, and parental depression.

Rationale for Bayesian Approach

Bayesian approaches to data analysis are generally superior to traditional frequentist approaches with their reliance on null hypothesis significance testing (NHST; Kruschke, 2010b). This study represents the first effort, which we are aware of, to apply Bayesian

data analytic techniques to the study of drinking motives. Of course, it is also the first study to examine the relation between parental drinking motives and their children's adjustment. Prior to introducing the details of the current study, it is worthwhile to further explicate our rationale behind choosing a Bayesian, as opposed to a frequentist, framework for making statistical inferences.

Problems with the Status Quo

Null hypothesis significant testing (NHST) and its reliance on p -values remains the *de facto* standard in social scientific communication. However, there are a number of serious problems with the use of p -values that researchers may or may not be aware of. For example, many researchers do not realize that classical statistical testing does not stem from a single philosophy of statistical inference, but rather, is an amalgam of two schools of thought: one popularized by Fisher and another advocated by Neyman and Pearson (Hubbard & Bayarri, 2003). Fisher's approach relied on Karl Pearson's p statistic, which was conceived of as an index of inductive evidence against the null hypothesis and is derived from a hypothetical, infinite sample. Neyman–Pearson's α and β thresholds for respectively controlling Type I and Type II error rates relied on repeated sampling of defined populations. The currently popular approach to use Fisherian p values within the Neyman–Pearson framework of controlling for errors has conflated statistical evidence (p -values) with error rates (α and β values) and makes it easy to misinterpret what p -values actually signify.

One common misinterpretation of p -values is that they speak to the probability of the null hypothesis being true. p -values are conditioned on the null hypothesis being true and therefore cannot be correctly interpreted as a *direct* index of support for the null hypothesis given that the null hypothesis must be true in order for a p -value to be defined. Further, the p -value, and by extension, confidence interval, are ill-defined because there are no unique p -values or corresponding confidence intervals for any particular set of data (Kruschke, 2010b). There are no unique p -values for specific data sets because p -values are not conditioned on the data (i.e., what is *known*), but rather, on *unknowable* parameter values and the often unspecified intentions of the researcher interpreting the data (Wagenmakers, Lee, Lodewyckx, & Iverson, 2008). The result of relying on researcher intentions to determine statistical significance is that it becomes “trivial to make any observed difference non-significant merely by conceiving of many other conditions with which to compare [one's] data” (Kruschke, 2010b, p. 294).¹ Further, these intentions are

¹Contrast this with Bayesian data analysis, in which multiple comparisons do not change one's interpretation of the data (see Gelman, Hill, & Yajima, 2012).

easily concealed and misrepresented. It has been noted that the flexibility in data collection, analysis, and reporting make it “unacceptably easy to publish ‘statistically significant’ evidence consistent with *any* hypothesis” (Simmons, Nelson, & Simonsohn, 2011, p. 1359, italics in original).

A comprehensive overview of the criticisms of NHST is beyond the scope of this article. However, it should be noted that published criticisms of NHST are plentiful (e.g., Armstrong, 2007; Bakan, 1966; Carver, 1978; Cohen, 1994; Edwards, 2008; Falk & Greenbaum, 1995; Gelman, 2010; Gelman & C. P. Robert, 2012; Gill, 1999; Glover & Dixon, 2004; S. N. Goodman, 1999a, 1999b; Haller & Krauss, 2002; Harlow, Muliak, & Steiger, 1997; Howson & Urbach, 2006; Hubbard, 2004; Hubbard & Armstrong, 2006; Hubbard & Lindsay, 2008; Hubbard & Ryan, 2000; Hunter, 1997; Ioannidis, 2005; Jaynes, 2003; Johansson, 2011; Kmetz, 2011a, 2011b; Lambdin, 2012; Levine, Weber, Hullett, Park, & Linsey, 2008; Loftus, 1996; McCloskey, 1992; Meehl, 1967, 1978, 1990; Murray, 1993; Nix & Barnette, 1998; Omi, 2012; Rodgers, 2010; Rozeboom, 1960; Shaver, 1993; Shrout, 1997; Siegfried, 2010; Stang, Poole, & Kuss, 2010; Wagenmakers, 2007; Wagenmakers et al., 2008; Westover, Westover, & Bianchi, 2011; Ziliak & McCloskey, 2007, 2009). Fortunately, there is a readily available alternative to the NHST framework.

A Bayesian Alternative

Bayesian data analysis resolves most of the problems inherent in NHST and p -values, but represents a paradigm shift that, while intuitive, is intimidating to many trained in classical methods. Historically, frequentists have conceded Bayesian inference’s philosophical superiority² while dismissing it as impractical (e.g., Efron, 1986). In the past, Bayesian data analysis was limited by the computational costs associated with integrating high-dimensional posterior distributions when no closed-form analytic solutions were available. However, the advancement of computer technology and the discovery of efficient algorithms for sampling high-dimensional spaces has now made the integration problem largely moot. Bayesian data analysis has only become practical within the past decade or so, and its promulgation in psychological research is still limited; however, Bayesian data analysis is gaining traction at a steady rate and has been predicted to become the predominate method of data analysis by the middle of the 21st century (e.g., S. P. Brooks, 2003; Efron, 2010; Gelman, 2010; Kruschke, 2011; Lindley, 1975).

²Unlike frequentist theory, Bayesian inference is *coherent* (in the technical sense) inasmuch as it does not violate the likelihood principle (Birnbaum, 1962)—which states that “models and data sets leading to the same likelihood function should generate the same statistical inferences” (Little, 2006, p. 5).

Bayesian inference relies on applying Bayes' Theorem (see Equation 1.1), which simply states that the probability distribution of plausible (i.e., *credible* or *believable*) parameter values θ , given the observed data \mathbf{D} is a function of the likelihood of obtaining the data \mathbf{D} given the parameter values θ multiplied by the prior plausibility of various values of θ divided by all possible data combinations.³ In Bayes' Theorem, $p(\theta|\mathbf{D})$ is referred to as the *posterior*, $p(\mathbf{D}|\theta)$ as the *likelihood*, and $p(\theta)$ as the *prior*.⁴

$$p(\theta|\mathbf{D}) = \frac{p(\mathbf{D}|\theta)p(\theta)}{p(\mathbf{D})} \quad (1.1)$$

Bayesian data analysis results in a distribution of plausible parameter values (not just a point estimate), providing an intuitive way to assess statistical power and replication probability (Kruschke, 2011). Further, the impact that data will have on different theories (i.e., the 'robustness' of one's conclusions) is testable within the Bayesian inference by using a variety of different prior plausibility distributions and/or likelihood functions. Unlike in certain NHST methods (e.g., ANOVA) where unequal numbers of data points are problematic, Bayesian data analysis is computationally robust, not only against unequal sample sizes (Kruschke, 2010b), but also against multiple comparisons (Gelman, Hill, & Yajima, 2012). Finally, one of the key advantages of Bayesian data analysis over NHST is that inference is conditioned on the data as opposed to the intentions of the researcher; for example, if a researcher takes a 'sneak peek' at his/her data, the interpretation of the data does not change.

Bayesian data analysis facilitates scientific progress by providing a natural means of accumulating scientific evidence. The posterior distribution of a previous experiment can become the prior distribution of a replication experiment. Thus, if data are consistent, the new posterior will lead to stronger conclusions (i.e., be more accurate), and if the data are inconsistent, then the added uncertainty in the previous experiment's conclusions is now formally specified in the form of a new posterior distribution. Bayesian analysis is more conservative than NHST; by incorporating prior knowledge into one's inferences, Bayesian data analysis "goes with what is already known, unless the data force a change" (Gelman, 2010; see also Gelman & Jakulin, 2007).⁵

³ $p(\mathbf{D})$ is merely a normalizing constant so that the posterior probability distribution sums to 1. The normalizing constant is often omitted (Koch, 2007), leaving $p(\theta|\mathbf{D}) \propto p(\mathbf{D}|\theta)p(\theta)$.

⁴Bayesian inference is the "the reallocation of credibility across a space of possibilities" (Kruschke, 2011, p. 300). Herein we use the words 'credible,' 'plausible,' and 'believable' interchangeably, and in lieu of the term 'statistical significance.' Thus, we speak of *credible* differences or *highly plausible* differences as opposed to significant differences. This terminology has the added benefit of not confounding connotations of 'important' with 'reliably different.'

⁵In contrast, estimates from NHST are subject to radical change from data set to data set (Cumming, 2008; Gelman, 2010).

Participants

Participants were 154 families taking part in a larger study of parental alcohol use, conflict, and child sleep. Participants were recruited from the greater Lexington, Kentucky area. Each family included married or cohabiting parents who are at least 21 years of age and a child between the ages of 6 and 11. Only one child from each family was included in the study. Inclusion criteria required parents to have lived together for at least 2 years prior to participating in the study. Participants were required to complete questionnaires in English. Children with mental retardation, developmental delays, or attention-deficit hyperactivity disorder (ADHD) were excluded from participating along with children who had an acute or chronic illness. Children with acute illnesses were allowed to participate once they recovered. In order to obtain a sample with sufficient variability in alcohol consumption, a screening questionnaire was used to classify potential participants as light, moderate, or heavy drinkers. Light drinkers were defined as someone who consumes no more than two drinks per occasion, with no more than one drinking occasion per month. Moderate drinkers were defined as women who consume no more than one drink per day or men who consume no more than two drinks per day. Heavy drinkers were defined as individuals who consume greater alcohol in greater quantities than moderate drinkers. Families were classified based on the partner who exhibits the highest level of drinking. An effort was made to recruit participants such that roughly $\frac{1}{3}$ of the sample fell within each category.

A total of 288 parents had complete data including 142 fathers and 146 mothers. At the time of the study, couples had been together for a median of 14 years (*mean* = 13.8). Parents' ages ranged from 22 to 59 with a median age of 39 (*mean* = 39.1). Most parents were married (91.6%), Caucasian (86.5%), and well-educated with a median of 16 years of education (*mean* = 15.7 years). Approximately 10.1% of parents self-identified as African American, 2.1% as Asian, 1% as Hispanic, and 1.4% as "other." The majority of parents were Protestant (69.1%) with minorities endorsing Catholicism (20.8%), no religion (7.6%), Islam (1.4%), and Judaism (0.3%). Annual family income ranged from \$2,000 to \$228,000 with a median income of \$68,000 and a mean income of \$75,500. The median number of children in each family was 1 (*mean* = 1.8). Most of the guardians in the study were biological parents (*n* = 261), however, there were also step-parents (*n* = 8), foster parents (*n* = 1), adoptive parents (*n* = 13), and live-in boyfriends/girlfriends to the child's parent (*n* = 4); for the sake of simplicity, individuals in all of these categories are referred to collectively as 'parents' throughout this article. Approximately 14.2 percent of

the adults in the study had been divorced at least once with 2.4 percent reporting multiple divorces. The ages of the children participating in the study ranged from 5.5 to 12.9 with a median age of 9.1 (*mean* = 9.2). Participating children were roughly divided equally between boys (49.4%, *n* = 76) and girls (48.7%, *n* = 75).

Procedure

All participants were screened over the telephone to ensure they met inclusion criteria. Informed consent was obtained from each adult and informed assent was obtained from each child prior to participating in the study. The study was reviewed and approved by the University of Kentucky Institutional Review Board (IRB). At the end of the week-long assessment of the participating child's sleep behaviors, families came into the laboratory in order to fill out questionnaires and complete a variety of other physiological measures and tasks not included in the present study. Only one family attended the laboratory session at a time. The laboratory includes several rooms, and for the completion of questionnaires, family members were separated into different rooms to allow for privacy. Parents completed questionnaires on a computer while children completed questionnaires in an interview format. Only parent questionnaires were utilized in the current analyses with each parent completing each questionnaire separately (see below). At the end of the laboratory session, participants were debriefed and compensated. Families received \$150 for their participation; \$140 was divided evenly between the male and female partners, and the child was given a choice between a \$10 toy or a \$10 check.

Instruments

Drinking Motives Questionnaire–Revised (DMQ-R)

The DMQ-R is a 20-item measure of the relative frequency of four major categories of drinking motives, including *social motives* (e.g., “because it helps you enjoy a party”), *enhancement motives* (e.g., “to get high”), *conformity motives* (e.g., “so you won't feel left out”), and *coping motives* (e.g., “to forget your problems;” M. L. Cooper, 1994). Subscales named after each of these categories of drinking motives are derived by averaging across the 5 items contained in each subscale. Items were scored using a 1–5 Likert scale with the following anchors: 1 = *almost never/never*, 2 = *some of the time*, 3 = *half of the time*, 4 = *most of the time*, 5 = *almost always/always*.¹ For the current study, only the three subscales of the original DMQ (M. L. Cooper, Russell, et al., 1992) were

¹Note that the original DMQ utilized a 1–4 Likert scale as opposed to the 1–5 range of the revised version.

included (i.e., the Conformity Motives subscale was not included). The DMQ-R has well-established psychometric properties (M. L. Cooper, 1994; M. L. Cooper, Krull, et al., 2008; E. Kuntsche, Stewart, & Cooper, 2008), and its factor structure has been confirmed in validation studies in several different countries including Brazil, Canada, Switzerland, and the United States (e.g., V. V. Grant, Stewart, O'Connor, Blackwell, & Conrod, 2007; Hauck-Filho et al., 2012; E. Kuntsche, Stewart, & Cooper, 2008; MacLean & Lecci, 2000).

The Alcohol Use Disorders Identification Test (AUDIT)

The AUDIT is a 10-item questionnaire developed by the World Health Organization (WHO) to screen for hazardous and harmful alcohol consumption (Saunders, Aasland, Babor, de la Fuente, & Grant, 1993). Responses are provided in a Likert format with anchors that vary by question and range from 0 to 4. Most of the questions (numbers 3–8) ask about the frequency of alcohol-related behaviors and problems (e.g., “How often do you have six or more drinks on one occasion?”) with the following response options: 0 = *never*, 1 = *less than monthly*, 2 = *monthly*, 3 = *weekly*, and 4 = *daily or almost daily*. The first two questions ask about drinking frequency and volume, and the last two questions ask if the respondent’s drinking has ever harmed someone or if anyone has suggested the respondent “cut down” on their drinking.

The AUDIT is a well-established measure of alcohol use disorders and has generally good support for its reliability and validity with high specificity and adequate sensitivity to current hazardous alcohol use (e.g., Allen, Litten, Fertig, & Babor, 1997; Berner, Kriston, Bentele, & Härter, 2007; K. A. Bradley, Bush, McDonell, Malone, & Fihn, 1998; O’Hare & Sherrer, 1999). However, there are some concerns with the AUDIT’s factor structure (e.g., Gmel, Heeb, & Rehm, 2001). Specifically, it is not clear to what degree drinking *frequency* is related problem drinking. A two-factor structure reflecting a) *consumption* and b) *consequences* is probably the most strongly indicated (Gmel et al., 2001; C.-Z. Peng, Wilsnack, Kristjanson, Benson, & Wilsnack, 2012; Wade, Varker, O’Donnell, & Forbes, 2012) and was adopted in the current study. Consumption scores were calculated by summing across the first three questions of the AUDIT while the score for the Consequences subscale was calculated by summing across the remaining seven questions. The total AUDIT score was used to classify participants as “Hazardous Drinkers” (a score of 8 or greater) and “Alcohol Dependent” (indicated by a score of 13 or above for women and 15 or above for men; Berner et al., 2007).

Child Behavior Checklist (CBCL)

Parents completed the Internalizing Problems and Externalizing Problems scales of the CBCL (Achenbach, 1991)—the most widely used dimensional rating scales of child psychopathology (Seligman, Ollendick, Langley, & Baldacci, 2004). Each parent rated their child’s behavior over the past 6 months in relation to numerous descriptive statements using a 3-point Likert scale (0 = *not true*, 1 = *somewhat or sometimes true*, 2 = *very true or often true*). The Internalizing Problems scale includes items that measure anxiety (e.g., “nervous, high strung, or tense,” “too fearful or anxious”), mood (e.g., “feels worthless or inferior,” “unhappy, sad, or depressed”), and somatic complaints (e.g., “overtired,” “stomachaches or cramps”). The Externalizing Problems scale includes items that measure rule-breaking behavior (e.g., “lying or cheating,” “swearing or obscene language”) and aggressive behavior (e.g., “gets in many fights,” “temper tantrums or hot temper”). Internalizing and Externalizing scores on the CBCL were summed and transformed into *T*-scores based on child gender and age (see Achenbach & Rescorla, 2001). Following Achenbach’s recommendations, *T*-scores below 60 were considered average, *T*-scores between 60 and 63 were considered “borderline clinical,” and *T*-scores 64 and above were considered clinically elevated (Achenbach & Rescorla, 2001). The CBCL has well-established reliability and validity (e.g., Berg, Lucas, & McGuire, 1992; Bingham, Loukas, Fitzgerald, & Zucker, 2003; Fanti & Henrich, 2010; Lowe, 1998) and the Internalizing and Externalizing scales have empirically substantiated clinical utility (Dutra, Campbell, & Westen, 2004; Seligman et al., 2004; Warnick, Bracken, & Kasl, 2008).

Conflicts and Problem-Solving Scales (CPS)

The CPS is an 82-item measure of conflict and conflict resolution among partners in a relationship consisting of a set of subscales designed to be administered separately (Kerig, 1996). The subscales utilized in the present study include conflict frequency, collaborative conflict resolution, and verbally aggressive conflict resolution. The conflict frequency subscale measures the combined number of ‘minor’ and ‘major’ conflicts over the previous year rated on a 6-point ordinal scale, ranging from “once a year or less” to “just about every day.” Major conflicts are weighted twice as much as minor conflicts, thus the total score can range from 3 to 18 (see Kerig, 1998). The conflict resolution scales are rated on a 4-point scale where participants are asked how often they use a particular strategy (0 = “never” and 3 = “often”) with a differing number of items in each scale. The verbal aggression subscale includes 8 items (e.g., “raise voice, yell, shout”) while the

collaboration subscale includes 6 items (e.g., “try to reason with the other”). Scores for these two subscales were calculated by averaging across the relevant responses. The CPS has been shown to have good psychometric support with subscale reliability coefficients ranging from .70 to .98 (see Johnson, 2001).

Parent-Child Conflict Tactics Scale (CTSPC)

The CTSPC was designed as a parent-to-child version of the popular Conflict Tactics Scale (CTS) in order to better conduct epidemiological research on child maltreatment (Straus, Hamby, Finkelhor, Moore, & Runyan, 1998). The scale contains 22 items assessing nonviolent discipline, psychological aggression, and physical assault. Response options range from 0 “this has never happened” to 6 “more than 20 times in the past year.” The CTSPC has five subscales: Nonviolent Discipline (e.g., “put him/her in time out”), Psychological Aggression (e.g., “called him/her dumb or lazy or some other name like that”), Physical Assault (e.g., “spanked him/her on the bottom with my bare hand”), Severe Physical Assault (e.g., “hit him/her on the bottom with something like a belt, hairbrush, a stick or some other hard object”), and Very Severe Physical Assault (e.g., “grabbed him/her around the neck and choked him/her”). The CTSPC has shown good internal consistency with the exception of the Severe Assault and Very Severe Assault subscales, which suffer from very low rates of endorsement (see Friedrich, Olafson, & Connelly, 2004). In the current study, only the Physical Assault and Psychological Aggression subscales were included and were computed by averaging across the relevant responses.

Parent Report of Parent Behavior Inventory (PRPBI)

The PRPBI is the parent rating form of the Child Report of Parent Behavior Inventory (CRPBI; Margolies & Weintraub, 1977; E. Schludermann & S. Schludermann, 1970), one of the most popular measures of parenting behavior (M. Smith, 2011). Respondents rate the similarity of their parenting style to 30 items on a three-point scale where 1 = *not like*, 2 = *somewhat like*, and 3 = *like*. Factor analytic studies have identified three major dimensions of the CRPBI: acceptance versus rejection—*warmth*; psychological autonomy versus control—*psychological control*; and firm control versus lax control—*behavioral control* (Burger & Armentrout, 1971; E. Schludermann & S. Schludermann, 1970). These subscales have been shown to have good psychometric characteristics (e.g., Butler, Skinner, Gelfand, Berg, & Wiebe, 2007; Zeller, Boles, & Reiter-Purtill, 2008).

Center for Epidemiologic Studies Depression Scale (CES-D)

The CES-D is a short 20-item questionnaire designed to measure depressive symptoms in the general population (Radloff, 1977). Response options include the relative frequency of experiencing each symptom where 1 = *rarely or none of the time (< 1 day)*, 2 = *some or a little of the time (1–2 days)*, 3 = *occasionally or a moderate amount of the time (3–4 days)*, and 4 = *most or all of the time (5–7 days)* with the exception of items 4, 8, 12, and 16, which are reverse scored. An overall depression score is computed by averaging across the items, and scores above 2.05 suggest possible major depression while scores between 1.75 and 2.05 suggest mild to moderate depression. The CES-D is one of the most widely used measures of depression and has been validated across different ethnicities, languages, and regions (e.g., Roberts, 1980). The CES-D provides an overall index of depressive symptomatology that incorporates somatic, affective, and, to a lesser extent, interpersonal elements (see Shafer, 2006).

Analyses

A series of Pearson product-moment correlation coefficients were computed between parental drinking variables and externalizing and internalizing scores (T -scores) using hierarchical Bayesian models. A model of the dependencies involved in estimation of Pearson's r along with the parameter values for the various priors are presented in Figure 2.1 after the manner of Kruschke (2010a) where Greek letters (μ and τ) represent random variables and capitalized roman letters (M , T , S , R) represent scalars. T and M represent the fixed precision and mean of a normal distribution while τ and μ are the randomly distributed equivalents, and S and R represent the fixed values for the shape and rate parameters of a gamma distribution. Arrows indexed with '=' indicate deterministic relationships while arrows indexed with '~' indicate stochastic relationships. Finally, arrows indexed with ellipses '...' indicate repeated variables. An alternative graphical model, adapted from M. D. Lee and Wagenmakers (2012), using the more traditional plate notation is presented in Appendix 4.4 along with the corresponding BUGS code. Plausible differences between correlations were assessed by estimating the correlation models in parallel with an added $r_{\text{difference}}$ parameter. The mean correlation coefficient from the posterior distribution along with the 95% highest density interval (HDI) is reported for each pair of variables. One advantage of HDIs over their NHST equivalents (i.e., confidence intervals) is that because they are not based on a point estimate, they are not biased when posterior distributions are skewed (Kruschke, 2010b). Differences were considered credible only if the 95% highest density interval did not include the value 0

(i.e., analogous to the *de facto* 95% standard for NHST confidence intervals).

Minimally informed priors were used in calculating posterior estimates consistent with commonly accepted practice (e.g., Kruschke, 2010a; M. D. Lee & Wagenmakers, 2012). The mean of each variable was estimated using a Gaussian prior with low precision for its mean (e.g., $\mu \sim Normal(0, 0.001)$) and a gamma prior with small shape (S) and rate (R) parameters for its precision (e.g., $\tau \sim Gamma(0.001, 0.001)$). The prior for mean Internalizing/Externalizing scores was set to have a mean of 50 corresponding to the mean score the CBCL validation sample with a precision of .01 (equivalent to a standard deviation of 10). The priors for drinking motive and alcohol problems scores were each assigned a mean of 1 and precision of .01. Note that a large standard deviation on the prior is considered *minimally informative* because it will be largely washed out by the likelihood and have only a *minimal* impact on the posterior distribution. The minimally informative priors for Pearson's r values were set to a uniform distribution ranging from -1 to 1 ($r \sim Uniform(-1, 1)$).

Posterior probability estimates were estimated using Markov chain Monte Carlo methods (Gibbs sampling via JAGS). MCMC methods are able to approximate high-dimensional probability distributions by generating chains of randomly sampled values from the parameter space of interest where each subsequent step in the chain relies only on the previous step (i.e., fulfills the Markov property; see Gelman, Carlin, Stern, & Rubin, 2003; C. Robert & Casella, 2004). The Gibbs sampler is a popular MCMC algorithm considered to be the “workhorse of the MCMC world” (C. Robert & Casella, 2010, p. 199), which capitalizes on the computational efficiency of sampling from conditional distributions as opposed to directly sampling from joint distributions.²

We conducted three-step hierarchical regression analyses where basic demographic variables including family income, child age, child sex, and child race were entered at step one. Step two consisted of drinking consumption and drinking problems as measured by the AUDIT. Finally, Step Three involved entering coping, enhancement, and social drinking motives. The following minimally informed priors were used for the multiple linear regression analyses:

$$\beta_0 \sim Normal(50, 0.001)$$

$$\beta_j \sim Normal(0, 0.01)$$

$$\tau_y \sim Gamma(0.01, 0.01)$$

where β_0 is the intercept of the regression equation distributed normally with mean 0 and

²For an accessible overview of MCMC methods and the Gibbs algorithm in particular, see Resnik & Hardisty, 2010.

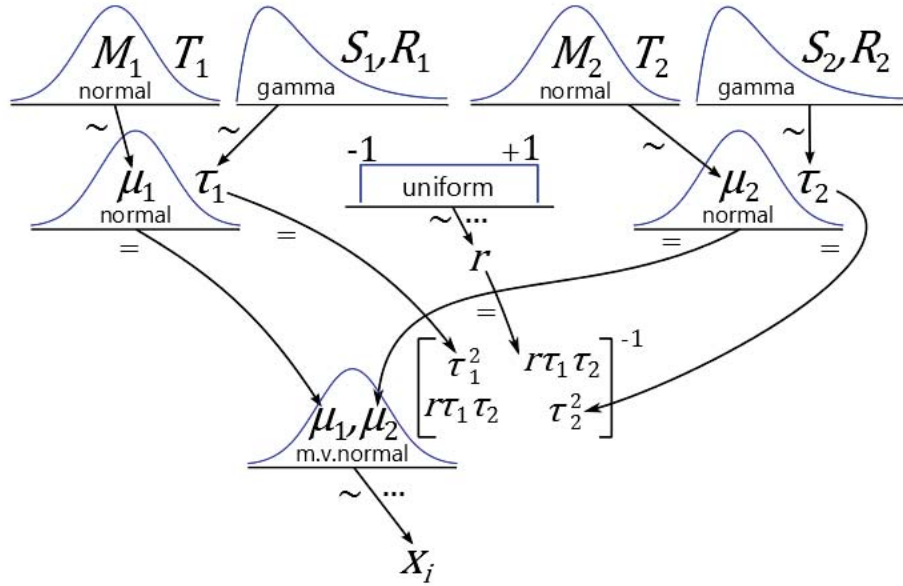


Figure 2.1: Graphical Model of Pearson Correlation Model Dependencies

precision 0.001, β_j is the regression coefficient for variable j , also distributed normally with mean 0 and precision 0.01, and τ_y is the precision of the regression estimate distributed as a gamma distribution with shape = 0.01 and rate = 0.01. See Figure 2.2 for the graphical model and Appendix 4.4 for the BUGS code.

Assessing Model Fit

Model fit between each step of the hierarchical regression model was assessed by comparing deviance information criterion (DIC) values. The deviance information criterion is calculated as $DIC = p_D + \bar{D}$ where p_D is the effective number of model parameters and \bar{D} is the expected model deviance. \bar{D} is calculated by averaging $D(\theta)$ over the MCMC samples of θ , and p_D is calculated by subtracting $D(\bar{\theta})$ from \bar{D} where $D(\bar{\theta})$ is the value of D evaluated at the average of the MCMC samples θ . DIC has been shown to be large-sample equivalent to the natural model-robust version of the Akaike information criterion or AIC (Claeskens & Hjort, 2008). Absolute values of DIC are not particularly meaningful and only differences in DIC should be interpreted. Differences of 1–2 are considered ‘negligible,’ differences of 3–7 are considered ‘moderate,’ and differences greater than 7 are considered ‘large’ (Spiegelhalter, Best, Carlin, & Van Der Linde, 2002).

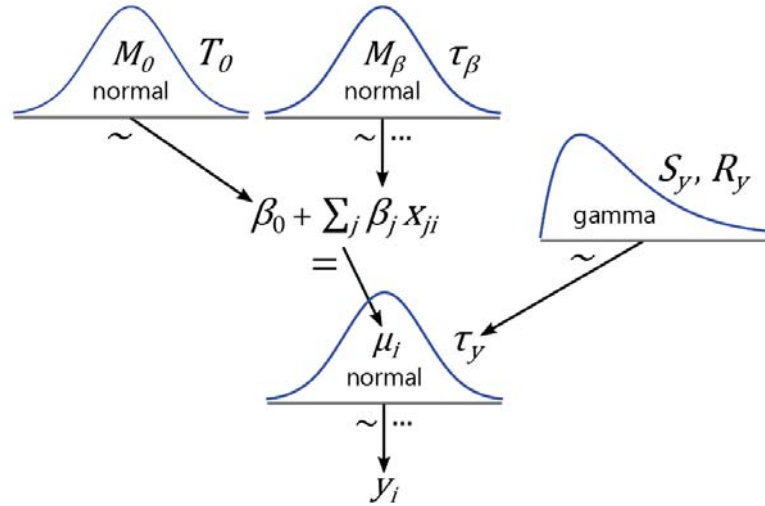


Figure 2.2: Hierarchical diagram for multiple linear regression

Bayesian p -values

Bayesian p -values are not interpreted in a similar fashion to frequentist p -values (i.e., as a statistic uniformly distributed under the null hypothesis)³ but rather as posterior probabilities comparing replicated data to observed data (Gelman, 2007). One advantage of the MCMC simulations used to estimate the posterior sampling distribution is that they facilitate the generation of data sets y^{rep} that could have arisen from the model generated by the observed data y . Bayesian p -values are calculated as $p(y^{\text{rep}}|y)$, which probability distribution is often referred to as the posterior predictive distribution given that y^{rep} are equivalent to predictions. Thus, values of p close to .5 suggest that the model parameters generated data y^{rep} that are interchangeable with the observed data y while values close to 0 or 1 would suggest model misspecification. While Bayesian p -values provide a useful, informal tool for identifying possible model misspecification, they should not be considered a formal decision analysis tool due to a number of mathematical limitations such as having non-uniform distributional properties (see Metcalf, Stephens, Rees, Louda, & Keeler, 2009). In other words, Bayesian p -values are useful for identifying possible model misspecification, but should not be used as the basis for rejecting models or favoring one model over another.

³Andrew Gelman refers to traditional p -values as u -values to reflect such assumptions (Gelman, 2007).

Bayesian Mediation Analysis

In order to assess whether partner conflict, partner problem-solving style, child-parent conflict, parental depression, or parental style act as mediators between parental drinking motives and their children's adjustment, Bayesian mediation analysis was implemented as recommended by Yuan and MacKinnon (2009). These authors note that Bayesian mediation analysis is superior to frequentist mediation analysis, especially when dealing with small sample sizes. Bayesian inference facilitates the construction of credibility intervals for mediation effects, which are exact in finite samples. Posterior credibility intervals "do not impose restrictive normality assumptions on sampling distributions of estimates and do not rely on large sample approximations" (Yuan & MacKinnon, 2009, p. 301). This is particularly relevant when dealing with mediation because it is well known that the sampling distribution of mediation effects is not normal (e.g., Bollen & Stine, 1990; MacKinnon & Dwyer, 1993; Stone & Sobel, 1990).

Descriptives and Associations Among Variables

Descriptive statistics for study variables including means, medians, modes, standard deviations, skewness, kurtosis, minimum, maximum, ranges, Chronbach's α , and Guttman's λ_6 ¹ are included in Table 3.1 and Table 3.2. In the current study, the DMQ exhibited good internal consistency with the Social Motives scale having the highest degree of consistency (*mothers*: $\alpha = 0.9$, $\lambda_6 = 0.93$; *fathers*: $\alpha = 0.92$, $\lambda_6 = 0.91$) followed by the Coping Motives scale (*mothers*: $\alpha = 0.86$, $\lambda_6 = 0.85$; *fathers*: $\alpha = 0.83$, $\lambda_6 = 0.87$), and the Enhancement Motives scale (*mothers*: $\alpha = 0.75$, $\lambda_6 = 0.77$; *fathers*: $\alpha = 0.85$, $\lambda_6 = 0.85$). These ratings of internal consistency are comparable to other studies utilizing the DMQ (e.g., Adams, Kaiser, Lynam, Charnigo, & Milich, 2012; Coskunpinar & Cyders, 2012; V. V. Grant, Stewart, & Mohr, 2009; E. Kuntsche, Stewart, & Cooper, 2008; LaBrie, Ehret, Hummer, & Prenovost, 2011; Lyvers, Hasking, Hani, Rhodes, & Trew, 2010; MacLean & Lecci, 2000; Rousseau, Irons, & Correia, 2011).

Ten fathers and four mothers had total AUDIT scores in the hazardous drinking range, while only two fathers and two mothers had scores in the alcohol dependence range. Moreover, the consequences factor of the AUDIT (as measured by questions 4 through 10) tended to be quite low with median values of 0 for both parent genders. The AUDIT Total and Consequences scales exhibited adequate internal consistency within the the present study for both mothers (*Total*: $\alpha = 0.78$, $\lambda_6 = 0.93$; *Consequences*: $\alpha = 0.88$, $\lambda_6 = 0.95$) and fathers (*Total*: $\alpha = 0.75$, $\lambda_6 = 0.86$; *Consequences*: $\alpha = 0.77$, $\lambda_6 = 0.84$) consistent with other empirical reports (e.g., Allen et al., 1997; O'Hare & Sherrer, 1999); however, the AUDIT consumption score exhibited poor internal consistency for both mothers ($\alpha = 0.48$, $\lambda_6 = 0.53$) and fathers ($\alpha = 0.15$, $\lambda_6 = 0.09$).

The distributions of internalizing and externalizing scores are presented in Figure 3.1. Most parents rated their children in the average range for externalizing and internalizing problems (75% and 64.9% of parents respectively); however, there were still a substantial percentage of parents who rated their child as either in the borderline clinical range (10.8% for externalizing and 15.3% for internalizing) or in the clinical range (14.2% for externalizing and 19.8% for internalizing). Parents' ratings of internalizing and externalizing symptoms were correlated, $r = 0.44$, 95% *HDI*[0.34, 0.53]. Agreement between parents' ratings of the same child appeared to be moderately correlated for internalizing ratings ($r = .32$, 95% *HDI*[.18, .47]) and strongly correlated for externalizing

¹Note that Guttman's λ_6 is an alternative to Chronbach's α , which considers the variance in each item that can be accounted for by the linear regression of all other items (Revelle, 2012). λ_6 is more robust than Chronbach's α and is sensitive to the 'lumpiness' of a test.

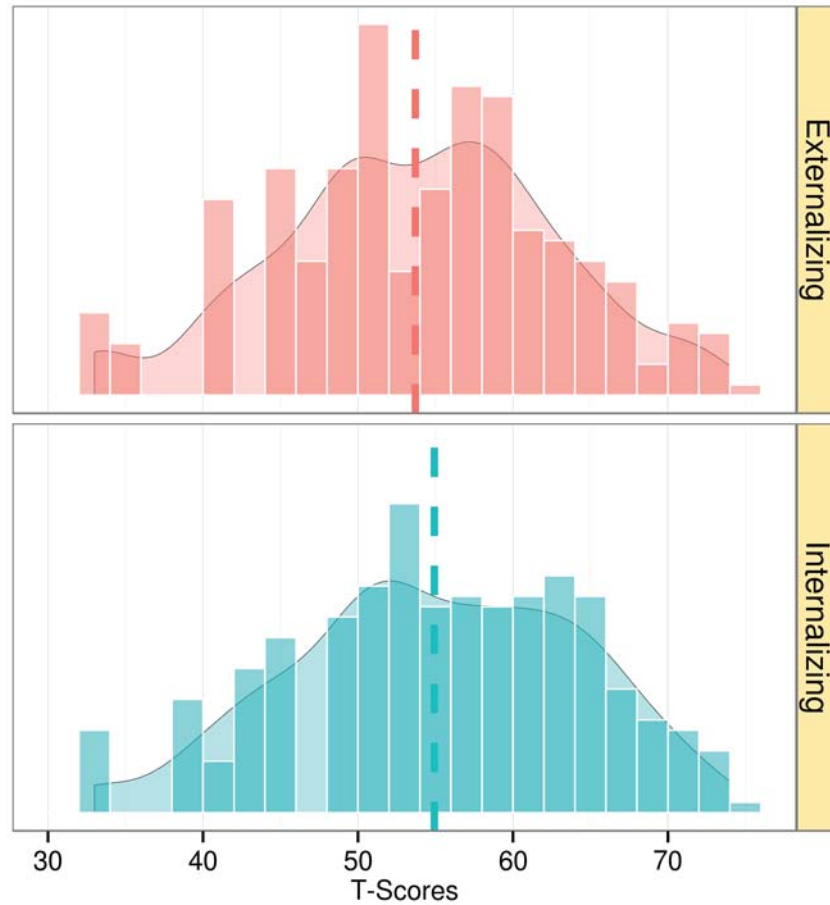
Table 3.1: Descriptive Statistics for Main Study Variables

Scale	<i>min</i>	<i>max</i>	<i>mean</i>	<i>median</i>	<i>mode</i>	<i>SD</i>	<i>skewness</i>	<i>kurtosis</i>	α	λ_6	$\bar{r}_{\text{inter-item}}$
Demographics											
Mother's Age	22	58	38.29	38	38	7.11	0.14	-0.47			
Father's Age	24	59	39.98	40	37	6.86	0.25	-0.04			
Child's Age	6	12	8.76	9	7	1.95	0.14	-1.23			
Family Income (\$1,000s)	0	203	64.6	60.5	58	37.3	1	1.7			
Mother's Education (years)	11	20	15.78	16	16	2.26	-0.23	-0.83			
Father's Education (years)	9	20	15.52	16	16	2.69	-0.2	-1.12			
Number of Children in Family	1	5	1.79	1	1	1.01	1.17	0.54			
Years Married/Cohabiting	2	31	13.58	14	16	6.06	0.27	0.15			
Parental Drinking Motives (DMQ)											
Mother's Coping Motives	1	4.8	1.38	1	1	0.7	2.46	6.45	0.86	0.85	0.56
Mother's Enhancement Motives	1	5.4	1.86	1.8	1	0.83	1.08	1.6	0.75	0.77	0.36
Mother's Social Motives	1	5.8	2.56	2.6	2.6	1.1	0.49	-0.11	0.9	0.93	0.66
Father's Coping Motives	1	4.2	1.39	1	1	0.64	1.85	3.21	0.83	0.87	0.47
Father's Enhancement Motives	1	6	2.1	1.8	1	1.04	1.11	0.98	0.85	0.85	0.54
Father's Social Motives	1	6	2.55	2.6	1	1.22	0.46	-0.45	0.92	0.91	0.69
Parent's Alcohol Problems (AUDIT)											
Mother's Consumption	0	6	1.73	2	1	1.29	0.96	1.13	0.48	0.53	0.31
Mother's Consequences	0	21	0.42	0	0	1.95	8.58	83.78	0.88	0.95	0.55
Mother's Total	0	24	2.13	2	1	2.66	4.69	31.95	0.78	0.93	0.39
Father's Consumption	0	8	2.4	2	2	1.92	1.15	0.98	0.61	0.64	0.38
Father's Consequences	0	11	0.53	0	0	1.72	4.25	19.37	0.78	0.83	0.43
Father's Total	0	18	2.89	2	2	3.14	2.38	6.81	0.75	0.86	0.35
Child Adjustment (CBCL)											
Mother's Report of Internalizing Problems	33	72	55.42	56	52	8.89	-0.23	-0.29	0.76	0.83	0.11
Mother's Report of Externalizing Problems	33	72	53.44	55	59	9.27	-0.32	-0.39	0.84	0.88	0.15
Father's Report of Internalizing Problems	33	74	54.42	54	52	9.62	-0.18	-0.79	0.79	0.84	0.12
Father's Report of Externalizing Problems	33	74	53.97	53.5	44	8.84	0.03	-0.27	0.86	0.92	0.18

Table 3.2: Descriptive Statistics for Mediator Variables

Scale	min	max	mean	median	mode	SD	skewness	kurtosis	α	λ_6	$\bar{r}_{\text{inter-item}}$
Conflicts and Problem-Solving Scales (CPS)											
Mother's Marital Conflict	2	11	5.93	6	6	1.95	0.18	-0.26	0.66	0.5	0.5
Father's Marital Conflict	2	11	6.01	6	6	2.02	0.33	-0.37	0.75	0.6	0.6
Mother's Collaborative Problem Solving	2.5	4	3.64	3.67	4	0.37	-1.02	0.47	0.79	0.78	0.39
Father's Collaborative Problem Solving	1.83	4	3.56	3.67	4	0.4	-1.11	1.71	0.76	0.77	0.36
Mother's Aggressive Problem Solving	1.25	3.88	2.48	2.5	2.62	0.51	-0.08	-0.29	0.82	0.83	0.37
Father's Aggressive Problem Solving	1.12	3.5	2.34	2.38	2.12	0.5	-0.18	-0.57	0.8	0.81	0.34
Parent-Child Conflict Tactics Scale (CTSPC)											
Mother-Child Physical Conflict	0.25	5	1.92	1.62	1.5	1.01	0.85	0.31	0.41	0.36	0.15
Father-Child Physical Conflict	0.25	6	1.96	1.75	1.25	1.07	1.05	1.02	0.4	0.39	0.16
Mother-Child Verbal Conflict	0.8	5.2	3.05	3.1	3.4	0.97	0.05	-0.64	0.45	0.61	0.17
Father-Child Verbal Conflict	0.8	5.6	2.91	2.8	2.2	1.05	0.3	-0.53	0.32	0.52	0.1
Center for Epidemiologic Studies Depression Scale (CES-D)											
Mother's Depression	1	3.05	1.42	1.3	1.1	0.4	1.74	3	0.89	0.92	0.29
Father's Depression	1	3.05	1.41	1.3	1	0.41	1.66	2.69	0.89	0.93	0.3
Parent Report of Parent Behavior Inventory (PRPBI)											
Mother's Warmth	1	2.06	1.33	1.28	1.22	0.23	0.77	0.05	0.77	0.83	0.18
Father's Warmth	1	2.28	1.43	1.39	1.39	0.25	0.71	0.76	0.77	0.83	0.18
Mother's Behavioral Control	2.25	3	2.85	2.88	3	0.15	-1.33	1.86	0.69	0.72	0.11
Father's Behavioral Control	1.94	3	2.85	2.94	2.94	0.2	-2.28	5.94	0.83	0.85	0.22
Mother's Psychological Control	2	2.93	2.64	2.67	2.8	0.2	-0.71	-0.07	0.6	0.67	0.1
Father's Psychological Control	1.6	3	2.61	2.67	2.8	0.27	-1.13	1.03	0.77	0.81	0.19

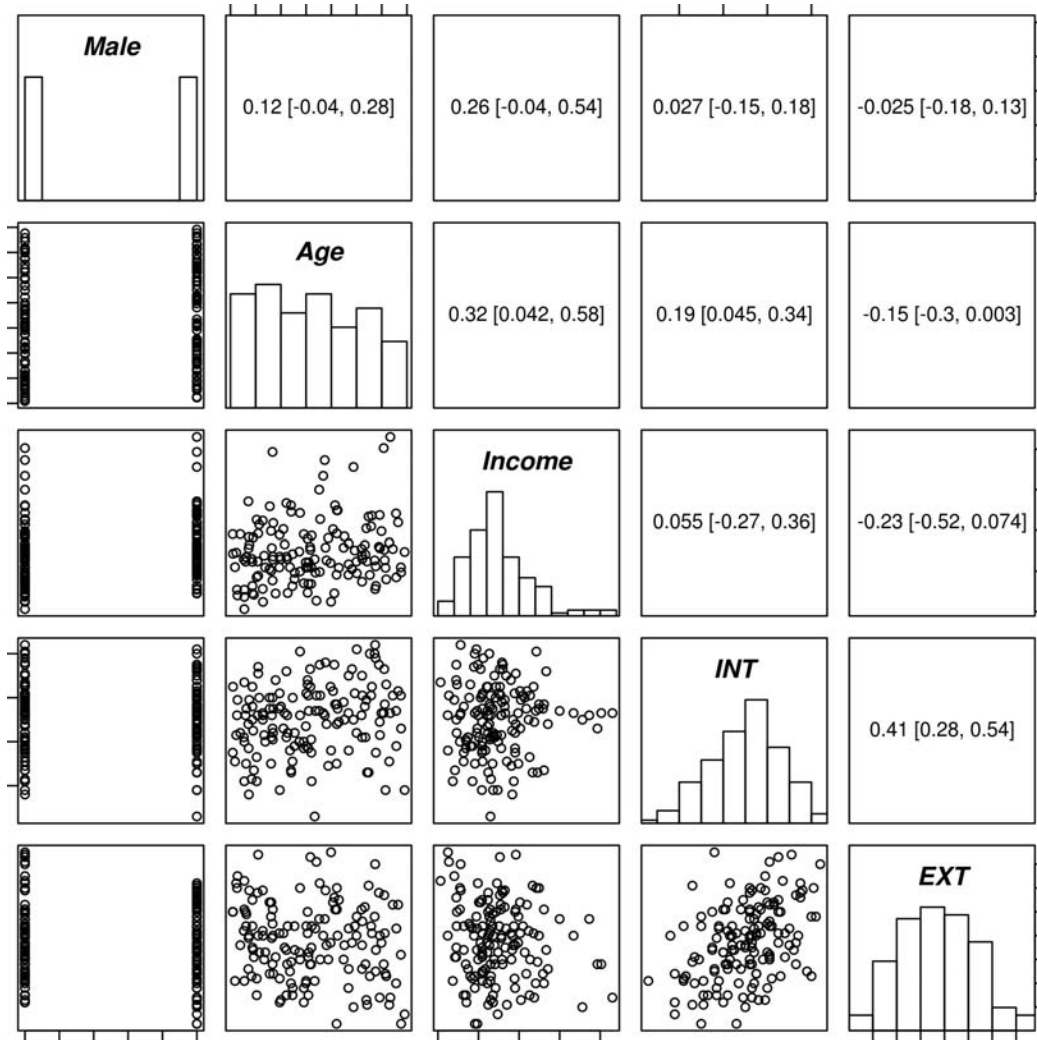
Figure 3.1: Histograms and Density Estimates of Children's Adjustment



ratings ($r = .47$, 95% HDI[.35, .60]). Percent agreement for clinical classifications followed a similar pattern with higher agreement for externalizing psychopathology (74.63%) than internalizing psychopathology (55.97%). All additional analyses were conducted after averaging ratings of internalizing and externalizing symptoms across parents. The Externalizing Problems scale exhibited slightly higher internal consistency (*mothers*: $\alpha = 0.84$, $\lambda_6 = 0.88$; *fathers*: $\alpha = 0.86$, $\lambda_6 = 0.92$) than the Internalizing Problems scale (*mothers*: $\alpha = 0.76$, $\lambda_6 = 0.83$; *fathers*: $\alpha = 0.79$, $\lambda_6 = 0.84$), which is consistent with previous research (e.g., Fanti & Henrich, 2010).

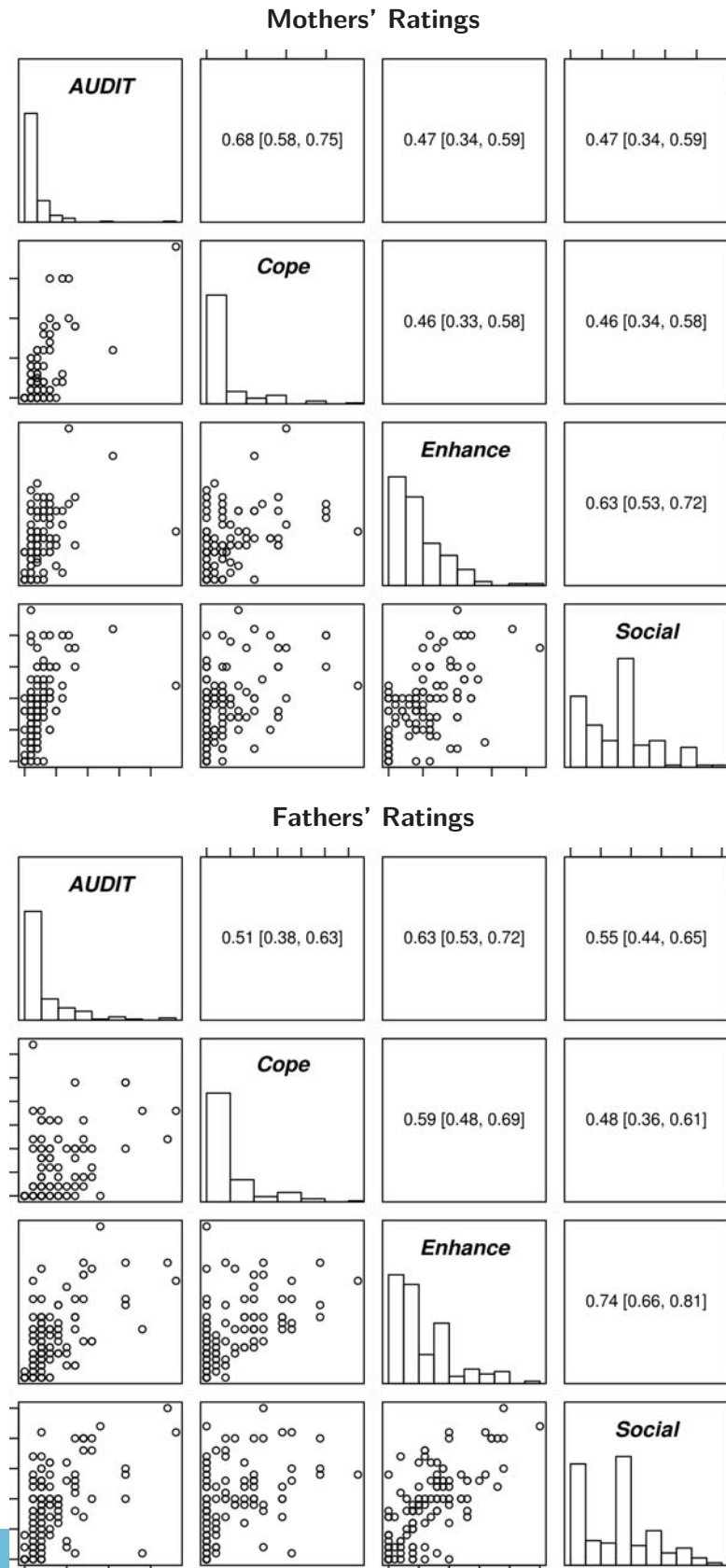
Correlations between demographic variables and internalizing and externalizing symptoms are presented in Figure 3.2 while correlations between alcohol measures are presented separately for each parent in Figure 3.3. Ratings of internalizing and

Figure 3.2: Correlation plot for demographic variables and children’s adjustment



externalizing symptoms did not differ as a function of child gender, minority status, or family income; however, child age was positively correlated with internalizing symptoms, $r = .19$, 95% HDI[.04, .34], and inversely correlated with externalizing symptoms, $r = -.15$, 95% HDI[-.3, .003]. Mothers and fathers’ AUDIT scores were not reliably correlated to their children’s internalizing symptoms ($r = .07$, 95% HDI[-0.1, 0.23] and $r = .02$, 95% HDI[-.14, .18]) or externalizing symptoms ($r = .04$, 95% HDI[-0.11, 0.20] and $r = -.08$, 95% HDI[-.23, .10] respectively).

Figure 3.3: Correlation plots for drinking variables separated by parent



Hierarchical Regression Analyses

In order to test whether parental drinking motives provide meaningful gains in predicting their children's internalizing and externalizing symptoms, data were modeled as a series of hierarchical multiple regressions and then analyzed using Bayesian inferential procedures (Kruschke, 2010a). Demographic variables including family income, child's age, gender, and racial minority status were controlled for by entering them in the initial step of the analyses. The second step included the two components of the AUDIT: alcohol consumption (AUDIT-consumption) and negative consequences (AUDIT-consequences). In the third and final step of the model, coping, enhancement, and social drinking motives were added. Mothers' and fathers' alcohol use patterns and motives were analyzed separately. Because internalizing and externalizing symptoms as measured by the CBCL were also analyzed separately, a total of four sets of models were analyzed. Results are reported in Table 3.3 along with deviance information criterion values (DIC), and Bayesian p -values for each step in the model.

The pattern of findings was mixed. DIC values were compared for each step in each model. In no case did the inclusion of AUDIT scores substantially improve the model fit. For mothers, the addition of drinking motives led to substantial improvement in model fit for internalizing problems ($\Delta DIC = 8.6$) and a negligible improvement in fit for externalizing problems ($\Delta DIC = 1.3$). For fathers, the addition of drinking variables led to substantially worse model fit ($\Delta DIC = -6.6$ and -7.2 for internalizing and externalizing problems respectively) due to an increase in the number of effective parameters and a negligible increase in model fit. For ease of interpretation, frequentist analyses were also conducted on the models revealing effects sizes of ΔR^2 s of .096 ($p = .002$) for mothers' drinking motives on internalizing problems and .064 ($p = .022$) for mothers' drinking motives on externalizing problems. The equivalent ΔR^2 s for fathers' drinking motives were respectively .027 ($p = .29$) and .031 ($p = .22$) for internalizing and externalizing problems.

Mothers' self-reported enhancement motives were inversely related to their children's internalizing symptoms ($B = -2.98$, 95% HDI[-4.98, -0.72]) and externalizing symptoms ($B = -2.55$, 95% HDI[-4.80, -0.45]) while mothers' social drinking motives were positively related to their children's internalizing symptoms ($B = 2.91$, 95% HDI[1.33, 4.51]) and externalizing symptoms ($B = 2.04$, 95% HDI[0.34 3.60]). On the other hand, mothers' self-reported coping motives were not related to either internalizing symptoms ($B = 0.44$, 95% HDI[-2.03, 2.94]) or externalizing symptoms ($B = 1.61$, 95% HDI[-1.17, 4.18]). Fathers' self-reported drinking motives (coping, enhancement, and social) were

not related to their children's internalizing or externalizing symptoms (see Table 3.3).

Mediator Analyses

Given the failure to identify any relation between paternal drinking motives and children's adjustment, mediator analyses were restricted to maternal drinking motives only. Potential mediators were identified by regressing them upon the full model used above (i.e., with demographic variables, AUDIT scores, and drinking motives) using a similar set of minimally informed priors. The following variables were tested: partner conflict, partner collaboration, and partner aggression from the CPS, child-parent physical aggression and verbal aggression from the CTSPC, depression as measured by the CES-D, and parental warmth, behavioral control, and psychological control as measured by the PRPBI. In the majority of cases maternal drinking motives were not predictive of these variables; however, there were a couple of notable exceptions. Maternal enhancement drinking motives were positively related to collaborative partner problem-solving ($B = 0.114$, 95% HDI[0.02, 0.21]) and negatively related to maternal depression ($B = -0.113$, 95% HDI[-0.22, 0.02]). Also, maternal coping drinking motives were positively related to maternal depression ($B = 0.250$, 95% HDI[0.13, 0.37]) and verbal child-parent conflict ($B = 0.372$, 95% HDI[0.06, 0.69]).

These three variables (maternal collaborative problem-solving, depression, and child-parent verbal conflict) were then tested by augmenting them to the full models predicting children's internalizing and externalizing symptoms. Only maternal depression was predictive of children's internalizing symptoms ($B = 3.91$, 95% HDI[0.36, 7.14]). However, all three variables were predictive of externalizing symptoms (depression: $B = 5.01$, 95% HDI[1.55, 8.58]; collaborative problem-solving: $B = -3.57$, 95% HDI[-7.10, -0.14]; verbal parent-child conflict: $B = 1.90$, 95% HDI[0.59, 3.19]).

Finally, mediation effect sizes ($\alpha\beta$) were examined using both Bayesian and frequentist analyses. For the Bayesian analyses (Yuan & MacKinnon, 2009), in no case were the mediation effects credibly different from zero. Frequentist analyses confirmed no significant mediating effects between maternal drinking motives and their children's adjustment (all p -values $> .05$).

Table 3.3: Regression analyses of parental drinking motives on children's adjustment

Variable	Internalizing Symptoms						Externalizing Symptoms					
	Mothers			Fathers			Mothers			Fathers		
	B	95% <i>HDI</i>	SE	B	95% <i>HDI</i>	SE	B	95% <i>HDI</i>	SE	B	95% <i>HDI</i>	SE
Step 1												
Intercept	55.21	[54.03, 56.44]	0.62	54.64	[53.42, 55.97]	0.64	53.78	[52.58, 55.07]	0.65	54.66	[53.44, 55.92]	0.64
Age	0.87	[0.25, 1.51]	0.33	0.61	[-0.09, 1.28]	0.35	-0.51	[-1.17, 0.15]	0.35	0.60	[-0.12, 1.29]	0.36
Gender ^a	0.58	[-1.96, 3.03]	1.30	0.19	[-2.49, 2.62]	1.30	0.11	[-2.49, 2.76]	1.36	0.17	[-2.22, 2.68]	1.29
Race ^b	-0.97	[-4.28, 2.50]	1.74	-0.78	[-4.10, 2.51]	1.67	-0.25	[-3.81, 3.27]	1.80	-0.81	[-3.82, 2.65]	1.68
Family Income	0.01	[-0.03, 0.04]	0.02	0.01	[-0.02, 0.04]	0.02	-0.02	[-0.05, 0.02]	0.02	0.01	[-0.02, 0.04]	0.02
<i>DIC; Bp</i>		1023.6; .509			981.9; .507			1026.1; .506			982.3; .516	
Step 2												
AUDIT-consumption	-0.49	[-1.91, 0.79]	0.69	-0.17	[-1.15, 0.79]	0.49	-1.14	[-2.40, 0.36]	0.69	-0.18	[-1.11, 0.81]	0.49
AUDIT-consequences	0.46	[-0.30, 1.27]	0.41	-0.19	[-1.11, 0.68]	0.46	0.05	[-0.76, 0.89]	0.42	-0.18	[-1.13, 0.65]	0.46
<i>DIC; Bp</i>		1024.6; .521			985.8; .510			1027.7; .502			985.8; .506	
Step 3												
Coping	0.44	[-2.03, 2.94]	1.26	1.42	[-1.21, 4.02]	1.33	1.61	[-1.17, 4.18]	1.34	1.41	[-1.26, 3.96]	1.34
Enhancement	-2.98	[-4.98, -0.72]	1.09	-0.36	[-2.54, 1.66]	1.07	-2.55	[-4.80, -0.45]	1.11	-0.40	[-2.43, 1.83]	1.08
Social	2.91	[1.33, 4.51]	0.82	0.97	[-0.83, 2.64]	0.89	2.04	[0.34, 3.60]	0.84	0.99	[-0.83, 2.68]	0.89
<i>DIC; Bp</i>		1015; .545			988.5; .522			1024.8; .523			989.5; .508	

Note. ^aGirls = 0, boys = 1; ^bOther = 0, Caucasians = 1; *DIC* = deviance information criterion; *Bp* = Bayesian p-value; *HDI* = highest density interval.

Table 3.4: Longitudinal analysis of parental drinking motives on children's adjustment

Variable	Internalizing Symptoms						Externalizing Symptoms					
	Mothers			Fathers			Mothers			Fathers		
	B	95% <i>HDI</i>	SE	B	95% <i>HDI</i>	SE	B	95% <i>HDI</i>	SE	B	95% <i>HDI</i>	SE
Step 1												
Intercept	0.06	[-4.00, 4.14]	2.05	-0.03	[-3.59, 3.92]	1.89	-0.02	[-2.81, 2.50]	1.32	0.04	[-3.56, 3.67]	1.82
Age	0.03	[-0.77, 0.73]	0.37	-0.01	[-0.65, 0.75]	0.35	-0.57	[-1.42, 0.08]	0.38	-0.34	[-1.06, 0.29]	0.34
Gender ^a	-3.50	[-12.92, 5.90]	4.78	4.40	[-4.22, 13.01]	4.33	2.45	[-4.11, 8.02]	2.99	6.35	[-2.03, 14.59]	4.23
Race ^b	-15.05	[-30.19, -0.11]	7.52	-1.95	[-14.46, 11.88]	6.68	-1.12	[-8.14, 6.64]	3.68	2.29	[-10.69, 14.78]	6.54
Family Income	0.06	[-0.05, 0.19]	0.06	-0.02	[-0.12, 0.09]	0.05	0.05	[-0.03, 0.13]	0.04	0.06	[-0.04, 0.17]	0.05
<i>DIC; Bp</i>		186.9; .548			182.1; .541			182.8; .527			193; .541	
Step 2												
T1 Symptoms	-4.54	[-10.56, 1.51]	3.04	0.35	[-4.85, 6.51]	2.88	0.18	[-1.01, 1.44]	0.62	0.80	[-4.60, 6.34]	2.75
<i>DIC; Bp</i>		186.9; .540			176.1; .562			160.6; .536			180.8; .537	
Step 3												
T1 AUDIT	-4.54	[-10.56, 1.51]	3.04	0.35	[-4.85, 6.51]	2.88	0.18	[-1.01, 1.44]	0.62	0.80	[-4.60, 6.34]	2.75
<i>DIC; Bp</i>		186.7; .534			181.7; .555			165.1; .540			182.3; .539	
Step 4												
T1 Coping	0.66	[-8.30, 10.87]	4.74	1.15	[-6.42, 9.88]	4.17	-1.70	[-9.78, 7.24]	4.25	2.41	[-5.78, 10.61]	4.20
T1 Enhancement	3.08	[-7.29, 12.27]	5.01	-2.13	[-11.96, 7.72]	4.93	0.46	[-2.92, 3.75]	1.69	-4.31	[-13.34, 4.95]	4.55
T1 Social	1.80	[-4.64, 7.48]	3.08	0.62	[-4.32, 5.97]	2.59	-0.57	[-4.45, 3.23]	1.95	-1.18	[-6.00, 4.78]	2.72
<i>DIC; Bp</i>		198.4; .525			193.4; .538			177.5; .544			193.6; .561	

Note. ^aGirls = 0, boys = 1; ^bOther = 0, Caucasians = 1; *DIC* = deviance information criterion; *Bp* = Bayesian p-value; *HDI* = highest density interval.

Additional Analyses

Seeking to clarify the relation between parental drinking motives and child internalizing and externalizing problems, we conducted a series of additional statistical analyses. First, we tested possible interactions among drinking motive and between drinking motives and alcohol consumption by including the cross product of the relevant variables as an additional step in our model (i.e., coping \times enhancement, coping \times social, enhancement \times social, coping \times AUDIT-consumption, etc.). Results suggested no interaction effects with interaction terms leading to decreased model fit. Second, we looked for the presence of curvilinear relations by using a variety of power functions on the drinking motive variables—none of which led to any noticeable gains in model fit. Finally, we conducted longitudinal analyses on a subset of the data.

A small number of participants in the study had participated in an earlier study (T1) in our lab that included measures of alcohol use problems (i.e., AUDIT) and drinking motives (i.e., DMQ). Overall, 24 children participated in both studies. Similar to our primary analyses above, a series of hierarchical regression models were generated and then evaluated using Bayesian data analytic techniques. Each set of models consisted of demographic variables (step 1), internalizing/externalizing symptoms measured at time 1 (T1; step 2), T1 AUDIT scores (step 3), and T1 drinking motives (step 4). Results are presented in Table 3.4. T1 AUDIT and drinking motive scores did not improve the fit of any of the models predicting internalizing/externalizing problems at T2.

Overview

Researchers examining the impact of parental drinking on children's adjustment have typically treated drinking behavior as a unitary phenomenon; however, there is ample evidence to suggest that drinking behavior is highly dependent upon contextual and motivational factors. In the first ever study of the influence of parental drinking motives on their children's psychological adjustment, 288 parents completed questionnaires measuring their own alcohol use, drinking motives, familial conflict, depression, parenting behavior, and their children's adjustment. We made three main hypotheses: (a) drinking motives would predict children's adjustment, (b) coping motives would be associated with worse outcomes than enhancement and social drinking motives, and (c) the relation between parental drinking motives and children's adjustment would be mediated by family conflict, parental depression, and parenting style. Our first and third hypotheses were partially supported by our findings; however, our second hypothesis was not.

Do Parental Drinking Motives Predict Children's Adjustment?

Our hypothesis that parental drinking motives would provide incremental predictive ability of children's adjustment over a measure of problematic drinking received mixed support. Specifically, mothers' drinking motives were found to account for some of the variance in their children's internalizing and externalizing problems while fathers' drinking motives were found to be unrelated to their children's adjustment. Maternal drinking motives proved to be much more predictive of children's adjustment than maternal problem drinking, which, contrary to expectations was not predictive of adjustment problems in the current study. The finding that father's drinking behaviors and motivations did not relate to ratings of their children's internalizing and externalizing symptoms was somewhat surprising. There is some evidence to suggest that mother's psychopathology may be more important in predicting children's internalizing problems than father's psychopathology (Connell & S. H. Goodman, 2002); however, previous research has suggested a greater impact of father's substance abuse than mothers' substance abuse on children's adjustment (see Connell & S. H. Goodman, 2002). It is not clear how to square our findings with the growing literature recognizing the importance of father's influence on their children's adjustment (e.g., Ang, 2006; Kane, Garber, et al., 2004). One possibility is that our study was limited by a relatively small amount of hazardous drinkers. It is possible that a large number of fathers who were classified as "light drinkers" masked the detrimental impact of fathers who were classified as "heavy

drinkers” (the sample only included 2 fathers classified as “alcohol dependent” on the AUDIT and only 10 classified as “hazardous drinkers”).

Are Coping Drinking Motives the Most Harmful?

Our second hypothesis was that coping drinking motives would be the strongest predictor of children’s adjustment problems followed by by enhancement and social drinking motives. This hypothesis was not supported by our findings. In fact, we found that parental coping motives were unrelated to children’s adjustment even when accounting for possible mediators such as parental depression and parent-child conflict. Mothers’ social and enhancement drinking motives were related to children’s adjustment; however, counter-intuitively, self-reported maternal enhancement motives were *positively* related to their children’s adjustment. Thus, the class of drinking motives that we predicted to be the most benign — social motives — was actually the strongest predictor of negative outcomes. We discuss this finding in more detail below while discussing the clinical implications of our study’s results.

What Mediates the Relation?

We posited that the relation between parents’ drinking motives and their children’s adjustment would be mediated by family conflict (including both parent-parent conflict and parent-child conflict), conflict resolution approach, parental depression, and parenting style. Restricting our analyses to maternal drinking motives, we found that maternal enhancement drinking motives predicted increased collaborative conflict resolution and decreased maternal depression. Furthermore, maternal collaborative conflict resolution was associated with less internalizing problems while maternal depression was associated with more internalizing problems. While the indirect mediation term (i.e., $\alpha\beta$) was not credibly different from zero for these two variables, our investigation raises the possibility that maternal collaborative conflict resolution and maternal depression are important intervening variables between maternal drinking motives and children’s internalizing psychopathology.

One possible explanation for the positive link between maternal enhancement drinking motives and children’s adjustment is enhancement motives’ association with *approach motivation*. Approach motivation can be defined as “the energization of behavior by, or the direction of behavior toward, positive stimuli (objects, events, possibilities)” (Elliot, 2006, p. 112). Consistent with this hypothesis, our meta-analysis of the Drinking Motives Questionnaire (see Appendix 4.4) found some evidence for a limited relation between

enhancement drinking motives and extroversion ($r = .13$, 95% *HDI*[.05, .21]) as well as positive affect ($r = .12$, 95% *HDI*[-.03, .30]). Approach motivations have also been shown to be inversely related to depression (Dickson & MacLeod, 2004a, 2004b; Sideridis, 2005), which helps explain the inverse relation we observed between maternal enhancement motives and maternal depression. Moreover, the ‘energization of behavior’ towards positive possibilities would explain the positive relationship we observed between enhancement drinking motives and higher levels of collaborative conflict resolution. Ostensibly, collaborative conflict resolution efforts may be motivated by increased sensitivity to the possible rewards of collaborative as opposed to aggressive or avoidance conflict resolution tactics.

It is also possible that enhancement drinking motives lead to decreased sensitivity towards the risks of engagement. Our meta-analysis found that enhancement motives correlate positively with both sensation-seeking ($r = .35$, 95% *HDI* [.24, .46]) and risky behavior ($r = .16$, 95% *HDI* [.06, .27]; Appendix 4.4).¹ Previous research has linked parental behavioral inhibition (i.e., social anxiety and avoidance) to increased rates of children’s problem behaviors (Rettew, Stanger, McKee, Doyle, & Hudziak, 2006; Rinaldi & Howe, 2012; L. R. Williams et al., 2009). On the other hand, authoritative parenting, which is marked by both high levels of engagement and responsibility, has been repeatedly linked to positive adjustment outcomes in children (Amato & Gilbreth, 1999; Paulussen-Hoogeboom, Stams, Hermanns, Peetsma, & van den Wittenboer, 2008; Rinaldi & Howe, 2012; Suldo & Huebner, 2004; L. R. Williams et al., 2009). Thus, the potential effects associated with maternal enhancement drinking motives may lead to better children’s outcomes due to a corresponding increase in parental engagement and decrease in parental avoidance.

¹A decreased sensitivity to negative cues may even extend to ratings of their children’s behaviors. Just as depressed mothers have been shown to overreport problems in their children (Chilcoat, Breslau, et al., 1997; Clarke-Stewart, Allhusen, McDowell, Thelen, & Call, 2003; Gartstein, Bridgett, Dishion, & Kaufman, 2009; Najman, G. M. Williams, et al., 2000; Najman, G. Williams, et al., 2001), it is possible that enhancement motives may be associated with underreporting of children’s problems. The evidence for this latter hypothesis will have to be assessed in a future study.

Clinical Implications

“It is 2:30 a.m., Mom and Dad are still staggering around, screaming at each other. The last guest just left. I helped shove her out the door. Before leaving she managed to drop her drink in the vestibule and I had to clean up the broken glass. My parents were too smashed to notice.

I am writing because I know I won't be able to sleep until dawn. After a party like this Mom and Dad fight all night. She accuses him of making passes at other women and he says she is crazy and he is going to put her in a mental institution. . .”

— Landers, 1967

The above quotation comes from a young man who wrote to an advice columnist complaining about his “social drinker” parents. The recounting of his parents' intoxicated behavior provides anecdotal evidence that social drinking motives are not always innocuous and may in fact be quite detrimental to children's psychological adjustment. There has long been the realization that to truly understand how alcohol influences human behavior, we must take into account sociocultural factors (Heath, 1981). One of the most unexpected findings in our study was that maternal social drinking motives were the *strongest* predictor of adjustment problems. Our meta-analysis of the DMQ (Appendix 4.4) suggests that social drinking motives may be more harmful than previously thought. Not only are social drinking motives strongly correlated to both drinking quantity and frequency, they are more highly correlated to binge drinking/heavy episodic drinking than coping motives ($r = .38$, 95% HDI[.32, .44]) versus $r = .24$, 95% HDI[.20, .29]). Social drinking motives are the most prevalent type of drinking motive (E. Kuntsche, Knibbe, Gmel, & Engels, 2006) and are less likely to be coupled with acknowledgement that alcohol impairs one's functioning. One recent study found that drinking in the context of social facilitation was significantly predictive of alcohol abuse while drinking in other contexts (e.g., emotional pain, family, and peer-acceptance) was not predictive of alcohol abuse after accounting for the influence of social facilitation (Beck, Caldeira, Vincent, & Arria, 2013).

Social drinking motives have recently been highlighted as a neglected target for treatment of alcohol use disorders (Van Damme et al., 2013). Our findings suggest that social drinking motives, *especially maternal social drinking motives*, may be important to address as intervention targets when young children remain in the home. One way in

which social motives could be addressed within a clinical context is by challenging perceived subjective norms for consuming alcohol (see A. D. Berkowitz, 2005). Previous interventions have had some success in reducing drinking behavior by correcting exaggerated norms of alcohol consumption (Kypri et al., 2004); however, norms of consumption rates may not be as important as perceived injunctive norms supporting alcohol use (e.g., Trockel, Williams, & Reis, 2003) and alcohol-related group identity norms (Rimal & Real, 2005) when it comes to predicting alcohol-related problems.

One useful target for norms-based interventions may be to focus on correcting misconceptions surrounding the term “social drinker.” This unfortunate classification is often used both popularly and in research to refer to either (a) someone who drinks in moderation, (b) someone who drinks with others, (c) someone who is socially motivated to drink, and (d) someone who behaves more socially while under the influence of alcohol. The confounding of drinking motives, context, quantity, and outcome is problematic because these facets of alcohol consumption behavior are not always positively correlated (see Appendix 4.4). This conflation can have a negative impact because being a “social drinker” has a responsible connotation that is contrasted with the irresponsible or pathological connotation associated with being classified as a “problem drinker” (Gusfield, 1984). Given the reduced level of stigmatization associated with being a social drinker (Kilty, 1981), it is not surprising that individuals with alcohol use disorders typically describe themselves as social drinkers despite their problematic alcohol use (Daepfen, 1999).

Limitations and Future Directions

Previous research has highlighted the limitations of parental and family influences in predicting adverse child outcomes (Mesman & Koot, 2001). However, before addressing the current study’s limitations, it is worth highlighting some of the study’s strengths. First, the study utilized Bayesian data analytic procedures which have numerous advantages over traditional NHST and its reliance on *p*-values (see *Rationale for Bayesian Approach* section above). Second, the sample size of 288 parents was slightly larger than average for a study of its kind. Third, we were able to examine the influence of both fathers’ and mothers’ drinking motives separately. Finally, we were able to analyze a variety of well-validated measures using multiple statistical techniques (e.g., mediator analysis, longitudinal analysis, etc.).

In spite of these strengths, the results of our study must be interpreted with consideration of its limitations. One such limitation is that we were not able to adequately

delineate the process by which drinking motives influence children's internalizing and externalizing behaviors. While we identified potential mediating variables between maternal enhancement drinking motives and children's positive adjustment including collaborative conflict resolution and maternal depression, the actual indirect effects for these variables were not credibly different from zero. Thus, the mechanisms by which maternal drinking motives influence their children's adjustment remain equivocal and necessitate further research into other possible mediators. While we tested a simple mediation model in the current study, the actual relation between drinking motives and parents' behavior, environment, and personality is likely complex and, in many cases, bidirectional and causally multiplicative (see Cui, Donnellan, & Conger, 2007). Future studies may provide additional insight by implementing more complex statistical analyses that take multiple mediators into account simultaneously and also factor in the measurement error associated with each construct. While the studies included in the present study generally had high internal reliabilities, there were some notable exceptions such as the AUDIT-consumption subscale. The ability of measurement error to attenuate the observed relation between corresponding constructs is well documented (e.g., Fan, 2003; Muchinsky, 1996; Schmidt & Hunter, 1996) and may have contributed to the relative absence of credible associations observed in the present study.

Other limitations stem from the non-representativeness of our sample. For example, we only included participants who had something resembling a nuclear family (i.e., couples who had been together for at least two years and a dependent child). The research base on the influence of family structure on children's adjustment is vast and, at times, discordant. While some studies have found that family structural differences are less important than family processes in predicting children's adjustment (Amato & Gilbreth, 1999; Lansford, Ceballo, Abbey, & Stewart, 2001; Vandewater & Lansford, 1998), there is evidence that fathers' involvement with their children can be very important in terms of their adjustment (e.g., Bauserman et al., 2002) and that early parental divorce is predictive of worse adjustment (e.g., Lansford, Malone, et al., 2006). Regardless of the impact of family structure, the requirement for participants to have a partner or spouse does limit the generalizability of the findings. Other concerns with our sample include generally low levels of parental problematic drinking (see above) as well as an average level of education considerably higher than the national average.

Conclusion

The current study is notable for a number of *'firsts'*: the first effort to apply Bayesian data analytic techniques to the study of drinking motives and the first empirical study of the relation between parents' drinking motives and the psychological adjustment of their children (as well as the first meta-analysis of the drinking motives questionnaire; see Appendix 4.4). We found that in the case of maternal drinking behavior, drinking motives were predictive of children's adjustment while drinking consumption and drinking problems were not. Admittedly, in some cases our hypotheses were wrong — drinking in order to cope was not uniquely maladaptive, and drinking for social reasons was not as benign as previously thought. Moreover, future research will need to determine whether our finding that maternal enhancement motives were inversely related to children's adjustment problems is reliable and to try to understand the processes that would lead to this seemingly counter-intuitive relation. In spite of some limitations, our findings may have important clinical implications. Researchers should reconsider the assumption that social drinking motives are less damaging than other types of drinking motives, and clinicians should not neglect social drinking motives while attempting to treat the harmful downstream effects of maternal alcohol use.

Appendix A: DMQ Meta-analysis

Meta-analytic techniques are incredibly useful for succinctly reviewing large amounts of research and work intuitively within a Bayesian framework. Specifically, Bayesian inference provides a coherent way to combine *prior* information with new data to derive a *posterior* estimate of one's parameters. Such a posterior is a natural and obvious prior for the next set of data. This daisy chaining process is often referred to as 'Bayesian updating.' Meta-analysis is both a logical application of Bayesian updating and an excellent way to derive an estimate of the prior probability of parameter values before analyzing one's own data. Our meta-analysis of drinking motives, presented below, was inspired by a desire to assess the support for Cox and Klinger's Motivational Model of Alcohol Use (1988) and assess the psychometric profile of the *Drinking Motives Questionnaire* (DMQ) and its derivatives (M. L. Cooper, 1994; M. L. Cooper, Russell, et al., 1992).

Hypotheses

First, we predicted that the intercorrelations between different drinking motives would be consistent with Cox and Klinger's four-factor motivational model with orthogonal motives having lower intercorrelations than adjacent motives. **Second**, we hypothesized that positively valenced drinking motives (i.e., *social* and *enhancement*) would be positively correlated with extroversion and negatively correlated with neuroticism, anxiety, and depression. We also expected the opposite pattern with respect to negatively valenced drinking motives (i.e., *coping* and *conformity*). **Third**, and finally, we hypothesized that coping motives would have the strongest correlation with alcohol-related problems and social motives would have the weakest. This last hypothesis stems from several researchers' arguments that coping motives are the most deleterious of all the drinking motives (Park & Levenson, 2002; Rousseau et al., 2011). For example, several studies have found significant associations between coping drinking motives and alcohol-related problems even after controlling for frequency and amount of alcohol consumed (Carey & Correia, 1997; Goldstein & Flett, 2009; V. V. Grant, Stewart, & Mohr, 2009; E. Kuntsche, Stewart, & Cooper, 2008; Lyvers et al., 2010; Park & Levenson, 2002; Simons, Correia, & Carey, 2000).

Methods

Drinking Motives Questionnaire (DMQ)

The original DMQ is a 15-item measure of the relative frequency of three categories of drinking motives including *social motives* (e.g., “because it helps you enjoy a party”), *enhancement motives* (e.g., “to get high”), and *coping motives* (e.g., “to forget your problems;” M. L. Cooper, Russell, et al., 1992). Responses are recorded on a 1–4 Likert scale where 1 = *never* and 4 = *almost always* and drinking motive subscale scores are derived by computing the average from the corresponding questions. Cooper later revised the measure (*Drinking Motives Questionnaire–Revised; DMQ-R*) by adding 5 questions designed to measure *conformity motives* (e.g., “so you won’t feel left out”) and changing the response scale from 1–4 to 1–5 (1994). More recently, Kuntsche and Kuntsche created the *Drinking Motive Questionnaire Revised Short Form (DMQ-R SF)*, which reduced the 20-item measure down to 12 items with 3 items measuring each type of motive (2009) and changed the response scale to 1–3. Finally, Blackwell and colleagues created the *Modified Drinking Motives Questionnaire–Revised (MDMQ-R)*, which divided the Coping subscale into two components (Coping-anxiety and Coping-depression) and added 8 additional items measuring the two types of coping motives (V. V. Grant, Stewart, O’Connor, et al., 2007).

Search Strategy

A comprehensive literature search was conducted for empirical studies utilizing the DMQ or one of its derivatives by way of the PsycINFO and OpenGrey data bases. To be considered for inclusion, studies needed to report either (a) the intercorrelations between different motives or (b) correlations between drinking motives and personality traits and/or drinking behaviors. In each of the covered databases, titles, subjects, and keywords were searched from the source’s inception through March 2013 using the following search terms: (*drink* and motiv* and questionn**) or *DMQ* or *DMQ-R*. Note that an asterisk here is a wild card character used in many scholarly databases that will match with any number of letters within the same words, thus facilitating the search of a word stem with multiple affixes. For example, *motiv** matches *motive*, *motives*, *motivations*, *motivating*, etc. Limiters were used to narrow the search results from PsycINFO. Specifically, results were filtered to include only empirical studies with human participants published in the English language.

Analyses

All effect sizes were converted to correlation coefficients (r ; Borenstein, 2009). In order to account for dependencies introduced by studies with multiple-endpoints, r s were aggregated according to procedures outlined by Gleser and Olkin (2009), which take into account the correlation between the multiple measures. When the correlation between measures was not available, a default correlation of .5 was used to aggregate within-study effects (see Wampold, Moody, Stich, Benson, & Ahn, 1997). Prior to the analyses, all r s underwent Fisher's variance stabilizing and normalizing transformation r -to- z (Fisher, 1921). Results were subsequently transformed back to r prior to interpretation. Studies were weighted by the inverse of their variances (Shadish & Haddock, 2009) and analyzed using a random-effects model. The following priors were used for the meta-analysis:

$$\theta \sim Normal(0,0.01)T(-1,1) \quad (1)$$

$$\tau \sim Gamma(0.001,0.001) \quad (2)$$

where θ is the mean value of the correlation distributed normally with mean 0 and precision 0.01 truncated to be within the range of -1 to 1, and τ is the precision of the effect size estimate distributed as a gamma distribution with shape and rate parameters set to 0.001. For additional details regarding the implementation of the Bayesian meta-analysis included herein please refer to Appendix 4.4, which includes the BUGS code and sampling details.

Results

Comprehensive literature searches revealed 319 initial results. Title and abstract review revealed 150 results that were not relevant or failed to meet the inclusion criteria (e.g., qualitative studies). After obtaining the full text for the remaining 169 results, 66 additional studies were excluded because they did not include empirical measurement of drinking motives ($k = 16$), did not utilize a variant of the DMQ ($k = 27$), failed to report the relevant statistics ($k = 13$), or duplicated data published elsewhere already included in the meta-analysis ($k = 10$). In total, the meta-analysis included 93 published reports consisting of 345 effect sizes across 100 independent samples.

Mean weighted intercorrelations between DMQ subscales from 67 independent samples ($N = 41,714$) are presented in Table A.1. Mean weighted correlations between DMQ subscales and drinking behaviors and personality traits are displayed in Table A.2. Studies that reported the relation between drinking motives and drinking behaviors were unsurprisingly more prevalent than studies reporting correlations between drinking

Table A.1: Mean Weighted Correlations between Drinking Motives

	1	2	3	4
1. Cope	-	67 (41,714)	50 (32,187)	37 (21,967)
2. Enhance	.499 [.462, .533]	-	49 (31,934)	36 (21,183)
3. Social	.448 [.411, .489]	.693 [.660, .727]	-	36 (21,183)
4. Conform	.408 [.371, .447]	.285 [.236, .337]	.382 [.337, .423]	-

Notes. Mean weighted correlations along with 95% highest density intervals are reported below the diagonal; number of independent samples k and combined sample size used to calculate estimates (N) are reported above the diagonal.

Table A.2: Drinking Motive Correlates

Construct	Coping	Enhancement	Social	Conformity	N^\dagger	k^\dagger
Drinking Quantity	.23 [.19, .28]	.38 [.33, .43]	.33 [.27, .40]	.07 [.00, .13]	15,979	31
Drinking Frequency	.23 [.18, .29]	.33 [.26, .40]	.33 [.26, .40]	.04 [-.04, .11]	19,998	21
Alcohol Consumption	.28 [.21, .35]	.42 [.33, .53]	.41 [.27, .55]	.10 [.01, .19]	5,858	14
Alcohol-related Problems	.38 [.33, .42]	.40 [.35, .45]	.32 [.23, .41]	.15 [.09, .22]	7,229	19
Binge Drinking	.24 [.20, .29]	.41 [.37, .45]	.38 [.32, .44]	.13 [.04, .22]	15,170	22
Alcohol Dependence	.35 [.27, .42]	.38 [.27, .48]	.30 [-.05, .83]	.11 [-.28, .48]	4,731	6
AUDIT	.36 [.27, .44]	.47 [.38, .56]	.42 [.33, .51]	.15 [.01, .30]	3,128	10
RAPI	.45 [.39, .50]	.38 [.28, .47]	.33 [.20, .44]	.28 [.19, .38]	6,630	17
Anxiety	.31 [.24, .37]	.07 [.01, .13]	.07 [.01, .13]	.29 [.18, .39]	3,313	9
Depression	.21 [.06, .36]	.03 [-.07, .12]	.02 [-.08, .12]	.10 [-.20, .42]	5,981	12
Positive Affect	-.04 [-.29, .19]	.12 [-.03, .30]	.15 [-.04, .35]	-.03 [-.22, .14]	2,150	8
Negative Affect	.23 [.12, .33]	.12 [-.00, .24]	.11 [-.06, .28]	.16 [-.00, .28]	2,265	10
Sensation Seeking	.19 [.10, .27]	.35 [.24, .46]	.41 [.34, .49]	.08 [-.31, .52]	5,376	7
Self-Control	.02 [-.37, .40]	.04 [-.37, .39]	.06 [-.48, .62]	-.05 [-.80, .71]	4,152	4
Childhood Abuse/Trauma	.19 [.05, .32]	.12 [-.04, .28]	.07 [-.32, .45]	.14 [-.21, .54]	1,611	5
Hostility	.25 [.11, .41]	.18 [-.39, .83]	.26 [-.12, .61]	.14 [-.23, .42]	3,153	4
Risky Behaviors	.19 [.09, .28]	.16 [.06, .27]	.09 [-.37, .49]	.11 [-.03, .27]	3,810	4
Extraversion	-.09 [-.20, .05]	.13 [.05, .21]	.12 [-.02, .26]	-.12 [-.31, .07]	1,686	6
Agreeableness	-.17 [-.28, -.06]	-.05 [-.13, .03]	-.02 [-.13, .09]	-.08 [-.28, .09]	4,539	5
Conscientiousness	-.15 [-.21, -.08]	-.13 [-.22, -.03]	-.07 [-.19, .08]	-.09 [-.21, .05]	5,213	7
Neuroticism	.30 [.22, .36]	.06 [.00, .12]	.11 [-.06, .32]	.19 [-.09, .47]	5,198	7
Openness	-.04 [-.15, .09]	.09 [-.03, .19]	.01 [-.10, .11]	-.13 [-.33, .10]	1,093	4
Age	.01 [-.04, .07]	-.02 [-.09, .06]	.02 [-.07, .10]	-.02 [-.10, .04]	15,257	13
Male	.05 [.00, .10]	.09 [.05, .13]	.10 [.05, .15]	.09 [.00, .17]	11,852	12

Notes. \dagger The reported combined sample size, N , and number of samples, k , represent the maximum value across the various drinking motives. In many instances, correlations were only reported for two or three motives. AUDIT = Alcohol Use Disorders Identification Test; RAPI = Rutgers Alcohol Problem Index.

motives and personality traits. Male gender was positively correlated with each drinking motive. Age, however, was not reliably correlated with drinking motive scores. Given the popularity of the *Alcohol Use Disorders Identification Test* (AUDIT) and *Rutgers Alcohol Problem Index* (RAPI), correlations were reported separately for these measures instead of being included in the “Alcohol Problems” category.

Discussion

Overall, our meta-analysis of the DMQ and its derivatives provide moderate support for Cox and Klinger's motivational model of alcohol use (1988). As is apparent in Table A.1, the intercorrelations between drinking motives vary from moderate in size to quite large in size. Consistent with Cox and Klinger's (1988, 2011) motivational model of alcohol use and our primary hypothesis, the positive reinforcing drinking motives (social and enhancement) had the highest average correlation ($\bar{r} = .69$, 95% HDI [.66, .73]), while the lowest correlation was between the orthogonal motives of enhancement (positive-internal) and conformity (negative-external; $\bar{r} = .29$, 95% HDI [.24, .34]). The pattern of intercorrelations was not perfectly consistent with Cox and Klinger's model however—the correlation between coping motives and social motives was substantial ($\bar{r} = .45$, 95% CI [.41, .49]) despite these motives' supposed orthogonal relationship.

Our second hypothesis regarding the personality correlates of drinking motives was also moderately supported by the results of the meta-analysis. Mean weighted correlations between enhancement and social motives and extroversion were both positive ($r = .13$ and $r = .12$) while the opposite pattern held for coping and conformity motives ($r = -.09$ and $r = -.12$). Mean weighted correlations with neuroticism were positive for coping and conformity motives ($r = .3$ and $r = .19$) and not reliably different from zero for enhancement and social motives. Only coping motives were correlated to depression ($\bar{r} = .21$) whereas all four drinking motives were positively correlated to anxiety.

Our third hypothesis—that coping motives would have the strongest correlation with drinking problems—was not supported by our analyses. Social and enhancement motives had the largest mean weighted correlations with indices of drinking quantity, frequency, and total consumption ranging between $\bar{r} = .33$ to $\bar{r} = .42$. Coping motives had noticeably smaller mean correlations ($\bar{r} = .23 - .28$) and conformity motives were hardly correlated to amount of alcohol consumed ($\bar{r} = .04-.1$). These same patterns were evident when examining heavy episodic drinking/binge drinking with enhancement motives having the strongest mean correlation ($\bar{r} = .41$) followed by social motives ($\bar{r} = .38$), then coping motives ($\bar{r} = .24$) and conformity motives ($\bar{r} = .13$). The pattern of findings was slightly different with respect to alcohol problems where enhancement motives had the strongest mean correlations ($\bar{r} = .38-.47$), followed by coping motives ($\bar{r} = .36-.45$), social motives ($\bar{r} = .32-.42$), then conformity motives ($\bar{r} = .15-.18$). Thus, coping motives did not appear to be uniquely maladaptive compared to other motives. Furthermore, social motives did not appear to be uniquely benign. When examining Table A.2, it is apparent that conformity drinking motives tended to have much smaller correlations with drinking

variables than other motives.

The basic proposition that drinking motives provide insight into the context and personality of the person drinking is supported by an overview of the correlations between different drinking motives and various psychological constructs as is presented in Table A.2. Moreover, the generally high correlations between different categories of drinking motives, coupled with the above cited research, suggests that the motives underlying alcohol consumption can be both dynamic and complex.

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Appendix B: Analysis Implementation

Software

Analyses will be conducted using JAGS (Just Another Gibbs Sampler; Plummer, 2012) and WinBUGS accessed by way of the R language and environment for statistical computation and graphics (R Core Team, 2012) using the `rjags` (Plummer, 2011), `R2jags` (Su & Yajima, 2012), `rbugs` (Yan & Prates, 2012), and `R2WinBUGS` (Sturtz, Ligges, & Gelman, 2005) packages. JAGS (mcmc-jags.sourceforge.net), OpenBUGS (<http://www.openbugs.info>) and R (www.r-project.org) are freely available, cross-platform (Windows, Mac OS X, Unix, and Linux), open-source programs licensed under the Free Software Foundation's GNU General Public License.

JAGS is designed to facilitate the analysis of Bayesian models using MCMC methods (Plummer, 2012). JAGS, in many respects, is a successor to the popular WinBUGS program (<http://www.mrc-bsu.cam.ac.uk/bugs/winbugs/contents.shtml>) and is similar to the OpenBUGS program in that it uses the BUGS scripting language. MCMC diagnostics and output analyses will be conducted using the CODA package (Convergence Diagnosis and Output Analysis; Plummer, Best, Cowles, & Vines, 2006). Figures will be created using R and the `ggplot2` package (Wickham, 2009), which is an implementation of Wilkinson's Grammar of Graphics (2005).

The R platform has numerous advantages over other platforms such as SAS and IBM's SPSS, both of which, incidentally, allow for R integration. Not only is R freely available, it has become the *lingua franca* of statistical computing (Everitt, 2010; Theul, Ligges, & Hornik, 2010), including in the social sciences (Martin, Quinn, & Park, 2011), is widely used in industry (e.g., Google, Pfizer, Merck, Bank of America, Shell, etc.; Vance, 2009), and has been on the forefront of the reproducible research movement (e.g., Koenker & Zeileis, 2009; Leisch, Eugster, & Hothorn, 2011; R. D. Peng, 2009, 2011).² Furthermore, community resources available for learning R are far greater than for alternative platforms. For example, Stack Overflow (stackoverflow.com), a free programming Q & A site has over 14,000 active R questions compared to a mere 650 for SAS and 123 for SPSS. On the free statistics Q & A site Cross Validated (stats.stackexchange.com), there are over 2,100 questions relating to R, of which, less than 400 are currently unanswered. SPSS on the other hand has only 215 total questions, and SAS has a total of only 131.

The scientific community's "culture of replication" can be augmented by a "culture of reproducibility." Short of full replication, the gold standard in *reproducible research* is publishing one's results with linked and executable code and data (R. D. Peng, 2011).

²For information on current trends in statistical computing platforms see Muenchen, 2012.

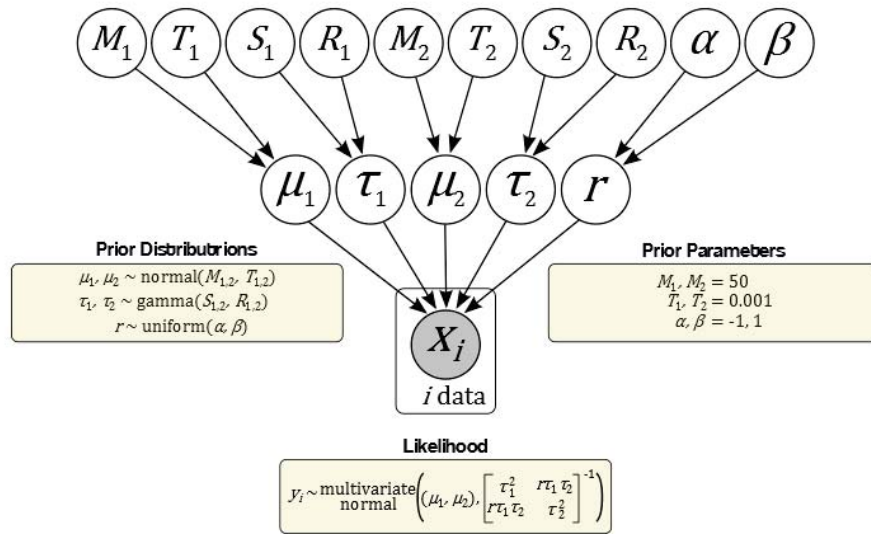


Figure B.1: Graphical Model of Pearson Correlation Model Dependencies

This task is greatly facilitated in R through the `knitr` package (Xie, 2012), which allows for dynamic report generation (i.e., embedding statistical analyses within the text of a report). The importance of making one's data and methods transparent cannot be overemphasized as failing to do so is increasingly considered unethical (Gelman, 2011; Simonsohn, 2012). The current article is typeset using \LaTeX , the *de facto* standard for publication of scientific documents (www.latex-project.org).

BUGS Code

Bayesian inference using Gibbs sampling is facilitated by several popular (and freely available) software packages, which implement the BUGS language, and acronym for Bayesian inference Using Gibbs Sampling. For the present study, the BUGS code used to calculate the correlations between variables of interest was adapted from M. D. Lee and Wagenmakers (2012) and appears below. Note that in the BUGS scripting language, the number sign ('#') at the beginning of a line comments out that line (i.e., it is skipped over by the compiler), the two-character sequence '<->' is the assignment operator (similar to '=' in many scripting languages), and the tilde operator (~) follows probability theory convention and is read as '*is distributed as*.' The entire BUGS model is contained within the curly braces following the `model` keyword (i.e., `model {*}`) or wrapped inside of an R function using the `R2jags` package. Indices are subset using square brackets ([&]) and repeated calculations are contained within a `for` loop. Note that the functions for the

```

# BUGS code for Pearson correlation
correlation_model <- function() {
  # Data
  for (i in 1:n) {
    x[i, 1:2] ~ dnorm(mu[], tauI[, ])
  }
  # Priors
  mu[1] ~ dnorm(0, 0.001)
  mu[2] ~ dnorm(0, 0.001)
  lambda[1] ~ dgamma(0.001, 0.001)
  lambda[2] ~ dgamma(0.001, 0.001)
  r ~ dunif(-1, 1)
  # Reparameterization
  sigma[1] <- 1/sqrt(lambda[1])
  sigma[2] <- 1/sqrt(lambda[2])
  tau[1, 1] <- 1/lambda[1]
  tau[1, 2] <- r * sigma[1] * sigma[2]
  tau[2, 1] <- r * sigma[1] * sigma[2]
  tau[2, 2] <- 1/lambda[2]
  tauI[1:2, 1:2] <- inverse(tau[1:2, 1:2])
}

```

Figure B.2: BUGS Code for Pearson Correlation

```

# BUGS code for regression model
regression_model = function() {
  for (i in 1:n) {
    y[i] ~ dnorm(mu[i], tau)
    mu[i] <- b0 + inprod(b[], x[i, ])
  }
  tau ~ dgamma(0.01, 0.01)
  b0 ~ dnorm(0, 0.001)
  for (j in 1:k) {
    b[j] ~ dnorm(0, 0.01)
  }
}

```

Figure B.3: BUGS Code for Multiple Linear Regression

normal and multivariate normal distributions in BUGS use a *precision* parameter as opposed to standard deviation. Precision is merely the inverse of the variance; thus, a ‘vague’ prior would be computed using a low precision value (equivalent to large variance).

```

# BUGS code for Mediation Analysis Adapted from Yuan & MacKinnon, 2009
mediation_model = function() {

  # PRIORS
  alpha ~ dnorm(0, 1e-04)
  beta ~ dnorm(0, 1e-04)
  beta2 ~ dnorm(0, 1e-04)
  beta3 ~ dnorm(0, 1e-04)
  tau.prime ~ dnorm(0, 1e-04)
  prec.y ~ dgamma(0.001, 0.001)
  prec.m ~ dgamma(0.001, 0.001)
  theta <- alpha * beta
  # LIKELIHOOD
  for (i in 1:length(x)) {
    m[i] ~ dnorm(mean.m[i], prec.m)
    mean.m[i] <- beta3 + beta * m[i] + tau.prime * x[i]
    y[i] ~ dnorm(mean.y[i], prec.y)
    mean.y[i] <- beta3 + beta * m[i] + tau.prime * x[i]
  }
}

```

Figure B.4: BUGS Code for Bayesian mediation analysis

```

# BUGS code for meta-analysis
meta_model = function() {
  # Priors
  theta ~ dnorm(0, 0.01) #T(-.99,.99)
  precision.tau ~ dgamma(0.001, 0.001)
  tau <- sqrt(1/precision.tau)
  # Likelihood
  for (i in 1:length(r)) {
    r[i] ~ dnorm(mu[i], r.precision[i])
    r.precision[i] <- 1/r.variance[i]
    mu[i] ~ dnorm(theta, precision.tau)
    # Assess model fit
    predicted[i] <- mu[i] # Predicted Values
    residual[i] <- r[i] - predicted[i] # Residuals for observed data
    sq[i] <- pow(residual[i], 2) # Squared residuals for observed data
    # Generate Replicate Data and Compute Fit Stats for Them One new data set
    # at each MCMC iteration
    r.new[i] ~ dnorm(mu[i], r.precision[i]) #T(-1,1)
    # Squared residuals for new data
    sq.new[i] <- pow(r.new[i] - predicted[i], 2)
  }
  # Assess model fit using a sums-of-squares-type discrepancy
  fit <- sum(sq[]) # Sum of squared residuals for actual data set
  fit.new <- sum(sq.new[]) # Sum of squared residuals for new data set
  test <- step(fit.new - fit) # Test whether new data set more extreme
  bpvalue <- mean(test) # Bayesian p-value
}

```

Figure B.5: BUGS Code for Meta-analysis

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Vita

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Education

UNIVERSITY OF KENTUCKY, Lexington, Kentucky
M.S., Clinical Psychology, 2010

BRIGHAM YOUNG UNIVERSITY, Provo, Utah
B.A., Political Science, 2008

Scholastic and Professional Honors

Ruth L. Kirschstein National Research Service Award, NIDA, 2011–2013

Research Challenge Trust Fund Fellowship, University of Kentucky, 2010–2011

Predocctoral Research Award, French National Research Agency (ANR), 2010–2013

Academic Scholarship Award, Brigham Young University, 2007

Brigham Young Bicentennial Scholarship Award, Brigham Young University, 2002–2005

Professional Positions

Invited Grant Reviewer, French National Research Agency (ANR)

Invited Article Reviewer, Journal of Studies on Alcohol and Drugs (JSAD)

Invited Article Reviewer, International Journal of Sport and Exercise Psychology (IJSEP)

Research Award Reviewer, Association for Psychological Science Student Caucus (APSSC)

Individual Therapist, Jesse G. Harris Jr. Psychological Services Center, University of Kentucky, 2009–present

Practicum Therapist, Federal Medical Center Sattelite Prison Camp, Lexington, Kentucky, 2012–2013

Assessment Coordinator, Jesse G. Harris Jr. Psychological Services Center, University of Kentucky, 2011–2012

Psychometrist, C. C. Allen Psychological Services Center, Lexington, Kentucky, 2010–2011

Parenting Skills Group Leader, Salvation Army Transitional Living Center, Lexington, Kentucky, 2010–2011

Behavioral Medicine Resident, Orofacial Pain Clinic, University of Kentucky, 2010

Teaching Assistant, Personality Assessment, Department of Psychology, University of Kentucky, 2010

Japanese Instructor, Brigham Young University, 2005

Mentor, Discovery Academy, Inc., Provo, Utah, 2006–2008

Children's Unit Volunteer, Utah State Hospital, Provo, Utah, 2006–2007

Professional Affiliations

Association for Psychological Science Student Caucus (APSSC)

American Psychological Association of Graduate Students (APAGS)

Kentucky Psychological Association Graduate Students (KPAGS)

Society for the Scientific Study of Religion (SSSR)

International Society for Bayesian Analysis (ISBA)

International Association for Correctional and Forensic Psychology (IACFP)

Professional Publications

Duke, A. A. & Giancola, P. R. (in press). Alcohol reverses religion's prosocial influence on aggression. *Journal for the Scientific Study of Religion*.

Duke, A. A., Bègue, L., Bell, R., & Eisenlohr-Moul, T. (2013, February 4). Revisiting the serotonin-aggression relationship in humans: A meta-analysis. *Psychological Bulletin*. Advance online publication. doi: 10.1037/a0031544

Giancola, P. R., Parrott, D. J., Silva, P. J., DeWall, C. N., Bègue, L., Subra, B., **Duke, A. A.**, & Bushman, B. J., (2012). The disguise of sobriety: Unveiled by alcohol in persons with an aggressive personality. *Journal of Personality*, 80 (1), 163185. doi: 10.1111/j.1467-6494.2011.00726.x

- Giancola, P. R., **Duke, A. A.**, & Ritz, K. (2011). Alcohol, violence, and the alcohol myopia model: Preliminary findings and implications for prevention. *Addictive Behaviors*, 36, 10191022. doi: 10.1016/j.addbeh.2011.05.006
- Duke, A. A.**, Giancola, P. R., Morris, D. H., Holt, J. C., & Gunn, R. L. (2011). Alcohol dose and aggression: Another reason why drinking more is a bad idea. *Journal of Studies on Alcohol and Drugs*, 72(1), 3443. ***Most cited JSAD article published in 2011.***
- Giancola, P. R., Josephs, R. A., Parrott, D. J., & **Duke, A. A.** (2010). Alcohol myopia revisited: Clarifying aggression and other acts of disinhibition through a distorted lens. *Perspectives on Psychological Science*, 5(3), 265278. doi: 10.1177/1745691610369467
- Bell, R., **Duke, A. A.**, Lynch, K., & Bègue, L. (manuscript submitted for publication). Lack of effect of the 5-HT₃ receptor ligands SR 57227A and MDL 7314EF on murine agonistic behavior.

Poster Presentations

- Miskell, S., **Duke, A. A.**, Bi, S., & Keller, P. S. (2013). *The influence of parental drinking motives on children's emotional security*. Poster presented at the Society for Research in Child Development (SRCD) biennial meeting. Seattle, Washington.
- Duke, A. A.** (2012). *Inadequacy of the serotonin deficiency hypothesis of human aggression: A meta-analysis*. Poster presented at the annual convention of the Association for Psychological Science. Chicago, Illinois.
- Duke, A. A.** (2012). *Disentangling the relation between serotonin and human aggression*. Poster presented at the annual spring academic conference of the Kentucky Psychological Association Foundation. Lexington, Kentucky. ***Award Winning Poster.***
- Bowman, R., Smith, T. B., Hamm, S., Jeppsen, B., & **Duke, A. A.** (2008, April). *The effects of client-therapist racial matching: A meta-analytic review of empirical research*. Presentation at the Rocky Mountain Psychological Association, Boise, Idaho.
- Hamm, S. Smith, T. B., Jeppsen, B., **Duke, A. A.**, Medina, E., & Cooper, H. (2008). *Retention of clients of color in psychotherapy: A comparative analysis*. Presentation at the Rocky Mountain Psychological Association, Boise, Idaho.
- Duke, A. A.**, Smith, T. B., Hamm, S. Jeppsen, B., & Medina, E. (2008). *Multicultural competence and its association with client variables and outcomes in*

psychotherapy. Presentation at the Rocky Mountain Psychological Association, Boise, Idaho.

Hamm, S., Alfalava, N., Bowman, R., Cañate, R., Cooper, H., **Duke, A. A.**, & Smith, T. B. (2008). *Multicultural competence in mental-health treatment*. Poster presented at the BYU School of Education mentored research conference, Provo, Utah.