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The Differential Effects of Mental Fatigue and Alcohol on Selective Attention

Emily Keller Bloesch
Washington University in St. Louis, ekbloesc@artsci.wustl.edu

THE DIFFERENTIAL EFFECTS OF MENTAL FATIGUE AND ALCOHOL ON SELECTIVE ATTENTION

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Emily Keller Bloesch

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Emily K. Bloesch August 2008 56 Pages

Directed by: Dr. Daniel Roenker, Dr. Sharon Mutter, and Dr. Steve Wininger

Department of Psychology Western Kentucky University

Abstract

Decrements in selective attention are a commonly experienced phenomenon that has practical implications for many industries. Two causes of such deficits are mental fatigue and alcohol intoxication, which impair selective attention by decreasing the efficiency of inhibitory processes. The present research examined the effects of these two factors on the selective attention subtest of the Useful Field of View test in both a baseline and an experimental session. Participants in the mental fatigue condition (n = 14) were tested while performing a divided attention task for two hours to induce mental fatigue. Those in the alcohol condition (n = 10) were tested while achieving a peak blood alcohol content of 0.05%. No differences between the two groups were observed, nor was a significant decline in selective attention observed as a result of either manipulation. The results indicate three possible explanations for this lack of a difference including a floor effect on the selective attention task, a pop-out effect in switching from the divided to the selective attention task, and an increase in attentional effort regulation due to the contrast in difficulty of the divided and selective attention tasks.

Introduction

Imagine driving on a straight stretch of quiet interstate with a passenger: you are able to carry on a conversation easily and feel that you need to watch the road minimally. By contrast, imagine navigating city streets during rush hour: you are now watching traffic vigilantly and are asking your passenger to stop talking so you can concentrate. How is it that these two situations, which consist of essentially the same processes, produce such different reactions and outcomes? It is because of the difference in demand of attentional resources and their allocation. More demanding tasks require that one allocate attention carefully in order to focus fully on the relevant aspects. A number of different theoretical processes have been proposed to explain how this allocation may occur.

Attention has been conceptualized many ways, but three ideas have remained relatively popular and have received empirical support. The first is the characterization of attention as a filtering process. Broadbent (1982) proposed that a person will block out, or filter, irrelevant information very early in the selection process and that this generally occurs based on sensory differences between relevant and irrelevant stimuli. However, data also supports the theory that filtering occurs later in the attentional process (Deutsch & Deutsch, 1963). One example of this is found in dichotic listening tasks, where participants are presented with two separate stimuli, one in each ear, and instructed to attend to only one of the channels. At times, participants are presented with words that form a coherent message in one ear and consciously attend to that message. However, if the message is switched to the other ear mid-sentence, participants continue to track the message in spite of it being in the ignored ear (Johnston & Dark, 1986). This means that information is being processed and filtered on a semantic level, because sensory filtering would preclude participants from following the message to the unattended ear.

One of the practical problems with filtering is that it comes with a cost (Kahneman, Treisman, & Burkell, 1983). Kahneman et al. (1983) tested participants' ability to detect and name words and shapes in the presence of distractors that were either perceptually similar or dissimilar to the target. They found that the presence of any type of distractor produced slower reaction times, even to automated tasks such as reading a word. Additionally, they determined that filtering is not an "all-or-nothing" process, but rather that the more distractors that are present in an environment, the more reaction time will be slowed. This means that each individual distractor serves to add to the amount of interference in a response. Overall, they concluded that any act of selection, no matter how simple or seemingly easy, involves filtering and will come with a cost in response time.

The second conceptualization of attention is as a central processor that has a limited capacity. By this view, all information that is obtained through effortful attention is acted upon by a single set of resources. These resources will have no difficulty executing a single action, but two or more tasks that require the use of the central processor will produce interference and delay outcomes for all of the actions (Posner & Boies, 1971). However, there is variability in the use of resources, in that they can be allotted to different tasks or to separate areas in differing degrees (Eriksen & St. James, 1986). For example, if a display is simple enough, meaning it has few noise items to distract from locating the target, resources can be distributed equally, which results in a parallel search where participants scan all items in the display simultaneously. If the display is more difficult and contains many distractor items, resources must be concentrated and search will proceed in a serial manner, where participants scan each item before moving on to the next. This leads to the final characterization of attention, which is that it is similar to a spotlight or a zoom lens.

The model of attention as a spotlight is a capacity model that suggests that resources can either be distributed over a field or focused in one spatial field. Because there is a functional limit on the available resources, the greater the area over which they are distributed the more thinly they will be spread. This results in the ability to respond to a stimulus in a large field, but a slower response time because fewer resources are allotted to each object. On the other hand, if the area is very small all the resources can be concentrated, allowing a person to respond to just one area or stimulus in a field but also to do so very quickly (Posner, Snyder, & Davidson, 1980). One problem with the spotlight model is that it does not specify whether attention is either focused or distributed, at the two extremes, or if it can be distributed unequally. Unequal distribution implies that the attentional spotlight may simultaneously be focused on multiple areas or focused on one area while it is distributed across the rest of the visual field. Eriksen and St. James (1986) contended that instead of lying at either extreme, attention is actually on a continuum from focused to distributed. They explained that this zoom lens model is similar to the spotlight theory in that a wider field results in a greater area within one's frame but less information extracted from each item, and a smaller, "zoomed-in" field results in a small frame but allows for maximal information extraction. The difference is that the zoom lens model envisions a scale between these two points where there continues to be a relatively equal trade-off between field size and the amount of information obtained. These two models have received much empirical support and have increased our understanding of the distribution of visual attention (Podgorny & Shepard, 1983), signal detection (Posner et al., 1980), and the shape of visual attention (Eriksen & St. James, 1986).

While the above discussion pertains to attention in general, there are actually three types of attention: focused, divided, and selective. Posner et al. (1980) aptly said of focused attention that "Detecting the presence of a clear signal in an otherwise noise-free environment is probably the simplest perceptual act of which the human is capable" (p. 160). Because of this, it allows for the study of basic attentional processes without the confounding issue of distractors. Divided attention consists of splitting attention equally between two separate and distinct stimuli. This has commonly been tested through the use of dichotic listening tasks (Somberg & Salthouse, 1982), but is also assessed using dual visual displays. Divided attention tasks allow attention to be studied under greater constraints such as heavier workload, which can shed light on resource and capacity abilities.

Selective attention is the process through which multiple sources of information are processed differentially based on relevance (Johnston & Dark, 1986), and it is what is employed most often in directing thought and action. This is because organisms are rarely, if ever, faced with a single stimulus to which they must attend. The environment is rich with distractors, from noises to visual cues to superfluous thoughts. For example, in order to drive safely one must necessarily attend to the road, other vehicles, signs, even pedestrians. But one must also refrain from being distracted by the radio, loud passengers, or considerations of personal problems or upcoming activities. If a person is unable to do this, he will not be able to drive optimally and is more likely to be involved in an accident. Therefore, selective attention is essential in order to complete a task efficiently and optimally.

Selective attention consists of dual processes that involve both enhancing relevant features of a task and inhibiting irrelevant features. Returning to the driving example given above, these processes would enhance stimuli such as the road while inhibiting or suppressing distracting stimuli such as passengers. Enhancement is achieved through the activation of mental representations that are important to task completion. Similarly, suppression occurs when inhibition mechanisms act on representations that have been activated by distractor input (Tipper, Weaver, & Kirkpatrick, 1991). Another way to conceptualize this process is through a match/mismatch paradigm. When visual input is received, the information is reviewed to find an object that matches one's internal representation of the target. Matching objects are activated, while mismatching objects are inhibited in order to prevent not only an incorrect response, but also the slowing of a reaction to the target (Houghton, Tipper, Weaver, & Shore, 1996).

Houghton et al. (1996) explain why it is necessary to have two separate systems for selective attention. First, with two systems the activation levels of the target and distractor can be more quickly and more widely separated. This is because the target's activation level will increase while the distractor's activation level decreases, as opposed to the target's activation level increasing against a stable, competing distractor. Second, if two stimuli of similar strength are detected, neither representation would be able to be selected by either excitatory or inhibitory mechanisms alone. This is because with two intense stimuli, there is little room for enhancement of a target, while with two very weak stimuli there is little room for inhibition. It is only by using both systems that a target can always be detected.

One phenomenon that provides support for the inhibition theory of selective attention is negative priming (Tipper, 1985). In negative priming, both a target and a distractor are presented simultaneously during a trial. In the proceeding probe trial, the distractor is then presented as the target. Reaction times in the probe trials have been found to be significantly slower than baseline trials, and this slowing has been attributed to the attempt to process inhibited internal representations (Tipper et al., 1991). As expected, the less a distractor is attended to, such as if there are many distractors to choose from, the less negative priming is observed.

While there is much support for the inhibition theory, others believe that selective attention actually works by enhancing relevant information instead of suppressing irrelevant information. Egner and Hirsch (2005) have found that this may actually be the case. They explain that the brain region usually thought to be responsible for inhibitory control, the prefrontal cortex (PFC), can perform the same functions through enhancement and that it intuitively makes more sense to conceptualize the PFC as being responsible for executing goal-directed thought and action instead of inhibiting stimuli that would interfere with this process. To test this, they presented participants with pictures of faces with words superimposed and varied whether the face or the word was the relevant information to which they should respond. The faces were of famous individuals, with either that individual's name printed over the face (a congruent trial) or another individual's name printed over the face (an incongruent trial). By doing this, Egner and Hirsch (2005) were able to differentiate between neurological responses following either congruent trials, where cognitive control is low, or incongruent trials, where cognitive control is high.

The authors found that on trials where the face was relevant, the brain region within the PFC that is active during face recognition, the fusiform face area (FFA) was indeed active. While it was active following congruent trials, it showed even higher levels of activity following incongruent trials. However, no modulations in activity in the FFA were observed following trials where the face was irrelevant. Egner and Hirsch (2005) explain that this finding indicates that the FFA was not inhibited when it was irrelevant; it was merely not active. This is because one would expect varying levels of activity in an area that is being inhibited when the level of available cognitive control varies, but this was not found. This supports the view of selective attention as an enhancement process, not an inhibitory one. Unfortunately, there are few studies at this point that have looked at selective attention from this angle, most likely in part because there are few, if any behavioral paradigms that allow one to separate enhancement from inhibitory processes. Perhaps with the greater use of neuroimaging research this question will find greater clarity.

The effects of impaired selective attention are far-reaching, especially in our present society that demands services 24-hours-a-day and makes few allowances for rest or recuperation. Many of today's occupations require sustained attention, such as ship, air, truck, rail, or plant operators, and maintaining a level of attention necessary for adequate performance has proved difficult (Jung, Makeig, Stensmo, & Sejnowski, 1997). One study on railway accidents in Australia highlights the impact of selective attention in industry (Edkins & Pollock, 1997). The aim of the study was to determine the contributing factors that appeared as common denominators in railway accidents. This was accomplished by first retrospectively categorizing the type of accident, such as a collision or operating a train in an unauthorized area. Each accident was then traced back to determine whether the event was precipitated by active failures on the part of the train operator or by latent failures on the part of the organization. These failures were further classified as being the result of either an unintended error or an intended violation, as well as whether the violations were allowed by the organization or necessary. Independent raters further classified accidents according to psychological precursors, which included both individual and organizational factors that influenced the accident. Finally, a checklist was developed that allowed railway workers and management to report problems that may lead to decreased safety, and this information was used to classify each accident by the most pervasive problem. They found that 70% of all accidents were due to attentional factors such as the misallocation of attention (Edkins & Pollock, 1997). It will only be through discovering the factors that affect and impair selective attention that industry will be able to begin to prevent these incidents. The current research will examine two such factors, mental fatigue and alcohol.

Mental Fatigue

Historically, mental fatigue has been difficult to define. This has stemmed in part from a lack of research on the topic, and unfortunately has also contributed to the continued trouble in understanding a commonly-experienced phenomenon (Boksem, Meijman, & Lorist, 2005). Many definitions address the external cause of mental fatigue, such as one given by Boksem et al. (2005): “Mental fatigue refers to the effects that people may experience after or during prolonged periods of cognitive activity” (p. 107).

This does not give any information as to the internal systems that underlie fatigued states or any probable outcomes. Other definitions set more boundaries, such as van der Linden, Frese, and Sonnentag's (2003) that states, "Mental fatigue can be defined as a psychophysiological state resulting from sustained performance on cognitively demanding tasks and coinciding with changes in motivation, information processing, and mood" (p. 484). Again, this does not explain any internal causes of fatigue, which are of central interest if fatigue is to be fully understood.

The definition of mental fatigue used for the purposes of this research is given by Soames-Job and Dalziel (2001): "Fatigue refers to the state of an organism's…central nervous system, in which prior…mental processing, in the absence of sufficient rest, results in insufficient cellular capacity or system-wide energy to maintain the original level of activity and/or processing by using normal resources" (p. 469). This definition is the most comprehensive and useful for a number of reasons. First, the external cause of mental fatigue is addressed by attributing the state to "prior mental processing," which can mean any type of mental activity from sustained attention to an auditory task. Second, "in the absence of sufficient rest" implies that the amount of necessary rest varies from person to person and that any amount of rest to be had within a given task may be enough to counteract the effects of mental fatigue. Third, "insufficient cellular capacity or system-wide energy" locates the internal cause of mental fatigue, be it on the neural cellular level or a system-wide level. Finally, "to maintain the original level of activity and/or processing by using normal resources" indicates that while there is a change in mental processing due to fatigue, performance itself may not decline. This is because other internal or external resources may be used to compensate for failing systems until sufficient rest is obtained (Soames-Job & Dalziel, 2001).

Given the above definition of mental fatigue, it is not surprising that there are countless methods by which to induce such a state. A variety of procedures has been used in the literature, although the most common technique is via computer. Standard procedure has the participant perform a computer-based task such as a continuous performance task (van der Linden, Massar, Schellekens, Ellenbroek, & Verkes, 2006), a scheduling task (van der Linden et al., 2003), or a switch task (Lorist et al., 2000) for between one and a half to three hours. However, it should again be noted that while computer-based tasks are most common for inducing mental fatigue, other methods are also used. For example, a study by Matthews and Desmond (2002) induced mental fatigue by having participants drive in a simulator while performing a secondary task of monitoring for pedestrians. Performance is then assessed as time on task (Galinsky, Rosa, Warm, & Dember, 1993) or through the use of a separate cognitive measure, such as the Wisconsin Card Sorting Task (van der Linden, Frese, & Meijman, 2002). In the latter case, cognitive measures are administered after mental fatigue induction to locate declines in performance.

Mental fatigue's effects can be broken down into three distinct categories: subjective, behavioral, and physiological responses. Subjective responses are those reported by participants during the course of an experiment. When fatigued, participants commonly complain of a diminished capacity for work, disinclination to apply effort to the task, perceived reductions in personal efficiency, and subjective discomfort and tiredness (Matthews & Desmond, 2002). Participants are more likely to become irritable and experience negative mood shifts (Galinsky et al., 1993) and because of this are more likely to disengage from the task itself (van der Linden et al., 2003).

These complaints are often difficult to separate conceptually from other factors such as a lack of motivation, boredom, habituation, or physical fatigue. However, mental fatigue is qualitatively distinct from these issues, especially when regarded in light of the definition given above. A lack of motivation and boredom may result from previous exposure to a task, performing a task that is too simple, or being disinterested in the task, and these two problems often manifest as performing at suboptimal levels. But these two problems are not linked to cellular or system-wide energy decrements, so unlike mental fatigue, performance will not be improved by rest (Soames-Job and Dalziel, 2001). Habituation may also initially appear behaviorally similar to mental fatigue, but habituation is a form of learning and is once again not linked to a lack of energy, so habituation to a stimulus will persist over rest while mental fatigue will not (Soames-Job and Dalziel, 2001). Physical fatigue is also a separate entity. Mental fatigue is strongly marked by aversion, whether it is to expend any more mental energy or to continue a task, while physical fatigue is not. These two states highlight the difference between being willing to apply effort but not being physically able and being physically able to apply effort but not being willing (Schwartz, 1999).

One of the most consistent behavioral impairments caused by mental fatigue is a change in attention. Attentional tasks show a decline in performance due to sustained attention (Galinsky et al., 1993), which includes not only a decrease in signal detection probability, but also an increase in overall reaction times. While mentally fatigued, participants shift from exhibiting goal-driven behavior to stimulus-driven behavior (van der Linden et al., 2003). Goal-driven behavior consists of executing planned actions to accomplish a purpose, whereas stimulus-driven behavior consists of responding to environmental information based on its salience. Participants may make this shift because mental fatigue weakens the general cognitive inhibitory process (Schwartz, 1999). In order to perform a task optimally, one must not only pay attention to relevant stimuli, but also ignore or suppress irrelevant stimuli. When a person becomes mentally fatigued, the activity of attentional focus itself remains unaffected while the inhibitory processes are diminished (Houghton et al., 1996; Schwartz, 1999). This means that on a selective attention task, where inhibition is key to favorable performance, more difficulties will be observed. Because mental fatigue produces global changes in inhibitory processes, behavioral changes are not task-specific, but rather generalize across tasks.

One study that supports the theory that inhibitory processes are diminished under mental fatigue comes from research on sensorimotor gating and pre-pulse inhibition (PPI) (van der Linden et al., 2006). Sensorimotor gating refers to the protection of stimulus processing from interference that is caused by subsequent incoming information. It has been shown to play a role in cognitive control and attention, which are thought to be compromised under mental fatigue. Sensorimotor gating can be assessed by pre-pulse inhibition, which occurs when a participant's startle response to an intense stimulus is reduced by first presenting a lower-intensity stimulus. It is believed that sensorimotor gating prevents the full processing of the intense stimulus due to the current processing of the pre-pulse stimulus. This means that some of the effects of PPI are due to inhibition of the startle response's primary pathway.

Pre-pulse inhibition facilitates goal-driven behavior, and people with low PPI often display problems with attention and the inhibition of distractors. It was found that mentally fatigued participants did show a significant decrease in PPI, which is representative of a lowered sensorimotor gating ability (van der Linden et al., 2006). This suggests that the difficulties that are typically associated with mental fatigue might partly arise from disturbances in the cognitive mechanism responsible for preventing interference from task-irrelevant stimuli or cognitions.

The shift from goal- to stimulus-driven behavior is also why complex behavior shows decrements under mental fatigue while simpler tasks do not. Simple tasks are often stimulus-driven and are thus unaffected by mental fatigue. On the other hand, complex tasks require participants to make use of higher-order cognitive processes, which are more sensitive to fatigue (Lorist et al., 2000). Because complex tasks are dependent upon goal-driven behavior, when inhibitory processes are weakened the ability to perform complex behavior declines (Matthews & Desmond, 2002; van der Linden et al., 2003).

It is hypothesized that mental fatigue acts to impair inhibitory processes, and thus attention, in two different ways. The first is through depletion of energetical resources. It is believed that attention is sustained through energetical pools that, over time, will run low due to cognitive demand. Information processing relies on these pools in order to efficiently regulate higher-order cognitive functioning (Lorist et al., 2000). Complex, cognitively demanding tasks rely on higher-level cognitive functioning, causing them to be more vulnerable to impairments caused by mental fatigue because they rely more heavily on energetical pools than do simple or automated tasks (Lorist et al., 2000; van der Linden et al., 2003). This is supported by research showing that mental fatigue does not impair automated tasks, but does affect complex task performance (Lorist et al., 2000).

The second way mental fatigue may impair attention is through a loss of effort regulation. This theory posits that energetical pools themselves are not lost, but the ability to allocate those resources correctly and efficiently is (Matthews & Desmond, 2002). Here, a person will either voluntarily or involuntarily reduce engagement in a task (van der Linden et al., 2003), especially when the task is perceived to be simple and require minimal attention or effort (Matthews & Desmond, 2002). This means that even a mentally fatigued person has the ability to perform complex tasks as well as a non-fatigued person, as long as she is motivated or the task is complex enough to warrant a certain amount of effort (Matthews & Desmond, 2002).

Both theories have been supported in the literature, but a resolution of these differences may be possible. Matthews and Desmond (2002) found that performance on a driving simulator task after inducing mental fatigue was dependent on the difficulty of the task; the easy, straight section of road showed driving impairment when the participant was mentally fatigued while the more difficult, curved section did not. They attribute these differences to a loss of effort regulation, not energetical resources because if energetical resources had been depleted participants would have performed more poorly on the difficult, curved section. Instead, they performed more poorly on the easier, straight section, which implies that participants underestimated the level of performance necessary. However, van der Linden et al. (2003) found that during mental fatigue, performance does not completely break down, but is instead marked by reduced task engagement that produces mediocre performance. This reduced engagement may be from a lack of effort, but it may also be from a temporary lack of resources. When a person applies less effort, which may be an attempt to not only temporarily halt energetic depletion, but also to give those pools time to recover in order to perform a task once again to the highest level possible.

One class of tasks that may appear highly related to mental fatigue research is that of vigilance. Vigilance tasks are common in both real-world and laboratory settings and require a person to monitor a display for a temporally-uncertain target that occurs amid more common neutral signals. A consistent finding is that target detection decreases over time spent on the task, a phenomenon known as the vigilance decrement (Parasuraman, 1986). This may appear similar to findings on mental fatigue, which show that performance declines with time spent on the task. Some common laboratory vigilance tasks do assess selective as well as sustained attention (Bearden, Cassisi, & White, 2004) and after prolonged performance may also elicit subjective complaints similar to that of mental fatigue (Helton et al., 2005).

However, vigilance should not be confused with mental fatigue. While vigilance produces a decrease in performance and signal sensitivity over time, it does so for different reasons than mental fatigue. Though once believed to be relatively simple and benign, recent research has found that vigilance tasks are actually quite taxing and stressful (Grier et al., 2003). Vigilance problems are hypothesized to be the result of overloading the information-processing system, and the subsequent decrement in performance is a consequence of the participant attempting to reduce the stress that arises from this overload (Grier et al., 2003). This means that while vigilance tasks may lead to disengagement and lowered performance in the form of signal detection, this shift is a voluntary method for coping with the stress of task demands (Helton et al., 2005). Mental fatigue, on the other hand, is believed to be an involuntary and uncontrolled outcome of prolonged mental processing that results in global, not specific, changes in processing (Soames-Job & Dalziel, 2001). These global changes are perhaps best illustrated by the fact that vigilance decrements are task-specific and can be ameliorated by changing tasks (Parasuraman, 1986), whereas mental fatigue's effects transfer across tasks. Most importantly, the vigilance decrement has not been attributed to deficits in inhibitory processes, unlike mental fatigue.

Alcohol

Alcohol consumption produces a variety of subjective responses depending upon the level of intoxication. Alcohol is generally thought of as a depressant, but for many people alcohol actually serves as a stimulant at low blood alcohol concentrations (BACs) on the ascending limb of the blood alcohol curve (Martin, Earleywine, Musty, Perrine, & Swift, 1993). However, these subjective differences show much individual variability in both the magnitude of the effect and the BAC at which it occurs. Sedative effects generally appear at higher BACs and on the descending limb of the blood alcohol curve, but also with variability (Martin et al., 1993). Alcohol's stimulant-like effects generally manifest as feelings of euphoria and elation, emotional expression, and talkativeness (Holdstock & de Wit, 1998), whereas sedative effects include difficulty concentrating, inactivity and sluggishness, slow thoughts, and tiredness (Martin et al., 1993).

Alcohol consumption among young adults in the US is a problem. While the legal blood alcohol concentration (BAC) limit in most states is 0.08%, studies report subjective intoxication at BACs as low as 0.05-0.06%, along with slowed visual search speed

(Newman, Speake, Armstrong, & Tiplady, 1997) and impairments in divided attention (Schulte, Muller-Oehring, Strasburger, Warzel, & Sabel, 2001). Previously, the deficits caused by alcohol consumption were believed to be attributable to a generalized slowing of reaction time, but research has shown that BACs of 0.08-0.10% only slow reaction time by no more than 10% (Newman et al., 1997). Recent theories indicate that the real issue is alcohol's impairment of selective attention and attentional control (Fillmore, Dixon, and Schweizer, 2000).

Alcohol has been shown to produce a variety of behavioral impairments even at low to moderate blood alcohol levels. BACs of less than 0.08% impair psychomotor function, learning, memory, and attention (Falleti, Maruff, Collie, Darby, & McStephen, 2003). Attention appears to be particularly vulnerable, and alcohol has been shown to affect measures of attention such as choice reaction time (Falleti et al., 2003), and visual search (Newman et al., 1997). This is because, unlike in simple cognitive processing tasks, these complex tasks require control over attentional resources. This would explain why divided and selective attention tasks show performance decrements during intoxication while more automatic processes like simple reaction time tasks do not (Schulte et al., 2001).

An example of alcohol's effects on controlled but not automatic processes is the slowing of reaction time to a random target after a repetitive sequence during choice reaction time tasks. This may be because during the repetition sequences, participants are not limited by their information-processing capacity, but rather by their choice or judgment. When the task again switches to a random target, the slowing down may be caused by the time needed to engage controlled processing once again after a period of automaticity. This can be compared to the types of automobile accidents that are associated with alcohol: that of single cars crashing on a bend in the road after a stretch of straight, unimpeded driving (Newman et al., 1997).

Until recently, little research has been done on the effects of alcohol on selective attention. Numerous theories have been put forth as to the cause of alcohol's detrimental effects on attention, such as one that attributes the difficulties to alcohol's slowing down of cognitive processing speed (Moskowitz, Burns, & Williams, 1985). A newer theory, however, explains attentional decrements through the suppression of inhibitory processes. Here, alcohol does not affect the attentional processes that identify and highlight target stimuli, but rather compromises the ability of inhibitory processes to suppress distracting information. Fillmore et al. (2000) tested inhibitory processes in 28 male participants by using a Stroop task to measure negative priming. They found that participants, while at a BAC of 0.06% on the ascending limb of the blood alcohol curve, did not show any negative priming. Negative priming is believed to be a key indicator of inhibitory processes at work in selective attention, and the lack of negative priming is evidence that those inhibitory processes are not functioning to their fullest extent (Tipper et al., 1991).

A further study by Abroms, Gottlob, & Fillmore (2006) provides additional support for the theory that alcohol impairs inhibitory control. The study compared participants' performance on a saccadic interference (SI) task, where a distractor stimulus is presented during a saccade to produce interference, and a delayed ocular response (DOR), where a visual stimulus is presented and participants are required to delay the saccade to the target. SI provides a measure of automatic inhibitory control, while DOR reflects intentional inhibitory control. Results showed that automatic inhibitory control remained intact under alcohol, but intentional inhibitory control deteriorated with rising BACs. Interestingly, and perhaps not surprisingly, similar outcomes are seen in participants with mental fatigue, indicating again that it is the same underlying processes responsible for deficits in selective attention in both conditions.

There have been contradictory findings on the existence of behavioral differences on the ascending versus descending limb of the blood alcohol curve. Some studies report finding deficits on the ascending but not the descending limb (Fillmore et al., 2000), while others find no difference (Newman et al., 1997). One reason effects may be seen on the ascending limb but not the descending is due to acute tolerance. This occurs during physiological exposure to a drug over time and is attributed to an adaptive process wherein one develops the ability to function at a near-normal performance level in spite of still being under the influence. Little is known about the cognitive effects of acute tolerance, so it is possible that some studies report deficits on both limbs because the BACs that are being achieved are too high to allow participants to compensate (Fillmore et al., 2000).

The aim of the present research is to further the understanding of the manner and the extent to which mental fatigue and alcohol impair selective attention. It is surprising that mental fatigue and alcohol have never been directly compared, especially since it is hypothesized that both act to impair selective attention through the same process. Additionally, there is a large amount of information on the practical effects of alcohol on tasks necessary to daily life, especially driving ability. However, there is not nearly as much research on the practical effects of mental fatigue outside of driving simulator studies (e.g., Matthews & Desmond, 2002). Even with driving simulator research, it does not elucidate exactly what mental fatigue may do to actual driving ability or the risk of having an accident. Directly comparing alcohol and mental fatigue on the same metric will give clarity to the practical effects of mental fatigue on driving ability.

On the basis that alcohol and mental fatigue both impair inhibitory processes, it is hypothesized that both will significantly increase the time needed to identify targets in a selective attention task. What is unknown, and is of primary interest to this research, is the differential extent to which alcohol and mental fatigue will increase this identification time. Specifically, we hypothesize that both alcohol and mental fatigue will increase identification time. However, the absence of any literature comparing the effects of both treatments on a common metric does not permit a reasoned prediction about the level of impairment produced by mental fatigue relative to that induced by alcohol. To the extent that fatigue can be consistently induced it may well be the case that its effects are similar to those of alcohol. Alternatively, because mental fatigue is inherently aversive to individuals, participants may find subtle ways to divert attention from the fatiguing task. If this happens, the increase in target identification over time may be less in the mental fatigue condition than in the alcohol condition.

Method

Participants

Participants were 32 graduate students from Western Kentucky University. They were informed that the study was examining the effects of either mental fatigue or alcohol on performance of a computer task. Participants in both the mental fatigue and alcohol conditions were screened before participation for alcohol dependency or excessive drinking. Participants were asked to fast and refrain from drinking caffeinated beverages for four hours prior to the experiment and to not use any tobacco products for two hours or consume alcohol for 24 hours prior to the experiment. Additionally, they were also screened for both prescription and over-the-counter medication use. All participants had normal or corrected-to-normal vision and each received $60 for their participation. A total of six participants were excluded from the study, three due to a positive screening for alcohol problems and three due to an inability to complete the assigned tasks sufficiently (Table 1).

Table 1

Participant Exclusion

Stage	n Excluded	Condition	Reason for Exclusion
Prescreening	3	Not Assigned	Positive screening for alcohol problem
Prescreening	2	Not Assigned	Medication counterindicated for alcohol
Baseline	1	Mental Fatigue	Unable to optimize
Data Analysis	2	Mental Fatigue	Not stabilized at baseline

Materials

Selective attention. The stimuli were presented using the useful field of view (UFOV) test (Ball, Roenker & Bruni, 1990). This test produces a measure of visual attention under brief time conditions. The UFOV contains three subtests, two of which were employed in this study. The first is a measure of divided attention and requires participants to identify a central target as well as locate a peripheral target. The second is a measure of selective attention and requires participants to also identify a central target and locate a peripheral target, but in this task the peripheral target is embedded in distractors. Outcomes are expressed as the minimum length of time in milliseconds needed to identify targets correctly on 70% of the trials. The UFOV has a refresh rate of 16.7 ms, meaning that all frames are displayed for a length of time that is either 16.7 ms or a multiple of that number. For example, the next slowest display would be presented for 33.4 ms. Participant scores are calculated as an average of the final five trials. Deficits on the UFOV have been associated with a slowing in visual task performance, leading to such problems as impaired driving and vehicle crash involvement (Owsley & McGwin, 2004).

Drinking habits. The Alcohol Use Disorder Identification Test (AUDIT) (Bohn, Barbor, & Kranzler, 1995) is a 10-item questionnaire that gathers information pertaining to a participant’s frequency of drinking and amount of consumption, as well as negative behaviors that have arisen in the past year from drinking. Scores range from 0-40, and a score equal to or greater than six is considered a positive screening result for alcohol problems. Consequently, three participants who score a six or greater were excluded from the study (M = 12).

Blood alcohol concentrations (BACs). BACs were calculated from breath samples analyzed by the breathalyzer Alcohawk Pro (Q3 Innovations, LLC, Independence, IA).

Mental fatigue. Subsection B of the Symptoms of Fatigue Scale (Yoshitake, 1971) was used to assess subjective mental fatigue. This is a 10-item questionnaire that measures "decline of working motivation" (Yoshitake, 1971) by having participants answer questions on a nine-point likert scale with anchors of "feeling fit, rested" and "feeling extremely tired, exhausted."

Subjective intoxication. The Biphasic Alcohol Effects Scale (BAES) (Martin et al., 1993) measures the subjective stimulant- and sedative-like effects of alcohol. It consists of 14 adjectives that participants rate from 0 (not at all) to 10 (extremely) by circling the number that best describes their current state. It has high internal consistency on both the ascending limb (stimulant subscale $\alpha = .94$; sedative subscale $\alpha = .85$) and the descending limb (stimulant subscale $\alpha = .94$; sedative subscale $\alpha = .91$).

Procedure

Participants were randomly assigned to one of two treatment groups, either alcohol ingestion ($n = 10$) or mental fatigue ($n = 14$). An explanation of the participant's particular group and restrictions on participation were given before written consent was obtained, and they then completed the AUDIT and provided a list of all prescription medications they were currently taking. Those who were taking any medication with a counterindication for alcohol, such as antidepressants or antihistamines, were not allowed to participate. This excluded two participants who were on such medications. Participants were also asked about any over-the-counter (OTC) medications they had taken in the past 24 hours. If they had taken any OTC medications in that time period it was ensured that an extra two hours were allowed beyond the drug's recommended duration to allow it to metabolize completely. For example, a participant would have needed to take medication with a duration of six hours a minimum of eight hours prior to their lab appointment or they were not allowed to participate. No participants were excluded for this reason.

Next, participants in both groups completed the divided and selective attention subtests of the UFOV until they had three consecutive blocks with outcomes that were all within one standard deviation of one another. This was done to ensure proficiency and optimization of the task, which reduced the interference of practice effects. One participant was excluded due to an inability to achieve optimization and did not complete the baseline session. After optimization, participants remained in the lab and completed the selective attention subtest every 30 minutes a total of four times, providing a baseline against which to compare the experimental data and allowing participants to serve as their own control group. Upon completion of the final selective attention subtest, participants were allowed to leave.

Participants returned to the lab the same day and time the following week to complete the experimental session. All were again asked to refrain from eating or consuming any caffeine for four hours, using tobacco products for two hours, and consuming alcohol for 24 hours prior to testing, and were again also asked to report any OTC medications they had taken within the previous 24 hours. Again, this did not exclude any participants. Once in the lab, the participants in the mental fatigue condition completed the Symptoms of Fatigue Scale and then began performing the divided attention subtest of the UFOV for two hours in order to induce mental fatigue. After beginning, they completed the selective attention subtest of the UFOV every 30 minutes in order to measure selective attention. This not only provided multiple measures of the deterioration of selective attention functioning, but also allowed for a comparison between the mental fatigue and alcohol groups by measuring functioning for each group at the same points along the time course of the experimental conditions. After completion of the UFOV, participants completed the Symptoms of Fatigue Scale and were allowed to leave.

Participants in the alcohol condition returned to the lab the same day and time the following week and were weighed and given a breathalyzer to ensure a BAC of 0.00%. All participants in this condition were 21 years of age or older, and females were screened for pregnancy through self-report and urine analysis. They then completed the Symptoms of Fatigue Scale and received their treatment. Females received 1.12oz/100lbs and males received 1.28oz/100lbs of ethanol mixed with orange juice in a 1:5 ratio. Each beverage was divided into five separate glasses, and participants were asked to drink one glass every two minutes until all five glasses had been consumed. Twenty minutes after the consumption of the last beverage they completed the selective attention subtest of the UFOV. They repeated this process of consuming a drink and then completing the selective attention subtest until their BAC reached 0.05%, which was approximately four drinks, or two hours. After completing the selective attention subtest one final time, participants filled out the Symptoms of Fatigue Scale again in order to ensure that any attentional deficits were due to alcohol alone and not from a combination of alcohol and mental fatigue. All participants in the alcohol condition were then retained in the lab until their BAC returned to 0.00%.

Results

Manipulation Check - Subjective measures

Participants in the mental fatigue condition reported an increase in feelings of subjective mental fatigue from before beginning the fatigue-induction ($M = 2.87$, $SD = 1.53$) to completion of fatigue-induction ($M = 4.33$, $SD = 1.76$). This significant increase indicates that the task was successful in inducing feelings of mental fatigue, $t(13) = 3.418$, $p = .005$. Those in the alcohol condition did not report a similar increase in subjective mental fatigue from the beginning of the experimental condition ($M = 2.31$, $SD = 1.68$) to completion ($M = 2.99$, $SD = 1.62$), $t(8) = 1.12$, $p > .05$. All of the participants in the alcohol condition reached the minimum blood alcohol content (BAC) of 0.05% by either the third (n = 6) or the fourth drink (n = 4). However, they did not report differential stimulant- or sedative-like effects based on which limb of the blood alcohol curve they were experiencing. Those on the ascending limb did not report greater stimulant-like over sedative-like effects, $t(5) = 1.06$, $p > .05$ and those on the descending limb did not report greater sedative-like over stimulant-like effects, $t(3) = 0.64$, $p > .05$.

Cognitive measures

It should be recalled that the design permitted a determination of the stability of the UFOV selective attention measure at both baseline and in the two experimental conditions. The purpose of this was to assess the relative consistency in performance by examining the variance in the final three blocks, which were completed consecutively. Stability indices for each participant at both baseline and experimental session were derived by calculating standard deviations of the final three blocks. Participants were defined as being stabilized if their stability index fell within one standard deviation of the mean of the overall baseline stability index (*M* = 10.82, *SD* = 7.04). Based on this criteria, two participants from the mental fatigue condition were excluded from further analyses (Stability Indices = 36.6; 53.44).

The overall mean stability indices for the two experimental groups are shown in Table 2. The mean stability index differed significantly from baseline (*M* = 10.82, *SD* = 7.04) to experimental session (*M* = 7.51, *SD* = 6.45) ($t(23) = 2.14$, $p = .044$), with participants becoming slightly less variable in their performance during the final three blocks of the experimental session. The baseline and experimental session stability indices were also examined for a difference from zero, as a standard deviation of zero would indicate perfect stability. Both session means differed significantly from zero (baseline $t(23) = 7.54$, $p < .05$; experimental $t(23) = 5.71$, $p < .05$), which indicates that participants were still somewhat variable in their performance during three consecutive measurements. As may be recalled, measurements were taken every 30 minutes and then three consecutive times at the last measurement opportunity, both at baseline and at the end of the experimental session. In the analyses below the mean of these last three measurements was used as the measurement at the fourth time period. Table 3 shows performance by group at each of the four baseline and experimental session blocks.

Table 2

Mean Stability Indices by Condition

Condition	Baseline	Experimental
Alcohol	9.81	7.24
Mental Fatigue	11.55	7.70

Table 3

Mean Performance by Block

Condition	Baseline 1		Baseline 2		Baseline 3		Baseline 4	
	M	SD	M	SD	M	SD	M	SD
Alcohol	23.01	10.07	29.69	20.44	41.37	23.53	26.48	9.09
Mental Fatigue	39.32	15.74	30.52	15.14	35.76	18.54	33.13	13.06

Condition	Experiment 1		Experiment 2		Experiment 3		Experiment 4	
	M	SD	M	SD	M	SD	M	SD
Alcohol	26.37	11.69	31.70	17.23	29.37	14.28	31.50	17.15
Mental Fatigue	29.79	28.01	25.05	11.39	24.80	8.23	27.68	7.61

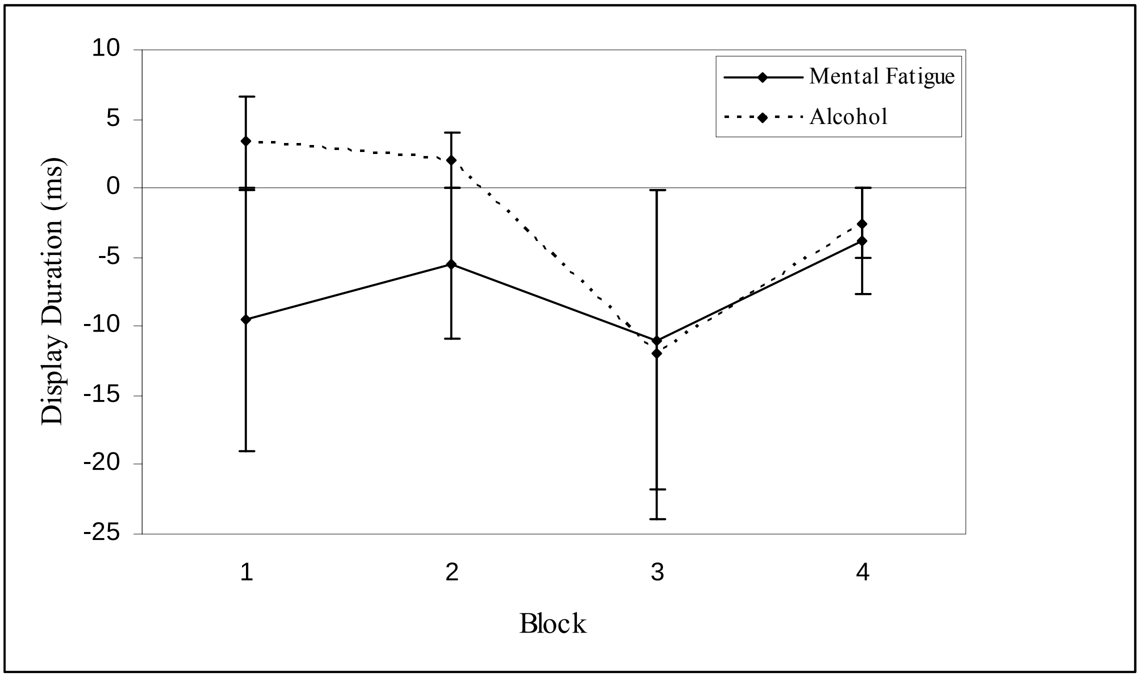
A repeated-measures 2 (condition) x 4 (block) ANOVA performed on the baseline scores revealed a significant interaction ($F(3, 20) = 3.42$, $p < .05$; $\eta^2 = .339$), with the two groups differing in their performance on the first block (mental fatigue M = 39.32, SD = 15.74; alcohol M = 23.01, SD = 10.07) ($F(1, 22) = 8.46$, $p = .009$). No differences were observed on any subsequent blocks. There were no main effects for condition ($F(1, 22) = 1.54$, $p > .05$), but a main effect was found for block ($F(5, 18) = 4.32$, $p = .009$), with display time decreasing over the baseline blocks.

To assess change in performance over time between baseline and experimental sessions, difference scores for each participant were computed by subtracting baseline scores from experimental-condition scores. This provided a single performance measure for each participant at four 30-minute intervals. A repeated-measures 2 (condition) x 4 (block) ANOVA performed on the difference scores did not reveal an interaction ($F(3,20) = .651$, $p > .05$; $\eta^2 = .031$; $\beta = .729$) (Figure 1). Note that because these tests did not reach significance it is not appropriate to discuss the level of power involved. Instead, beta (β), or the level of type II error, is reported. There were no main effects for block ($F(3, 20) = 1.18$, $p > .05$; $\eta^2 = .061$; $\beta = .904$) or condition ($F(1, 22) = 1.53$, $p > .05$; $\eta^2 = .065$; $\beta = .78$). Figure 1 illustrates the mean difference scores for each of the four blocks by condition as well as 95% confidence intervals about each mean. An inspection of the figure shows that none of the mean difference scores at any time block differed significantly from zero. Thus, at no point in the experiment was performance on the task significantly different from baseline, indicating that neither the fatigue nor alcohol condition were effective in decreasing selective attention performance.

As a final evaluation of the data, regression formulas were calculated by regressing each experimental block on its corresponding baseline block. From these four equations the residuals for each experimental block were found, and a repeated-measures 2 (condition) x 4 (block) ANOVA was performed on the error terms. No interaction was found ($F(3, 20) = .201$, $p > .05$; $\eta^2 = .029$; $\beta = .919$). Additionally, there were no main effects for block ($F(3, 20) = .005$, $p > .05$; $\eta^2 = .001$; $\beta = .949$) or condition ($F(1, 22) = 3.606$, $p > .05$; $\eta^2 = .141$; $\beta = .557$).

Figure 1

Mean Difference Scores by Condition



Discussion

This study attempted to identify and compare a connection between the attentional impairments observed during alcohol intoxication and mental fatigue. It was hypothesized that both would significantly increase the time needed to identify targets in the selective attention subtest of the Useful Field of View (UFOV) test. However, this was unsupported by the current findings; neither alcohol nor mental fatigue produced a significant decrement in performance on the selective attention task. Also of interest was the time course of the effect of mental fatigue. Again, mental fatigue did not appear to affect performance at any of the 30-minute intervals, and performance did not change over the course of the two-hour experimental session.

Neither experimental condition affected participants' performance on the UFOV, which was used to assess selective attention. There are some possible reasons why participants failed to show an attentional decrement. First, the UFOV's selective attention subtest may not be a sensitive enough measure for a younger sample. The UFOV's stimulus duration range is from about 17-500 ms. Typically, the UFOV is used to identify deficits in older adults, whose scores fall in the middle of that scale. Participants in this study, graduate students, routinely achieved scores at baseline of 17 ms. These low scores indicate that there may be a floor effect, and that even at floor the task is too simple. While the average scores shown on Tables 1 and 2 are above that baseline, recall that the refresh rate of the UFOV is 16.7 ms and the final score is an average of the final five correct trials. The majority of blocks in the baseline condition and all the blocks in the experimental condition have average scores below 33.4 ms. This shows that while participants did not have perfect scores at floor, they were still correctly identifying targets at this speed. Even if the alcohol or mental fatigue conditions did impair these young participants, it might not have been enough to see an effect if selective attention task was not demanding enough to assess a true optimal baseline score.

A second possibility for why an effect was not observed in the mental fatigue condition is that the selective attention task was too salient compared to the divided attention task, which was used to fatigue participants. In this case, the selective attention task would elicit a ‘pop-out’ effect, temporarily increasing arousal and aiding in performance. This pop-out effect would have been facilitated by the selective attention task being more difficult than the divided attention task, as well as that it would appear more novel to the participant after spending the previous 30 minutes on the divided attention task. However, the likelihood of this salience is questionable. The divided and selective attention tasks are highly similar in that they employ the same stimuli for both the central and peripheral target and require participants to respond in the same way on both tasks. Additionally, at baseline participants spent the majority of their time becoming familiarized and optimized on the selective attention task. The combination of the similarity between the two tasks and the amount of experience at baseline on the selective attention task would serve to reduce its novelty during the experimental session.

Another theory similar to the pop-out effect that explains the lack of findings is the effort regulation theory of mental fatigue. This theory posits that during periods of mental fatigue the ability to allocate resources correctly and efficiently to complete a task is impaired (Matthews & Desmond, 2002). A person will then either voluntarily or involuntarily reduce engagement in a task (van der Linden et al., 2003), especially when the task is perceived to be simple and require minimal attention or effort (Matthews &

Desmond, 2002). This means that even a mentally fatigued person has the ability to perform complex tasks as well as a non-fatigued person, as long as she is motivated or the task is complex enough to warrant a certain amount of effort (Matthews & Desmond, 2002). It is possible that the selective attention task was sufficiently more difficult than the divided attention task to require the participant to engage fully in its performance. While it has been observed that the selective attention task may have been too simple for our sample, when compared with the ease of the divided attention task the contrast may have induced participants to engage in the task once again. By having the participants complete a more difficult task while mentally fatigued, they may have been forced to match their effort to the perceived difficulty, resulting in improved performance.

Future research holds the possibility of elucidating effects of alcohol and mental fatigue on selective attention, as well as the relationship between those two factors. Most importantly, a more difficult task should be used to both induce mental fatigue and to measure selective attention. This would accomplish two goals. The first is that a difficult task would be more sensitive to performance decrements by reducing or eliminating a floor effect. The second is that by using a more difficult task to fatigue participants, the possible effect of the effort regulation theory is reduced. If participants become mentally fatigued on a task that is just as difficult as the selective attention task, there would be no need to increase effort because there would not be an increase in perceived difficulty.

Deficits in selective attention will continue to be of concern in the future given the method of operation in current society. As industry further demands levels of performance from workers that stretch the capabilities of attentional systems, factors such as mental fatigue will become necessary to understand. Additionally, incidents involving alcohol such as automobile accidents continue to be of concern in the United States. While the current research did not find deficits in selective attention as a result of mental fatigue or alcohol intoxication, it established a direct comparison between the practical impacts of mental fatigue and alcohol intoxication by placing both on the same metric. Future research will be able to utilize this knowledge to elucidate further the impact of mental fatigue and alcohol intoxication on selective attention.

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Appendix A

The Alcohol Use Disorders Identification Test

1. In the past year, when you drink alcohol, how many do you usually drink?

1 or 2	3 or 4	5 or 6	7 to 9	10 or more
(0)	(1)	(2)	(3)	(4)

2. How often do you drink that amount?

≤ Monthly	2-4 times/month	2-3 times/week	≥ 4 times/week
(0)	(1)	(2)	(3)

3. How often in the past year have you had 5 (male) / 4 (female) or more drinks on 1 occasion?

Never	<Monthly	Monthly	Weekly	Daily/almost daily
(0)	(1)	(2)	(3)	(4)

4. How often during the past year have you found that you couldn’t stop drinking once you had started?

Never	<Monthly	Monthly	Weekly	Daily/almost daily
(0)	(1)	(2)	(3)	(4)

5. How often during the past year have you missed something important because of drinking? For example, have you ever missed school, class, or other activities?

Never	<Monthly	Monthly	Weekly	Daily/almost daily
(0)	(1)	(2)	(3)	(4)

6. How often during the past year have you needed a first drink in the morning to get yourself going after a heavy drinking session?

Never	<Monthly	Monthly	Weekly	Daily/almost daily
(0)	(1)	(2)	(3)	(4)

7. How often during the past year have you “felt bad” or “felt guilty” after drinking?

Never	<Monthly	Monthly	Weekly	Daily/almost daily
(0)	(1)	(2)	(3)	(4)

8. How often during the past year have you been unable to remember what happened the night before because you had been drinking?

Never	<Monthly	Monthly	Weekly	Daily/almost daily
(0)	(1)	(2)	(3)	(4)

9. Has your drinking contributed to an injury to yourself or anyone else?

Never	Yes, but not in the last year	Yes, during the last year
(0)	(2)	(4)

10. Has a relative, friend, doctor, or other health worker been concerned about your drinking or suggested that you should cut down?

Never	Yes, but not in the last year	Yes, during the last year
(0)	(2)	(4)

Appendix B

The Biphasic Alcohol Effects Scale

Please circle the number that best describes your present feelings.

1. Difficulty concentrating

0 1 2 3 4 5 6 7 8 9 10

Not at all Extremely

2. Down

0 1 2 3 4 5 6 7 8 9 10

Not at all Extremely

3. Elated

0 1 2 3 4 5 6 7 8 9 10

Not at all Extremely

4. Energized

0 1 2 3 4 5 6 7 8 9 10

Not at all Extremely

5. Excited

0 1 2 3 4 5 6 7 8 9 10

Not at all Extremely

6. Heavy head

0 1 2 3 4 5 6 7 8 9 10

Not at all Extremely

7. Inactive

0 1 2 3 4 5 6 7 8 9 10

Not at all Extremely

8. Sedated

0 1 2 3 4 5 6 7 8 9 10

Not at all Extremely

9. Slow thoughts

0 1 2 3 4 5 6 7 8 9 10

Not at all Extremely

10. Sluggish

0 1 2 3 4 5 6 7 8 9 10

Not at all Extremely

11. Stimulated

0 1 2 3 4 5 6 7 8 9 10

Not at all Extremely

12. Talkative

0 1 2 3 4 5 6 7 8 9 10

Not at all Extremely

13. Up

0 1 2 3 4 5 6 7 8 9 10

Not at all Extremely

14. Vigorous

0 1 2 3 4 5 6 7 8 9 10

Not at all Extremely

Appendix C

Symptoms of Fatigue Scale

Please circle the number that best describes your present feelings.

1. Find difficulty in thinking

1 2 3 4 5 6 7 8 9

Feeling fit, rested | Feeling extremely tired, exhausted

2. Become weary while talking

1 2 3 4 5 6 7 8 9

Feeling fit, rested | Feeling extremely tired, exhausted

3. Become nervous

1 2 3 4 5 6 7 8 9

Feeling fit, rested | Feeling extremely tired, exhausted

4. Unable to concentrate attention

1 2 3 4 5 6 7 8 9

Feeling fit, rested | Feeling extremely tired, exhausted

5. Unable to have interest in thinking

1 2 3 4 5 6 7 8 9

Feeling fit, rested | Feeling extremely tired, exhausted

6. Become apt to forget things

1 2 3 4 5 6 7 8 9

Feeling fit, rested | Feeling extremely tired, exhausted

7. Lack of self-confidence

1	2	3	4	5	6	7	8	9

Feeling fit, rested — Feeling extremely tired, exhausted

8. Anxious about things

1	2	3	4	5	6	7	8	9

Feeling fit, rested — Feeling extremely tired, exhausted

9. Unable to straighten up in posture

1	2	3	4	5	6	7	8	9

Feeling fit, rested — Feeling extremely tired, exhausted

10. Lack patience

1	2	3	4	5	6	7	8	9

Feeling fit, rested — Feeling extremely tired, exhausted