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Demand on Mental Workload: Relation to Cue Reactivity and Craving in Women With
Disordered Eating and Problematic Drinking

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Abstract

The resource model of attention approaches the human mind as a limited-capacity information processing system. The present study introduced a novel paradigm that combined the clinical aspects of disordered eating and problematic drinking within an information-processing framework. One hundred seventy-five female undergraduates (median = 19) rated the difficulty of receiving olfactory cues and performing a disorder-salient Stroop task consisting of food and alcohol words. Results showed that women who were high on disordered eating symptomatology were more likely to engage in hazardous drinking. Both disordered eating and problematic drinking contributed to the women's rating the olfactory and Stroop tasks as being difficult on measures of mental demand and performance workload; problematic drinking accounted for more variance in these measures than disordered eating. Measures of food craving and alcohol craving were not significant moderators for the relationship between disordered eating, problematic drinking, and mental workload. In addition to the main study hypotheses, exploratory analyses also indicated that personality traits moderated the strength of the relationship between disordered eating and problematic drinking on measures of mental workload. Study findings suggest a need to target cognitions pertinent to the disordered eating or hazardous drinking, targeting the problematic drinking before progressing in therapy. Personality characteristics should be addressed when treating women with disordered eating and/or problematic drinking. Recommendations are discussed for broad cognitive behavioral interventions related to mental workload to target faulty cognitions.

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Demand on Mental Workload: Relation to Cue Reactivity and Craving in Women With Disordered Eating and Problematic Drinking

Significance

The resource model of attention theorizes that the mind's processing capacity can be conceptualized as reservoirs of energy that can be dedicated to different mental processes (Hirst & Kalmar, 1987). Research within this paradigm has approached the human mind as a limited-capacity information-processing system that allocates resources to cope with situations that confront it. In this investigation, this framework will be utilized while looking at clinical psychopathology in women with disordered eating and problematic drinking.

A high co-occurrence between eating disorders (ED) and alcohol use disorders (AUD) has been well documented in clinical and subclinical samples (Bulik, et al., 2004; Grilo, Sinha, & O'Malley, 2002; Holderness, Brooks-Gunn, & Warren, 1994). Holderness and colleagues (1994) reveal in a meta-analysis a co-occurrence ranging from 3% - 49%. The co-occurrence with problematic drinking rises for persons diagnosed with bulimia nervosa (BN) or binge eating disorder (BED) more so than anorexia nervosa (AN) given the impulsivity associated with both of these disorders (Holderness, Brooks-Gunn, & Warren, 1994; Garfinkel, Moldofsky, & Garner, 1980). Although the relationship between problematic drinking and disordered eating has been well established, the mechanisms underlying the relationship have not been extensively researched. Previous studies investigating personality traits have found that anxiety, impulsivity, restraint behaviors, and sensation-seeking have been found to predispose

individuals to engage in both disordered eating and problematic drinking (Loxton & Dawe, 2001). A preoccupation with food and alcohol is a cognitive symptom shared by some persons with BN, BED, and AUDs and can serve as a trait that can be measured in persons with disordered eating and problematic drinking.

The reaction to stimuli associated with the substance in question is an important factor that has been implicated to maintain disordered eating and alcohol-seeking behavior (Drummond et al., 1995). These reactions include autonomic arousal (e.g., increased heart rate) and an increase in subjective urges (e.g., craving). The reactions occur to the sight, smell, and taste of preferred food and beverages and to visual cues (Drobes & Thomas, 1999).

Cognitive processing differences based on attentional biases of certain words (associated with eating disorders and problematic drinking) are believed to play a large role in assessing people's psychologically disordered thoughts. In the field of compulsive behaviors—alcohol abuse/dependence (AA/AD) (Cox, Yeates, & Regan, 1998; Rofey & Corcoran, 2002a), nicotine addiction (Johnsen, Thayer, Laberg, & Asbjornsen, 1997), cocaine use (Rosse, Johri, Kendrick, et al., 1997), and disordered eating (Overduin, Jansen, & Louwerse, 1995; Rofey, Corcoran, & Tran, 2004)—hyperattention to and avoidance of cue words have been observed. Results support the idea that cues have an affective valence for the person who engages in that behavior. As a result, there is a delay or acceleration in response rate to meaningful stimuli (for review, see Rofey et al., 2004).

The Stroop (1935) task has been used extensively by experimental psychologists to study attentional processes. Stroop (1935) found that it takes participants longer to

read the name of a color word when the ink color does not match the content (e.g., when the word blue is written in red ink there is a longer color-naming latency). As Williams, Mathews, and MacLeod (1996) indicate in their review of the Stroop literature, several investigators in the late 1970s and 1980s used Stroop-like tasks to examine cognitive processing associated with emotional disturbance. These disorder-salient Stroop tasks were used to investigate information processing differences in people with pathological thoughts (e.g., disordered eating, problematic drinking, phobias, social anxiety). It has been suggested that the Stroop task is a valuable tool for examining cognitive processes in psychopathology (Segal, 1988; Williams, Mathews, & MacLeod, 1996). This model reveals that emotional stimuli are more salient and that such stimuli will be selectively attended to for individuals with a particular disorder more than individuals not experiencing that condition. Similar results were found in Rofey et al.'s (2004) study, though objective findings were not emphasized in the current investigation.

Similar to these visual cues, olfactory cues have also been shown to play an important role in disordered eating and problematic drinking. Studies of women experiencing ED and AA show that the presence of olfactory cues heightens cognitions pertaining to these substances (Drewnowski, 1997; Perkins, Ciccocioppo, Jacobs, Doyle, & Caggiula, 2003; Staiger, Dawe, & McCarthy, 2000). Women suffering with AN and BN like the smell and taste of high caloric foods as long as the possibility of ingestion is excluded (Drewnowski, Halmi, Pierce, Gibbs, & Smith, 1987); similarly, people suffering with AA and AD like the smell and taste of the alcoholic beverage that they typically use more so than an individual without disordered eating and problematic drinking (Rofey et al., 2003). Under a classical conditioning model, stimuli repeatedly

associated with the consumption of a substance (such as the sight and smell of food or alcohol) are thought to elicit conditioned responses related to an increased desire to consume the food or beverage. These stimuli referred to as cues, elicit cognitions related to responses to ingest the food and/or beverage. Thus, presenting olfactory cues to persons predisposed to disordered eating and problematic drinking may lead to a response interference similar to that of visual cues on the disorder-salient Stroop task (Rofey, et al., 2004).

Therefore, if individuals with disordered eating and problematic drinking are presented with olfactory cues related to their pathological thoughts (i.e., the smell of beer, whiskey, wine, graham crackers, chocolate, oatmeal and vanilla cookies), their ability to respond to a task without cognitive interference may seem more impaired. The food and alcohol-related cues have implicit implications to the people high in disordered eating and problematic drinking. Responses will be affected by these salient cues and thus reflected in the mental workload ratings.

Eating Disorders

Disordered eating occurs in epidemic proportions in Western society, and it is estimated that 5-10 million women in the United States may be diagnosed with eating disorders (Crowther & Mizes, 1992; Fairburn & Wilson, 1993; Hoek, 1993; Shisslak, Crago, & Estes, 1995). Research in this subject has been rising in the last 20 years as eating disorders—AN, BN, and Eating Disorder Not Otherwise Specified (EDNOS)—have received increased attention in the clinical and societal arenas (Fairburn & Brownell, 2002; Garner & Garfinkel, 1997; Grilo et al., 2002). Morbidity associated with these disorders is considerable, and the number of causes, interventions, and strategies for

prevention are plentiful (Garfinkel, 1995). There are a number of etiological and contributing factors that have been proposed and investigated.

Among women, the lifetime prevalence of BN is approximately 1% to 3%; the rate of occurrence of this disorder in males is approximately one-tenth of that in females (*Diagnostic and Statistical Manual of Mental Disorders, DSM-IV TR*, APA, 2000). Results of questionnaires indicate that approximately 19% of female college students report symptoms of BN (Hoek, 1993), marked by binge eating and inappropriate compensatory behavior to prevent weight gain (e.g., vomiting, laxatives, diuretics, enemas, excessive exercise). Rand and Kuldau (1992) argue that this rate is higher when looking at a college sample because they are enmeshed with their peers, experiencing an adjustment period, and recognizing that independence is challenging.

Recent research indicates that there may be genetic factors that contribute to the onset of an eating disorder. Kaye and his colleagues (2000) examined women who had recovered from BN and found that they had abnormal serotonin levels with an overall more negative mood and obsessions with perfectionism. Bulik and Tozzi (2004) found that this predisposition for disordered eating alongside of a conducive gene-environment interplay exacerbates the likelihood of an onset of an eating disorder. Mainstream society also sets high and often incompatible standards for women (Striegel-Moore, Silberstein, & Rodin, 1986). Women should have big breasts but small waists; they should be able to build-up stamina in an athletic manner, but not sweat; they should workout every day, but not get too muscular (Brownell & Rodin, 1994). Cultural pressure for women to be thin is much greater than that for men (Mitchell & Eckert, 1987). Furthermore, achieving an ideal body image may also represent another personal

achievement in females (Polivy & Herman, 1987). Although men do not escape judgments about their bodies, the desirable traits are much different—men should be muscular and women should be thin—men may be inclined to take steroids (or engage in other behaviors designed to enhance visible musculature) and women may have eating disorders in order to fulfill gender appropriate expectations.

Alcohol Use Disorders

AD Dependence (AD) and Alcohol Abuse (AA) are among the most prevalent mental disorders in the general population (*DSM-IV TR*, 2000). The lifetime prevalence of AD and AA is 8% and 5%, respectively, and both of these disorders are more common in males than in females, with a male-to-female ratio as high as 5:1 (*DSM-IV TR*, 2000). Although problematic alcohol use occurs across many age groups, young adults aged 18-24 show the highest rates of alcohol use and have the greatest percentage of problem drinkers (Kandel & Logan, 1984; U.S. Department of Health and Human Services, 1997). In addition, most students have consumed alcohol within the last year (O'Malley & Johnston, 2002; Wechsler, Dowdall, Maenner, Gledhill-Hoyt, & Lee, 1998); in fact, as many as 84.2% of college students report a “binge drinking episode” (i.e., 5+ standard drinks for men and 4+ standard drinks for women in one sitting) within the previous 90 days. Further, 31% of college men consume greater than 21 drinks per week and 19% of college women consume greater than 14 drinks per week, exceeding the established standards for safe levels of drinking (Hingson, Heeren, Zakocs, Kopstein, & Wechsler, 2002).

While the etiological factors contributing to AD and AA are not definitive, AD often has a familial pattern, and at least some of the transmission can be traced to genetic

factors (*DSM-IV TR*, 2002). Higher risk is associated with a greater number of affected relatives, closer genetic relationships, and the severity of the alcohol-related problems in the affected relative. However, genetic factors explain only a part of the risk for AD, with a significant part of the risk coming from environmental or interpersonal factors.

Although there has been a history of research consistently finding gender differences in drinking patterns, some researchers have speculated that women are becoming more like men in their drinking patterns (Goodwin, 1989; Ham & Hope, 2003; Maney, 1990). The prevalence of frequent binge drinking in women has increased to a greater degree in all-women's colleges (Keeling, 2002) than in coed or all-men's colleges. College women may be approaching their male counterparts' level of alcohol use and alcohol-related problems as gender drinking norms change with other evolving gender norms. Thus, the comorbidity between disordered eating and problematic drinking in college females is rising along with the need to understand cognitions underlying these disorders.

Mental Workload

Mental workload is the information processing load or resource demands imposed by a task (Eggemeier, 1988; O'Donnell & Eggemeier, 1986). It is the specification of the amount of information processing capacity that is used for task performance—the individual, the task, and the interaction between the individual and the task. As Wickens and Hollands (1991) reveal the concept of workload is fundamentally defined by the relationship between resource supply and task demand. In other words, how much demand does the task place on the operator and consequently, how capable is the operator to respond efficiently to the demand. Within this study, the clinical application of mental

workload addresses the amount of demand put on the operator (i.e., the woman responding to the olfactory and Stroop cues) and the resulting ability and workload ratings of the person depending on her level of disordered eating and problematic drinking symptomatology.

The cognitive-behavioral aspects of individuals with BN, AD, and AA include hyperattentiveness toward the substance, hypoaffectivity, and underlying personality characteristics that elicit distress (Fassino, 2001; Strober, 2000). This self-reported preoccupation with the substance is a cognitive symptom shared by those with symptoms of BN, AA and AD, and can serve as an objective trait that can be measured in clients experiencing disordered eating and/or problematic drinking.

Related to these cognitions is mental workload – the information processing load or resource demands imposed by a task (Eggemeier, 1988; O'Donnell & Eggemeier, 1986). From the initial hypotheses of capacity theorists who attempted to describe perceived mental workload, several theories have developed which are related to the task's demand for processing capacity, more commonly referred to as “resources” (Friedman, Polson, Dafoe, & Gaskill, 1982; Kahneman, 1973; Navon & Gopher, 1979; Norman & Bobrow, 1975; Wickens, 1980, 1984, 1986). These theories all hold that when multiple tasks are performed, performances should deteriorate as they compete for more of the same resources, to the extent that performance is limited by a common resource. Temple and his colleagues (2000) offer a position that posits resources as reservoirs of mental energy dedicated to the performance of a task (Hirst & Kalmar, 1987). During cognitive tasks, observers need to make active, continuous discriminations

under conditions of uncertainty without rest. The continuous nature of the mental work does not allow for full replenishment of resources.

Similar to the description above and utilizing socially relevant research, the limited resource view argues that the self has one limited stock which it expends when asked to perform a task (Baumeister & Heatherton, 1996; Baumeister, Muraven, & Tice, 2000). The same resource is used to regulate thoughts, control emotions, and inhibit impulses. Muraven, Tice, and Baumeister (1998) argue that self-control is a limited resource that must be regulated. A female high in disordered eating and/or hazardous drinking must resist temptation for the substance and exert strong self-control to prevent herself from carrying out a strong but forbidden impulse. Thus, administering salient cues to women high in disordered eating and problematic drinking leads to impaired performance on tasks requiring cognitive control. There is a depletion of resources due to the self-regulation necessary to suppress thoughts and emotions pertaining to the substances.

Craving

In lay terms, craving refers to an intense desire for a particular food or drug (Gendall, Joyce, & Sullivan, 1997); although the scientific term is defined as a distinct state of especially urgent desire for a substance (Kozlowski & Wilkinson, 1987). In typical cue reactivity research, people with disordered eating and problematic drinking are presented with related cues without the opportunity to consume or drink the substances. Participants' reactions to these cues—most done through self-report—are then measured (see Carter & Tiffany, 1999). Mere exposure to the sight and smell of a preferred substance without the opportunity for consumption has been shown to increase

self-reported desire as well as physiological measures (Cooney, Litt, Morse, Bauer, & Gaupp, 1997; Schulze & Jones, 1999). Weingarten and Elston (1991) suggest that cravings can also be conceptualized as cue-elicited expectations for the pleasurable sensations that accompany consumption of the desired substance. Sights and smells are two cues of food and alcohol which tend to create the desire for that substance (Cornell, Rodin, & Weingarten, 1989). Thus, olfactory and visual exposure to food and alcohol-related stimuli would increase the self-reported cravings that the person experiences. Craving alongside disordered eating and problematic drinking may lead to increased sensation-seeking towards the substance with amplified levels of cognitions (Kambouropoulos & Staiger, 2004). Conversely, if persons experiencing symptoms of disordered eating and hazardous drinking score low on craving measures, differential responses to related cues may occur (Perkins, Ciccocioppo, Jacobs, Doyle, & Caggiula, 2003).

Current Investigation

The current study introduces a novel paradigm that combines the clinical aspects of disordered eating and problematic drinking within an information-processing framework. Further, it requires a person to rate the difficulty of the information-processing task (receiving olfactory cues and performing the disorder-salient Stroop task with cues pertaining to the substance) according to the NASA-Task Load Index assessing mental workload. Craving is entered to assess individuals' preexisting levels of desire and drive to consume the substance. Due to the high prevalence of eating disorders and symptoms in women and the high frequency with which women use and abuse alcohol

within a college setting in comparison to the general population, the sample consists of women at a large university. The hypotheses are:

1. Individuals at higher risk for disordered eating, as indicated by high scores on the Eating Disorder Inventory-BN, Body Dissatisfaction, and Drive for Thinness subscales, will score higher on problematic drinking on the Alcohol Use Disorders Identification Test than those at lower risk for disordered eating.
2. Participants with more disordered eating symptoms and higher risk for problematic drinking will find the Stroop task more mentally taxing as rated on the NASA Task Load Index than those lower on disordered symptoms and problematic drinking.
3. Craving as indicated by high scores on the Food Craving Questionnaire-State will operate as a moderating variable, interacting with the responses to the Stroop task and olfactory cues and resulting in an even greater increase in eating-related measures of mental workload. Among women who endorse high cravings, those high in disordered eating will report higher mental workload than those low in disordered eating. A similar relation between disordered eating and mental workload was not predicted for individuals who report low food cravings.
4. Craving, as measured by the Obsessive Compulsive Drinking Scale will operate as a moderating variable, resulting in an even greater increase in alcohol-relevant mental workload difficulty. Among women who endorse high cravings, those high in problematic drinking will report higher mental workload than those low in problematic drinking. A similar relation between hazardous

drinking and mental workload was not predicted for individuals who report low alcohol cravings.

Exploratory analyses. Several researchers have suggested that the other issue neglected by existing workload research is the relationship between subjective performance and personality characteristics (Ballard, 1996a, 1996b; Berch & Kanter, 1984; Matthews & Desmond, 1998; Matthews, Dorn, & Glendon, 1991; Rose, Murphy, Byard, & Nikzad, 2002). Ballard (1996a) argues that subjective characteristics, or individual differences, influence performance on sustained attention tasks. Studies have reported that individual differences can be explained by personality traits. Broad traits such as Eysenck's Big Three – Extraversion, Neuroticism, and Psychoticism – have been frequently associated with objective performance (Davies & Parasuraman, 1982). The Eysenck Personality Scale results from 40 years of development focusing on developing sound psychometric properties. The scales are designed to measure the major dimensions of personality as they have emerged from self-ratings, ratings by acquaintances, experimental investigations, and psychophysiological analyses. The major factors of personality are measured in the EPQ-R and have achieved the widest consensus in the field of industrial psychology (Eysenck & Eysenck, 1994).

Studies that have been carried out with the EPQ-R and eating disorders suggest that BN is associated with high levels of Neuroticism, defined as a propensity to experience negative emotional states (Kendler, MacClean, Neale, Kessler, Heath & Eaves, 1991; de Silva & Eysenck, 1987; Feldman & Eysenck, 1986). Similarly, in the area of problematic drinking, the EPQ-Psychoticism scale has been found to be significantly related to alcohol use and behavior characteristics of low inhibition of alcohol consumption

(Brunas-Wagstaff, Bergquist, Richardson, & Connor, 1995; Jang, Livesley, & Vernon, 1999). More recently, the EPQ-Psychoticism scale has been defined as tough-mindedness, non-conformity, hostility and impulsivity. This classification system is a combination of four basic habits: (a) narrow impulsivity, (b) non-planning, (c) liveliness, and (d) risk-taking (Eysenck & Eysenck, 1977).

Thus, exploratory analyses were conducted with individual personality differences to examine people's subjective workload ratings for persons who are experiencing disordered eating and problematic drinking patterns. Two exploratory hypotheses were evaluated:

1. Individuals scoring higher on eating disordered symptomatology will rate the olfactory cues and Stroop task as being more difficult on the NASA Task Load Index. EPQR-Neuroticism will operate as a moderating variable, interacting with the differential responses to the cues and resulting in an even greater increase in eating-related mental workload difficulty. For women who endorse high levels of neuroticism, those high in disordered eating will report higher mental workload than those low in disordered eating. A similar relation between disordered eating and mental workload was not predicted for individuals who are low in neuroticism.

2. Participants with problematic drinking will be more likely to rate the cues as demanding on the NASA Task Load Index workload questionnaire.

Psychoticism on the EPQR will operate as a moderating variable, interacting with the differential responses to the cues and resulting in an even greater increase in mental workload difficulty. For women who are high on the

EPQR-Psychoticism scale, those high in problematic drinking will report higher mental workload than those low in hazardous drinking. A similar relation between problematic drinking and mental workload was not predicted for individuals who do not endorse high impulsivity.

Method

Participants

Participants were 175 undergraduate women psychology students at a large Midwestern university (ages 17 to 34 [$M = 19.7$, $SD = 1.9$]). Most of the participants were single (98.8%), Caucasian American (93.2%), and with freshman or sophomore status (89.2%). Racial/ethnic minority representation included 2.5% African American, 1.5% Asian American, .6% Hispanic American, and 1.2% others. Participants received research credit in their Psychology class for participation. All participants were treated in accordance with the *Ethical Principles of Psychologists and Code of Conduct* (American Psychological Association, 2002). A university-based Institutional Review Board approved this study.

Instruments

The Eating Disorder Inventory-2. The Eating Disorder Inventory-2 (EDI-2; Garner, 1991) is a self-report measure that assesses eating disorder symptomatology. It provides standardized subscales on 8 clinically relevant dimensions—Drive for Thinness, Ineffectiveness, Body Dissatisfaction, Interpersonal Distrust, BN, Perfectionism, Maturity Fear, Interoceptive Awareness, Impulse Regulation, Social Insecurity, and Asceticism—that are common in eating disorder populations (Garner & Olmsted, 1984,

1986; Garner, Olmsted, & Polivy, 1983). Each EDI subscale is intended to measure a conceptually independent trait, and calculating a total score poses a serious problem of interpretation.

Drive for Thinness, BN, and Body Dissatisfaction – the three subscales assessing attitudes and behaviors concerning eating, weight, and shape – were administered and used in analyses. The Drive for Thinness scale measures the relentless pursuit of thinness, the clinical manifestation of an intense fear of fatness, and is associated with maladaptive patterns of personality. Items on this subscale assess excessive concern with dieting, preoccupation with weight, and fear of weight gain, all cardinal features of AN and BN. Scores on the Drive for Thinness scale have been found to predict bulimic symptoms over a 10-year period (Joiner, Heatherton, & Keel, 1997; Kane, Loxton, Staiger, & Dawe, 2004). The BN subscale measures the tendencies to think about and to engage in bouts of uncontrollable eating (bingeing). This subscale has been found to have high convergent validity with other instruments assessing BN (Garner, 1991). Body Dissatisfaction measures unhappiness with the overall shape and size of the regions of the body that are of greatest concern to those with eating disorders. The Body Dissatisfaction subscale has been conceptualized as one aspect of the body image disturbance characteristics of eating disorders (Garner & Garfinkel, 1981; Garner, Garfinkel & Bonato, 1987; Thompson, 1990).

This instrument is recommended for clinical and non-clinical populations, and was validated with a female college population. Reliability coefficients for these EDI-2 subscales are between .79 and .93. Test-retest reliability for these scales of the EDI-2 administered one week apart to 70 students and staff revealed coefficients of .79 to .95

for all subscales. After 3 weeks, test-retest reliabilities for 70 nonpatient university undergraduates on Drive for Thinness, BN, and Body Dissatisfaction were all above .80. The original subscales show appropriate content, convergent, and discriminant validity. The psychometric properties of the instrument are sound and the constructs measure symptom domains and have clinical utility (Garner, 1991).

Alcohol Use Disorders Identification Test. The Alcohol Use Disorders Identification Test (AUDIT; Saunders, Aasland, Babor, de le Fuente, & Grant, 1993) is a measure consisting of 10 items that assess frequency and quantity of alcohol use, drinking behavior, and problems resulting from alcohol consumption. Participants' responses were weighted according to the AUDIT's scoring procedure, with a score of 8 or more indicating a strong likelihood of hazardous, problematic, or harmful alcohol consumption (Allen & Anthenelli, 2003; Fleming, Barry, & MacDonald, 1991; Saunders et al., 1993). This instrument has been extensively evaluated with different cut-off points and criterion standards in a variety of clinical settings including college students and alcoholic patients (Fleming, Barry, & MacDonald, 1991; McQuade, Levy, Yanek, Davis, & Liepman, 2000; Steinbauer, Cantor, Holzer, & Volk, 1998; Volk, Steinbauer, Cantor, Holzer, 1997). Using a cut-off point of 8 or more endorsed items, Babor and colleagues (2001) reported that the instrument's overall sensitivity value at 92% and a specificity value of 93%. Several studies show the AUDIT correlated with biochemical measures of drinking and with the Michigan Alcohol Screening Test (Allen, Litten, Fertig, & Babor, 1997; Skipsey, Burleson, & Kranzler, 1997). Indices of internal consistency and item-total correlations fall in the .80's (Allen, Litten, Fertig, & Babor, 1997).

NASA-Task Load Index. The NASA-Task Load Index (NASA-TLX; NASA Ames Research Center, 1985) is a multi-dimensional rating procedure that provides an overall workload score based on a weighted average of ratings on six subscales: Mental demand, physical demand, temporal demand, performance, effort, and frustration. Appendix A shows the directions and definitions given to the participants for the NASA-Task Load Index. An overall workload score and a paired comparison score (demarcating which scale was rated the hardest) can then be calculated. Mental, Physical, and Temporal Demand reflect the demands that tasks place upon operators, whereas Performance, Effort, and Frustration characterize the interaction between the operator and the task. As recommended, 20-step bipolar scales are used to obtain ratings for these dimensions. A score from 0 to 100 (assigned to the nearest point 5) is obtained on each scale. A weighting procedure required a paired comparison task to be performed prior to the workload assessments. Paired comparisons require the operator to choose which dimension is more relevant to workload across all pairs of the six dimensions. The number of times a dimension is chosen as more relevant is the weighting of that dimension scale for a given task for that operator. A workload score from 0 to 100 is obtained for each rated task by multiplying the weight by the individual dimension scale score, summing across scales, and dividing by 15.

The development and validation of the TLX has impacted laboratory research (Hart & Staveland, 1988), and the instrument's sensitivity has been demonstrated using a variety of tasks. The NASA-TLX has been applied in different multitask contexts, for example: in-flight, vigilance, memory, tracking, time estimation, and driving (Shively, Battiste, Matsumoto, Pepiton, Bortolussi, & Hart, 1987; Battiste & Bortolussi, 1988;

Byers, Bittner, Hill, Zaklad, & Christ, 1988; Matthews & Desmond, 1998; Tsang & Johnson, 1989; Warm & Dember, 1998; Warm, Dember, & Hancock, 1996). Further, the NASA-TLX has been found to be one of the most effective measures of perceived workload currently available with a test-retest correlation = .83 (Hill, Iavecchia, Byers, Zaklad, & Christ, 1992; Lysaght, et al., 1989; Nygren, 1991; Proctor & Van Zandt, 1994).

Eysenck Personality Inventory—Revised. The Eysenck Personality Questionnaire—Revised, Short Form (EPQ-R Short; Eysenck, Eysenck, & Barrett, 1985) is a revised version of the Eysenck Personality Questionnaire (Eysenck & Eysenck, 1977). This instrument includes a major revision of the Psychoticism (P) scale and minor revisions of the Extraversion (E) scale and the Neuroticism (N) scale. The Lie (L) scale remains the same as the original version. The questionnaire measures stability, tough-mindedness, socialability and the tendency to distort answers. The reliability of P, E, N, and L for females are higher than the original version and acceptable at .61, .84, .80, and .73, respectively; the convergent validity with alternate personality inventories is excellent, and scores from a random sample fall within a relatively normal distribution (Eysenck, Eysenck, & Barrett, 1985).

Labeled Magnitude Scale. The Labeled Magnitude Scale (LMS; Green, Dalton, Cowart, Shaffer, Rankin, & Higgins, 1996) is a semantic scale of perceptual intensity characterized by a quasi-logarithmic spacing of labels that has been adapted to rate pleasurable aspects of olfactory cues. The LMS has been shown to yield ratio-level data comparable with those produced by magnitude estimation. Pilot data provide evidence that the more pleasurable and easy the olfactory cue, the higher the possibility for craving

(Rofey et al., 2004). In the current study, this construct was measured to assure that the participant could smell the food/alcohol.

State Food-Craving Questionnaire. The State Food-Cravings Questionnaire (FCQ-S; Cepeda-Benito, Gleaves, Williams, & Erath, 2000) is a scale designed to measure physiological and psychological motivation states that promote substance-seeking and ingestive behaviors (usually) towards food and drugs. The FCQ-S is a useful instrument for measuring multiple dimensions of food cravings (i.e., an intense desire to eat, anticipation of positive reinforcement that may result from eating, anticipation of relief from negative states and feelings as a result of eating, obsessive preoccupation with food or lack of control overeating, and craving as a physiological state). The internal consistency of the FCQ-S is .94 and the test-retest reliability is .56. Data also provide evidence for the construct and convergent validity of the FCQ-S, especially with the Eating Inventory and Food Craving Inventory (Cepeda-Benito, Gleaves, Williams, & Erath, 2000; Stunkard & Messick, 1988).

Obsessive Compulsive Drinking Scale—Craving Measure. The Obsessive Compulsive Drinking Scale (OCDS; Anton, Moak, & Latham, 1995) has 14 items rated 0-4 that measures craving symptoms in individuals consuming alcohol. This self-rated questionnaire is based on the Yale-Brown Obsessive Compulsive Scale for heavy drinking interview (YBOCS-hd), and is a craving and outcome measure. The OCDS has acceptable test-retest reliability and good internal consistency (Anton, Moak, & Latham, 1995). Convergent validity for the scale is supported by a significant correlation between OCDS scores and the AD scale scores, the addiction severity index alcoholism composite

scores, and the number of past detoxifications (Anton, Moak, & Latham, 1996; Malcolm, Moore, Kajkas, & Roberts, 1998; Moak, Anton, & Latham, 1998).

Procedure

Participants completed a demographics checklist and questionnaires on troubled eating patterns, problematic alcohol consumption, craving and urge levels, and personality characteristics in groups of approximately 20 students. Four versions of the questionnaires were randomly counter-balanced and randomly distributed in even proportions to participants. Approximately 2 days after completing the first part, participants attended the second part of this experiment. On arriving, each participant was given the Dvorine Colorblind Test™ to assure that they could recognize color differences. Then they received food and alcohol olfactory cues that were rated on a scale of “most pleasant” to “not pleasant” on the Labeled Magnitude Scale (LMS; Green, Dalton, Cowart, Shaffer, Rankin, & Higgins, 1996). The participants were randomly assigned to receive the food or the alcohol condition first (i.e., the olfactory cues, the visual cues, the workload questionnaire, and the craving measures). The stimuli for the food and for the alcohol conditions were presented in a counterbalanced position with an intervening task to reduce carry-over effects. The olfactory cues were administered in numbered, opaque inhalation bottles and set in front of the participant. The participant was asked to leave the bottle on the table on the marked position and put her head at a predetermined height, squeezing the bottle and releasing the odor into the air (Cain, & Gent, 1991; Lundstrom & Hummel, 2000). Immediately following the sensory experience, the Labeled Magnitude Scale was completed to assure that the participant was able to smell the substance. After completing the Labeled Magnitude Scale, the

investigator explained to the participant that, in a few minutes, she was going to move to the computer-generated part of the study. Then, the participant went to the other side of the partition separating the laboratory to complete the Stroop task that “matched” the olfactory cues that she received (e.g., if the participant received the food smells first, she also received the disorder-salient Stroop task for food-related words). The Stroop tasks were set up on a Dell Pentium computer in the laboratory where the preliminary questioning took place. This 5-minute computer generated SuperLab program presented three groups of words: 1) color words (blue, green, red, yellow); 2) neutral words (phone, bowl, shoe, watch, mouse, floor, violin, window, deer, elephant, falcon, coyote, crocodile, geese, raccoon, mules each matched to an appetitive or alcohol word); and 3) appetitive words (chips, caramel, pastry, chocolate, cake, spaghetti, pizza, cookie); or alcohol words (gin, brandy, alcohol, beer, wine, vodka, bar, whiskey) (Cox, et al., 1999; Israeli & Stewart, 2001; Kucera & Francis, 1967; Stroop, 1935). All of the words were transcribed in each of the four colors: red, blue, green and yellow, as in the original Stroop. Participants were instructed to respond with response strokes (on the response box) corresponding to the color that the word was written in (Stroop, 1935). This response box (Cedrus, 1999) consisted of six keys – two gray keys, one red key, one yellow key, one blue key, and one green key. The experimenter for Session II instructed each participant to put her fingers on the color keys, and then read the following:

As soon as I push return, you will see a group of words, one word at a time. Each word will be written in a specific color (for example, red, blue, yellow, or green); you are to pay attention to the meaning of the word, but push the key on the response box that matches the color that the word on the screen is

written in. The computer will not move on to the next item until you respond.

Respond as quickly as possible and as accurately as possible. When the screen turns back to an aqua background, that means that you are done with this part of the experiment. Please tell me when you are finished. Do you have any questions? (Rofey, et al., 2004)

When the participant said that she was ready to continue, the researcher began the program and went to the other side of the partition to reduce distraction. If the participant asked more than one question after the Stroop task began, her data were not included in further analysis since this latent response provided skewed reaction times. The data of 9 participants were excluded as a result of this criterion. After the Stroop task was completed for the condition, the participants answered questions pertaining to level of workload difficulty and to level of craving pertinent to the condition. After both conditions, the participant was given credit for the experiment and left the room.

Data analysis. Independent variables for the current a priori hypotheses were: (1) the EDI-BN subscale to assess disordered/bulimic symptomatology; (2) the AUDIT overall score to demarcate hazardous drinking; (3) the FCQ-S to score food craving; and (4) the OCDS to assess alcohol craving. The independent variables of interest for the exploratory analyses were (1) the EDI-Drive for Thinness scale to measure unhealthy disordered thoughts surrounding food; (2) the AUDIT total to gauge problematic drinking; (3) EPQR-Neuroticism to gauge the propensity to experience negative emotional states; and (4) EPQR-Psychoticism to assess impulsivity.

While the overall NASA Task Load Index was calculated, no significant findings were found; however, mean weighted ratings on the subscales of the TLX were

determined. Mental Demand (mental or perceptual activity required), Performance Demand (success in accomplishing the task), Effort (difficulty of work to accomplish the level of performance), and Frustration (level of discouragement completing the task) were hypothesized to load significantly onto overall workload for this task. Pearson product correlations showed that EDI-BN and AUDIT scores were significantly correlated with scores on the significant subscales of the NASA-TLX—Mental Demand, Performance, and Effort ($r = .23$, $.16$, and $-.18$, respectively). The data in Table 2 were subjected to a 2 (Modality) X 5 (Subscales) ANOVA. The main effect for subscales was statistically significant, $F(1, 175) = 13.6$, $p < .05$. Thus the subscale scores were used in all subsequent analyses. It is evident that Mental Demand (MD; 125.8) and Performance (P; 118.0) contributed most to workload and that Physical Demand (PD; 23.3) contributed least on the overall NASA-Task Load Index. Due to the inverse relationship between the Effort subscale score on the NASA-Task Load Index and the other independent and dependent variables, this scale was not used as a dependent variable.

The Mental Demand and Performance subscale scores were similar for all analyses. Both results will be referred to within the text, and figures will illustrate the Performance subscale as the dependent variable to reduce report redundancy. In addition, since all participants received both the food and alcohol conditions in counterbalanced order, corresponding food-related mental workload ratings and alcohol-related mental workload ratings exist. The food and alcohol conditions were counterbalanced with an intervening task to reduce carryover effects. These ranking differences were not statistically significant for the Mental Demand and Performance subscales and the food and alcohol conditions were significantly correlated, $r = .62$, $p < .05$. Therefore, for the

food-related hypotheses, the food related mental workload is used as the dependent variable; similarly the alcohol related mental workload is used as the dependent variable for all alcohol-related hypotheses. However, since these measures did not differ from each other within the individual, a combined food mental workload subscale scores + alcohol mental workload subscale scores will be used as the dependent variable for hypotheses relevant to both food and alcohol.

A hierarchical regression analysis was used to assess whether women with problematic eating and hazardous drinking rated subscales of workload as more demanding than women without disordered eating and drinking. For this regression, the independent variables were the symptoms of disordered eating and problematic drinking as reported on the EDI-BN scale and AUDIT, respectively. The dependent variable was calculated by combining the individual Mental Demand and Performance workload subscale scores that were significant on the eating and drinking olfactory cues and Stroop task (e.g., Performance for alcohol and eating workload scores were combined to attain a Performance combined score). Conversely, the hierarchical regression analyses assessing whether craving acted as a moderator for the relationship between subjective workload and disordered eating utilized the workload rating based on the matched cue condition. For example, to test whether craving moderated the relationship between disordered eating and the mental demand/performance subscales on the NASA-TLX, only the food-related olfactory and Stroop cues were used. The same procedure was implemented for the analysis with hazardous drinking, craving, and alcohol Mental Demand/Performance workload scores.

The data analysis plan described is to test the specific hypotheses of the proposed study. Extensive preliminary data analyses were performed with the principal variables of interest. For each of the variables, descriptive statistics and univariate plots were computed. Appropriate measures of association (i.e., Pearson's product moment correlation coefficient) between the variables also were computed to identify important bivariate relationships. Table 1 shows descriptive statistics for the variables included in the regression analyses.

INSERT TABLE 1 HERE

Table 2 displays the mean scores for the workload subscales on the NASA TLX.

INSERT TABLE 2 HERE

Histograms of the independent variables and workload scales indicated normal distributions. Thus parametric tests were used for all data analyses. All variables of interest were centered in the regression analyses to reduce the covariance between the interaction term and the individual main effects (Aiken & West, 1991).

Pearson correlation analyses were used to test study hypothesis 1. Multiple regression analyses were performed to test remaining study hypotheses and exploratory hypotheses. To address whether disordered eating and problematic drinking had an additive effect on Mental Demand/Performance workload, a multiple regression analysis

was completed. Both independent variables—EDI-BN and AUDIT—were entered in Block 1. For subsequent analyses, the main effects were entered in the first step and the interaction effects were entered on the second step. Significant interactions were followed by post-hoc regression analyses (Aiken & West, 1991) to probe how craving and personality characteristics moderate the relations between workload and risks for eating disorders and hazardous drinking behavior.

Results

The results for study hypotheses will be presented first. These results will be followed by exploratory hypotheses focusing on individual difference variables.

Hypothesis 1: Relationship between disordered eating and problematic drinking.

As predicted and illustrated in Table 3, there was a statistically significant relationship between the three subscales of interest on the *Eating Disorder Inventory-2* (EDI-2; Garner, 1991) and the *Alcohol Use Disorders Identification Test* (AUDIT; Saunders, Aasland, Babor, de le Fuente, & Grant, 1993).

INSERT TABLE 3 HERE

First, Drive for Thinness, the tendency to have a relentless pursuit of thinness with an accompanying fear of fatness, was more likely to occur in women who were also using alcohol at problematic levels, $r = .25, p < .01$. Second, as indicated by the BN subscale, the tendency to think about and to engage in bouts of uncontrollable overeating (bingeing) was more likely to occur in women who engage in hazardous alcohol consumption, $r = .28, p < .01$. Last, women who had distorted body images and were

dissatisfied with the overall shape and size of their bodies as reported on the Body Dissatisfaction subscale were more likely to use alcohol at harmful levels, $r = .17$, $p < .05$.

Hypothesis 2: Regression model for workload with disordered eating and problematic drinking as predictors. Measures of disordered eating and problematic drinking accounted for 17% of the variance in the performance workload for the combined (eating + alcohol) olfactory and Stroop conditions, $p < .05$. Partial variances showed that alcohol accounted for 11% of this variance.

Hypothesis 3: Regression model to test the moderator effect of food craving. Higher disordered eating scores were associated with more difficult ratings on the Mental Demand and Performance subscales of the NASA-TLX. A statistically significant main effect for the EDI-BN was found on the mental demand and performance subscales of the NASA Task Load Index [$t(175) = -2.32$, $p < .05$ and $t(175) = -1.90$, $p < .05$, respectively]. As seen in Table 4, the interaction effect of the Food Craving Scale-State was non-significant, as was the EDI-BN X FCQ-S interaction.

INSERT TABLE 4 HERE

Hypothesis 4: Regression model to test the moderator effect of alcohol craving. Higher problematic drinking scores were associated with more demanding ratings on the alcohol-related Mental Demand and Performance subscales of the NASA-TLX. A statistically significant main effect between the AUDIT was found on the mental demand and performance subscales of the NASA Task Load Index [$t(175) = -1.90$, $p < .05$ and

$t(175) = -2.20, p < .05$, respectively]. As can be seen in Table 5, the effect of the Obsessive Compulsive Drinking Scale was insignificant, as well as the AUDIT X OCDS interaction.

INSERT TABLE 5 HERE

Exploratory Hypotheses 1: Regression model for workload according to Drive for Thinness and Neuroticism. As proposed and illustrated in Table 6, the regression equation for Performance workload, Drive for Thinness, and Neuroticism explained 6% of the variance [$F(3, 175) = 3.28, p < .05$].

INSERT TABLE 6 HERE

A statistically significant interaction effect between Drive for Thinness and Neuroticism was found on the Performance subscales of the NASA Task Load Index. The significant Drive for Thinness X EPQ-Neuroticism interaction indicated that Neuroticism acted as a moderator and changed the strength of the relationship between Performance workload and Drive for Thinness.

To examine how performance workload associated with the relation between Drive for Thinness and EPQ-Neuroticism, the interaction was plotted, and post hoc regression analyses were performed. Following the guidelines suggested by Cohen and Cohen (1983), high and low conditions of Drive for Thinness were set 2 standard deviations

above and below the mean EDI subscale score. Similarly, standard deviations were used to set high and low levels of Neuroticism on the EPQ-R, as well.

As shown in Figure 1, the workload scores changed for women with and without troubled mindsets for thinness, moderated by high and low levels of neuroticism.

INSERT FIGURE 1 HERE

These results show that among women who reported high Neuroticism, those who reported a high Drive for Thinness reported the olfactory and Stroop tasks to be significantly more demanding on the Performance subscale ($t = 1.96, p < .05$) than those who reported low Drive for Thinness and Neuroticism. Among women who reported low Neuroticism, women with high and low Drive for Thinness did not differ significantly on their rating of the tasks difficulty ($ps \geq .59$).

Exploratory Hypothesis 2: Regression model for workload according to AUDIT and Psychoticism. As shown in Table 7, the regression equation for workload, problematic drinking, and EPQR-Psychoticism explained 6% of the variance [$F(3, 175) = 3.37, p < .05$].

INSERT TABLE 7 HERE

A statistically significant interaction effect of problematic alcohol use and EPQR-Psychoticism was found on the Performance subscale of the NASA Task Load Index.

The significant AUDIT X EPQR interaction indicated that EPQR-Psychoticism acted as a moderator and changed the strength of the relationship between the workload subscales and problematic drinking.

To examine how the workload subscales associated with the relation between problematic drinking and EPQ-Psychoticism, the interaction was plotted, and post hoc regression analyses were performed. Following the guidelines suggested by Cohen and Cohen (1983), high and low conditions of problematic drinking were set 2 standard deviations above and below the mean AUDIT score. Similarly, standard deviations were used to set high and low levels of Psychoticism on the EPQR, as well. Statistical probing setting the conditions at 2 standard deviations above and below the AUDIT and EPQR scores yielded more clinically meaningful results than those results from analyses with high and low conditions set at 1 standard deviation.

As shown in Figure 2, the workload scores changed for women with and without problematic drinking, moderated by high (frequent) and low (infrequent) levels of EPQR-Psychoticism.

INSERT FIGURE 2 HERE

These results show that among women who reported high Psychoticism, those who reported a high level of problematic drinking reported the olfactory and Stroop tasks to be significantly more demanding ($t = 2.68, p < .05$) than those who reported a low level of problematic drinking and impulsivity. Among women who reported low Psychoticism,

women with high and low levels of hazardous drinking did not differ significantly on their rating of the tasks demand ($ps \geq .68$).

Discussion

Summary

This is the first investigation to utilize the concept of mental workload in an investigation of cognitive factors in clinically relevant variables. In this study, the results revealed that both disordered eating and problematic drinking contributed to the women's rating the olfactory and Stroop tasks as being difficult on measures of Mental Demand and Performance. For subscales on the NASA-Task Load Index, problematic drinking accounted for more variance than disordered eating (11% versus 6%). While measures of food and alcohol craving did not prove to be significant moderators for the relationship between disordered eating and problematic drinking, respectively, levels of bulimic symptoms and hazardous drinking taken separately were related to the level of difficulty that the participants rated the olfactory and visual cues on measures of mental workload. For women who reported high Neuroticism, those with high disordered eating symptoms reported more difficulty in responding to salient cues than those with low disordered eating symptoms. Among women who reported low Neuroticism, women with high and low Drive for Thinness did not differ significantly on their ratings of task demand. Similarly, among those who endorsed high impulsivity (as measured by the EPQ Psychoticism scale), women who engaged in more hazardous drinking rated alcohol salient cues as more mentally difficult than women who reported lower level of hazardous drinking. Among women who reported low Psychoticism, women with high

and low levels of problematic drinking did not differ significantly on their rating of mental demand and performance difficulty.

Interpretation

Hypothesis 1: Relationship between disordered eating and problematic drinking.

Significant findings revealed a relationship between bingeing/purging behaviors and problematic drinking. Comorbidity is a common and important issue to address when diagnosing, treating, or studying psychopathology. Eating disorders are most frequently described as comorbid with depression and anxiety (Swift, Andrews, & Barklage, 1986). Holderness and her colleagues also show in a meta-analysis that the co-occurrence of eating disorders and problematic drinking is relatively common. The problematic drinking is more prevalent for persons diagnosed with BN than those diagnosed with AN nervosa, given the impulsivity associated with both bulimic symptomatology and hazardous drinking (Holderness, Brooks-Gunn, & Warren, 1994; Garfinkel, Moldofsky, & Garner, 1980). Despite the lack of empirical work, a number of explanatory hypotheses have been put forward focusing on genetics, family environment, coping styles, and personality (Kozyk, Touyz, & Beumont, 1998; Krahn, Kurth, Demitrack, & Drewnowski, 1992; Xinaris & Boland, 1990). In the present investigation, issues surrounding control, craving, personality, and cognitions were at the forefront.

Hypothesis 2: Relationship of workload, disordered eating, and problematic

drinking. Results revealed that both disordered eating and hazardous drinking contributed to the women's rating the olfactory and Stroop tasks as being difficult on measures of Mental Demand and Performance. It is evident that Mental Demand and Performance subscales contributed most to overall workload ratings for women high in

disordered eating and problematic drinking on the disorder salient Stroop task and olfactory cues. Problematic drinking appeared to be more predictive than disordered eating for women rating task difficulty on the Mental Demand and Performance subscales on the NASA-Task Load Index. In addition, this study shows support for treating and decreasing the amount of alcohol consumed prior to treating the disordered eating. When women engage in hazardous drinking, there is sufficient evidence that bulimic symptoms will not remit. However, when problematic drinking is low, disordered eating may be more cognitively manageable while still being a complicated presenting problem (Grilo et al., 2002).

This finding can also be explained in that women high in both disordered eating and problematic drinking are using excessive resources to deal with the salient cues. Multiple, pertinent cues are being responded to simultaneously; consequently, women rate olfactory and Stroop tasks as more demanding on measures of Mental Demand and Performance. During the cognitive tasks, the women are making continuous discriminations without rest. The continuous nature of the mental work does not allow for full replenishment of resources and thus the appropriate responses are rated as more demanding.

Similar to the description above and utilizing a social explanation, the limited resources are being expended (Baumeister & Heatherton, 1996; Baumeister, Muraven, & Tice, 2000). The same resource is used to regulate thoughts, control emotions, and inhibit impulses. A person high in disordered eating and/or hazardous drinking must resist temptation for the substance and exert strong self-control to prevent her from

carrying out a strong but forbidden impulse. There is a depletion of resources due to the self-regulation necessary to suppress thoughts and emotions pertaining to the substances.

Hypotheses 3 and 4: Craving as a moderator of the relationship among disordered eating, problematic drinking and mental workload. Interestingly, both analyses involving craving resulted in non-significant results for the craving main effects and interaction effects with the disordered eating and problematic drinking. Since 1955, there have been many articles debating the use of craving in science (Gendall, Joyce, & Sullivan, 1997; Kozlowski & Wilkinson, 1987; Pickens & Johanson, 1992; Rankin, Hodgson & Stockwell, 1979; Shiffman, Hughes, West, & Marlatt, 1987; WHO Expert Committee on Mental Health, 1955; Wise, 1988). DSM-IV-TR (APA, 2000) does not contain any discussion of the term and cravings have generally been viewed as a motivational and individualistic state within the person.

The existing literature on food and alcohol cravings has several limitations that may help to explain the insignificant findings. First, the operational definition is still uncertain and the majority of studies rely on the participant's subjective understanding of the term (Hill, Weaver, & Blundell, 1991; Kozlowski, Mann, Wilkinson, & Poulos, 1989; Singleton & Gorelick, 1998; Weingarten & Elston, 1991). For example, Marlatt and Gordon (1985) proposed that cravings be distinguished from urges by calling the former a subjective motivational state and the latter an intention to engage in the behavior. Kozlowski, Mann, Wilkinson, and Poulos (1989) extended this research when 99 smokers were asked what the term craving meant to them. Fifty-five percent indicated that craving is any desire for the substance, even a weak one, while 49.5% of the

remainder reserved the term as indicative of a strong urge. All other subjects (15.2%) stated that a craving was neither of the above.

Second, studies examining the nature of food cravings are biased to certain groups within the population. Craving may have different implications for people on the low end of the disordered eating or problematic drinking continuum within this normal population. For example, people who are experiencing hunger pains may rate craving as being present (e.g., “I want a sandwich”) whereas people high in disordered eating symptomatology may rate craving as present if it predisposes a binge that meets clinical criteria (e.g., “I need to go through the fast-food window and order 4 hamburgers”).

Third, is the issue of a subjective threshold at which point a desire for a substance (food or alcohol) qualifies as a craving. While psychophysiological indices (e.g., heart rate, salivation, skin conductance) have been proposed as scientific measurements of craving, participants’ subjective self-report that a craving is present/absence may affect findings (Cooney, Baker, Pomerleau, & Josephy, 1984; Kozlowski & Wilkinson, 1987; Laberg & Ellertsen, 1987; Nirenberg & Miller, 1982; Wooley & Wooley, 1973). Thus, requiring convergent validity on different measures to ascertain this threshold is achieved may be more helpful.

Exploratory Hypothesis 1: Relationships for Workload According to EDI-Drive for Thinness and EPQ-Neuroticism. Study findings indicated that among women who reported high Neuroticism, those who reported a high Drive for Thinness reported the olfactory and Stroop tasks to be significantly more demanding on the Mental Demand and Performance subscales than those with low Drive for Thinness. Among women who reported low Neuroticism, women with high and low Drive for Thinness did not differ

significantly on their mental workload ratings of the tasks. Ballard (1996a, 1996b) identifies personality as the most significant individual difference in human factors research. Studies have reported that individual differences in human factors experiments can be explained by personality traits such as field dependence (Moore & Gross, 1973), Type A personality (Perry & Laurie, 1992), and locus of control (Sanders, Halcomb, Fray, & Owens, 1976). The study of the disorder-salient Stroop task provides an ideal condition to examine previous links with specific pathology and Eysenck's theory.

In the present investigation, this finding revealed that the association between bulimic symptomatology, Mental Demand and Performance subscales of the NASA Task Load Index were moderated by EPQ-Neuroticism. Neuroticism has also been found to be strongly associated with eating disorder symptom level (Diaz-Marsa, Carrasco, & Saiz, 2000; Gual, et al., 2002; Tylka & Subich, 1999), and has been predictive of subsequent bulimic symptomatology including future binge episodes and compensatory behavior (Leon, Keel, Klump, & Fulkerson, 1997).

Exploratory Hypothesis 2: Relationships for Workload According to Alcohol Use and EPQ-Psychoticism. Results showed that among women who reported high impulsivity, those who reported a high level of problematic drinking reported the olfactory and Stroop tasks to be significantly more demanding on measures of Mental Demand and Performance than those who reported low problematic drinking. Among women who reported low impulsivity, those with high and low levels of hazardous drinking did not differ significantly on their rating of the tasks' demand. Given these findings, it is important to address the underlying traits in the Eysenck Personality Questionnaire-Revised (EPQ-R; Eysenck, Eysenck, & Barrett, 1985). To begin, Eysenck

and Eysenck (1985) defined Psychoticism as tough-mindedness, non-conformity, hostility and impulsivity. Further, this classification system is a combination of four basic habits: (a) narrow impulsivity, (b) nonplanning, (c) liveliness, and (d) risk-taking (Eysenck & Eysenck, 1977). In regards to a problematic drinking framework, this scale correlates with physiological measures (e.g., heart rate), drinking behavior in the lab, and self-reported drinking (Conrod, Petersen, Pihl, & Mankowski, 1997). These findings suggest that impulsivity may be a predisposing factor to alcohol consumption, and therefore an important underlying factor when evaluating mental workload in persons with problematic drinking.

An overarching finding was also found showing that the more symptomatology participants experienced (e.g., the more disordered eating and problematic drinking; the more disordered eating and neurotic; the more problematic drinking and psychotic), the less effort as rated on the NASA-TLX Effort subscale the participant put forth. From a resource model of attention, women may be affected by the salient food and alcohol words because these cues are connected to things that are meaningful; resources are being used to process these extraneous thoughts. As a coping mechanism, the women exert less effort as the cognitive task becomes cognitively taxing. Similarly, Muraven, Tice, and Baumeister (1998) argue that people have a limited capacity for self-regulation, similar to a limited supply of strength or energy. Thus, exertion will be followed by a period of diminished capacity. When these women engage in self-regulation of the visual and olfactory cues, they show subsequent decrements on effort because of their regulatory depletion (see Muraven, Tice, & Baumeister, 1998; Vohs and Heatherton, 2000; Wegner, 1994).

Recent studies have adopted a resource theory, a position that is widely used to characterize attention and information-processing (Gopher & Kimchi, 1989). Resources have been conceptualized as reservoirs of energy that can be dedicated to information-processing tasks (Hirst & Kalmar, 1987). Parasuraman and his colleagues (Davies & Parasuraman, 1982; Parasuraman, 1979; Parasuraman & Davies, 1977; Parasuraman, Warm, & Dember, 1987; Warm & Dember, 1998) have adopted a unitary approach, proposing that because of the need to make continuous discriminations under conditions of great uncertainty and little opportunity for situational control, attention tasks consume processing resources that are not replenished in the time available. If there are finite resources to use to help pay attention to several stimuli/cues, then women with more symptoms indicative of problematic eating and drinking who are experiencing underlying personality traits may expend a great deal of available resources attending to these stimuli. This would drain available resources and adversely influence workload.

Clinical Implications

As indicated by the correlations between disordered eating and problematic drinking, co-occurrence of symptoms related to disordered eating and problematic drinking can complicate treatment of one or both conditions. To begin, routine screening in these populations is important; for example, clinicians/researchers should assess these patients carefully for the co-occurrence of ED and not attribute abnormal eating behavior to symptomatic expression of alcohol use (Jonas & Gold, 1987; Blinder, Blinder, & Sanathara, 1998). While more research needs to be done on treating these co-occurring disorders, addressing both disorders seems to be a reasonable starting point (Grilo, Sinha, & O'Malley, 2002). As evidenced by the finding that hazardous drinking affects mental

workload above what is accounted for by disordered eating, it may be more advantageous to first address and reduce alcohol consumption. Cognitive behavioral therapies may be enhanced by targeting automatic thoughts pertaining to food and alcohol that underlie complicated schemas about coping with these pathological thoughts (Beck et al., 1985; Brownell & Fairburn, 1995; Garner & Garfinkel, 1997). These results, as they pertain to salient olfactory and visual cues, also support the use of systematic desensitization – muscle relaxation with visual imagery or direct exposure to a series of situations that involve food and alcohol cues. In using this technique, therapy would assist in lessening the salience of the pertinent cues (Key, George, Beattie, Stammers, Lacey, & Waller, 2002). It may also be helpful for a researcher/therapist to take into consideration that craving seems to be a concept that is hard for an individual to identify and may be a helpful target for intervention. Since the majority of “relapses” may occur due to retrospective craving (Kozlowski, et al., 1989), helping the client to identify triggers, instances, and coping mechanisms to urges may prove to be more effective.

Due to the exploratory findings related to neuroticism and impulsivity, underlying personality characteristics should be considered in assessing the co-occurring conditions. While addressing clinical interventions, cognitive-behavioral therapies may be enhanced by targeting the negative personality traits that underlie disordered eating and drinking (Beck, Emery, & Greenberg, 1985; Brownell & Fairburn, 1995; Garner & Garfinkel, 1997). Research has consistently linked patients with BN – purge subtypes to personality profiles with more impulsivity; whereas BN – restricting subtypes are typically more perfectionistic (Westen & Fischer, 2001). Moreover, being able to identify these varying personality subtypes may allow for clearer conceptualizations with co-occurring

disorders; women with BN who purge are more likely to have alcohol problems as a result of the underlying similarities (Bamber, Cockerill, & Carroll, 2000). Conversely, people suffering with bulimic symptoms who also restrict their food intake are less likely to engage in hazardous drinking but more likely to be depressed (Westen & Fischer, 2001).

Study Limitations and Future Directions

The current investigation has some limitations, including (1) a homogenous sample, (2) issues related to craving measurement, and (3) low variance accounted for in the analyses with personality variables. Future research using this information processing approach to psychopathology should use control and clinical samples with women diagnosed with ED, AA, and a personality disorder. Since craving measures were not significant moderators for the models proposed, alternative measures that are more sensitive and hold up under scrutiny could serve as predictors for cognitive outcomes (e.g., hunger has been found to be positively correlated with binge eating episodes more so than craving). Defining the term craving for the participants may also help to operationalize the concept. It may also be helpful to control for variables that affect situation-specific craving (e.g., time of day, food eaten prior to testing situation). While the exploratory analyses provided information about individual differences, incorporating more detailed Axis II questions may lead to more variance accounted for in the regression models. While this is a new paradigm within clinical psychology, it may be advantageous to compare the NASA-TLX profiles with other human factors profiles (e.g., vigilance, memory, tracking, time estimation). Human factors researchers have

spent decades studying vigilance and fatigue, two cognitively oriented facets that can lend themselves to psychopathology to better understand the underlying symptomatology.

In conclusion, this novel paradigm combining clinically-relevant variables in an information-processing approach may serve to shed light on underlying cognitive and personality variables. Women endorsing disordered eating and problematic drinking pose a complicated presentation to both researchers and clinicians who must attain accurate symptom levels and provide beneficial treatment interventions. Further, it argues that broad cognitive behavioral interventions targeting co-occurring symptomatology possibly alongside personality characteristics may be conducive in lowering issues of mental demand and subjective performance.

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Table 1 - Means and standard deviations for the variables included in the regression analyses

Variable	M	(SD)	Range
1. AUDIT	5.79	5.66	0-32
2. EDI-2 – Drive for Thinness	5.30	6.34	0-22
3. EDI-2 – Bulimia	2.33	5.81	0-32
4. EPQ-R – Psychoticism	2.49	1.83	0-8
5. EPQ-R – Neuroticism	5.64	3.30	0-12

Table 2 – Mean weighted ratings for the NASA-TLX subscales in each condition.
(Standard deviations are in parentheses).

Condition	<u>MD</u>	<u>PD</u>	<u>TD</u>	<u>P</u>	<u>E</u>	<u>F</u>	<u>Mean</u>
Alcohol	123.86 (105.56)	24.80 (54.96)	99.71 (105.76)	117.02 (121.70)	124.77 (120.44)	43.68 (76.04)	88.973
Food	127.65 (114.45)	21.84 (48.57)	81.38 (97.64)	118.98 (121.27)	122.19 (112.53)	60.36 (119.65)	88.733
Mean	125.755	23.32	90.55	118.0	123.48	52.02	88.853

Note. MD = Mental Demand, PD = Physical Demand, TD = Temporal Demand, P = Performance, E = Effort, F = Frustration

Table 3 – Relationship between disordered eating and problematic drinking

Variable	2	3	4
1. AUDIT	.25 ^b	.28 ^b	.17 ^a
2. EDI – Drive for Thinness		.59 ^b	.71 ^b
3. EDI – Bulimia			.61 ^b
4. EDI – Body Dissatisfaction			--

^a $p < .05$.^b $p < .01$.

Table 4 – Regression Model for Performance Workload (Eating) by EDI – Bulimia and State Food Craving Questionnaire

Predictors	R ²	B	Beta
Step 1: Main effect	.05 ^a		
EDI – Bulimia		.10 ^a	.19 ^a
State Food Craving Scale		.04	.15
Step 2: Interaction effect	.06		
EDI – Bulimia X FCQ-S		-.00	-.09

^a p < .05.

Table 5 – Regression Model for Performance Workload (Drinking) by AUDIT and Obsessive Compulsive Drinking Scale

Predictors	R ²	B	Beta
Step 1: Main effect	.06 ^a		
AUDIT		-6.36 ^a	-.21 ^a
OCDS		-1.04	-.03
Step 2: Interaction effect	.07		
AUDIT X OCDS		.65	.17

^a p < .05.

Table 6 – Regression Model for Performance Workload (Eating) by EDI – Drive for Thinness score and EPQR – Neuroticism

Predictors	R ²	B	Beta
Step 1: Main effect	.014		
EDI – Drive for Thinness score		3.17	.17
EPQR – Neuroticism		-8.84 ^a	-.23 ^a
Step 2: Interaction effect	.061 ^a		
EDI – Drive for Thinness X EPQR		-.16 ^a	-.54 ^a

^a p < .05.

Table 7 – Regression Model for Performance Workload (Alcohol) by AUDIT score and EPQR-Psychoticism

Predictors	R ²	B	Beta
Step 1: Main effect	.018		
AUDIT score		-3.81 ^a	-.174 ^a
EPQR-Psychoticism score		-3.67	-.057
Step 2: Interaction effect	.063 ^a		
AUDIT X EPQR		2.08 ^a	.219 ^a

^a p < .05.

Figure 1: Relation between Performance Workload and Drive for Thinness score for low and high Neuroticism

Note: Highs and lows were graphed 2 standard deviations above and below means

Figure 2: Relation between Performance Workload and Alcohol Use for low and high EPQR—Psychoticism

Note: Highs and lows were graphed 2 standard deviations above and below means

Appendix

Instructions to Participants NASA-TLX

(Part I)

Rating Scales. We are not only interested in assessing your performance but also the experiences you had during the experiment. In the most general sense, we are examining the “workload” you experienced. Workload is a difficult concept to define precisely, but a simple one to understand generally. The factors that influence your experience of workload may come from the task itself, your feelings about your own performance, how much effort you put into it, or the stress and frustration you felt. In addition, the workload contributed by different task elements may change as you become more familiar with the task. Physical components of workload are relatively easy to conceptualize and evaluate. However, the mental components of workload may be more difficult to assess. Since workload is something that is experienced individually by each person, there are no set “rulers” that can be used to estimate the workload associated with different activities. One way to find out about workload is to ask people to describe the feelings they experienced while performing a task. Because workload may be caused by different factors, we would like you to evaluate several of them individually rather than lumping them into a single, global evaluation of overall workload. This set of six rating scales was developed for you to use in evaluating your experiences during this task. Please read the descriptions of the scales carefully. If you have any questions about any of the scales in the table, please ask me about them. It is extremely important that they be clear to you. You may keep the descriptions with you for reference while completing the scales.

[Allow the participant to read through the descriptions now]

For each of the six scales, you will evaluate the task by typing in a multiple of 5 that can range from 0 to 100 to reflect the point that matches your experience. Pay close attention to each scale's endpoint descriptors while making your assessments. Note that when the rating scale for PERFORMANCE appears, the scale will go from "good" on the left to "poor" on the right. This means that a low number will represent good performance, while a high number will signify poor performance. This order has been confusing for some people. Upon completing each scale, press the "return" key to go on to the next one. Read the description for each scale again before making your rating.

Do you have any questions?

(Part II)

Pairwise comparisons. Rating scales of this sort are extremely useful, but their utility is diminished by the tendency people have to interpret them in different ways. For example, some people feel that mental or temporal demands are the greatest contributors to workload regardless of the effort they expended in performing a given task or the level of performance they achieved. Others feel that if they performed well, the workload must have been low; and if they performed poorly, then it must have been high. Still others believe that effort or feelings of frustration are the most important determinants of their experiences of workload. Previous studies using this scale have found several different patterns of results. In addition, the factors that determine workload differ depending on the task. For instance, some tasks might be difficult because of the degree of mental or physical effort required. Some tasks may seem difficult because they cannot be performed well no matter how much effort is expended.

The next step in your evaluation is to assess the relative importance of the six factors in determining how much workload you experienced. You will be presented with pairs of rating scale titles (e.g. EFFORT vs. MENTAL DEMAND) and asked to choose which of the two items was more important to your experience of workload in the task that you just performed. Each pair of rating scale titles will appear separately on the video screen.

Type in “1” if the uppermost scale title in a pair represents the more important contributor to the workload of the task. Type in “2” if the lower scale title in a pair represents the more important contributor to workload. After indicating your response to a pair of scale titles, press the “return” key to go on to the next pair.

Please consider your choices carefully and try to make them consistent with your scale ratings. Refer back to the rating scale definitions if you need to as you proceed. There is no correct pattern of responses. We are only interested in your opinions.

Do you have any questions?

NASA-TLX rating scale definitions (Hart & Staveland, 1988).

Title/Source	Endpoints	Description
MENTAL DEMAND	<i>Low/High</i>	How much mental or perceptual activity was required (e.g., thinking, deciding, calculating, remembering, looking, searching, etc.)? Was the task easy or demanding, simple or complex, exacting or forgiving?
PHYSICAL DEMAND	<i>Low/High</i>	How much physical activity was required (e.g., pushing, pulling, turning, controlling, activating, etc.)? Was the task easy or demanding, slow or brisk, slack or strenuous, restful or laborious?
TEMPORAL DEMAND	<i>Low/High</i>	How much time pressure did you feel due to the rate or pace at which the task or task elements occurred? Was the pace slow and leisurely, or rapid and frantic?
PERFORMANCE	<i>Low/High</i>	How successful do you think you were in accomplishing the goals of the task set by the experimenter (or yourself)? How satisfied were you with your performance in accomplishing these goals?
EFFORT	<i>Low/High</i>	How hard did you have to work (mentally and physically) to accomplish your level of performance?
FRUSTRATION	<i>Low/High</i>	How insecure, discouraged, irritated, stressed, and annoyed <i>versus</i> secure, gratified, content, relaxed, complacent, did you feel during the task?