SLEEP-WAKE STATE TRADEOFFS, IMPULSIVITY AND LIFE HISTORY THEORY

By

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Much appreciation is owed to my committee chair and members. Rob, your guidance and kindness are invaluable. Marsha and Courtney, you have each taught me to be a better writer and brought cheer to my day on numerous occasions.

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Michelle, Sarah, Mark, Sean Michael and Phil each of you has provided me with endless entertainment, friendship, and a willingness to share a/several bottle(s) of wine. Thanks for making me laugh.

Special thanks are also extended to the CAL FIRE Riverside Unit/Riverside County Fire employees for their willingness to participate in this project.
SLEEP-WAKE STATE TRADEOFFS, IMPULSIVITY AND LIFE HISTORY THEORY

Abstract

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Research has shown that ecological uncertainty results in future discounting, whereby organisms will seek immediate survivability to secure eventual fertility. This research investigates sleep acquisition as cue of local environmental conditions and how this translates into behavioral life history strategies, as measured by contextual state impulsivity inclinations. Firefighters are a unique population for sleep studies, as they exhibit large differences in the average number of minutes slept and the quality of sleep obtained per night resulting from variable nighttime wakeful events. It was hypothesized that firefighters who slept more and reported better quality sleep on average would exhibit lower impulsivity inclinations. Online surveys were used to gather individual self-reported sleep averages. Impulsivity scores were obtained using the Brief UPPS Impulsive Behaviors Scale (Keye, et al. 2009). As predicted, regression analysis disclosed negative associations between sleep variables and urgency and a positive association with premeditation. Perseverance, and in some cases premeditation, however, disclosed an unpredicted marginally significant positive association between increased and emergency nighttime waking-related sleep deprivation. Sensation seeking was not associated with sleep variables, but was associated with number of biological children. This research contributes to understanding the implications of human sleep across ecological and behavioral contexts and implies further research is necessary for constructing evolutionarily oriented measures of impulsivity inclination.
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Dedication

This manuscript is dedicated to my dad, Heavy Fire Equipment Operator, Charlie Miller, for his countless acts of selflessness on the behalf of others.
CHAPTER ONE
INTRODUCTION

Humans, like other animals, spend a great deal of their daily energy and time budget sleeping. Sleep provides necessary maintenance and repair as a counter to waking activities of reproduction and production. Therefore, a fundamental tradeoff exists between sleep/wake, and certain risky or resource poor environments may result in shifts directing time away from sleep toward waking activities. Impulsivity, a measure of future discounting and risk inclination, is associated with fast life history strategies. This research proposes that sleep quantity and quality may queue alterations in future discounting as measured by impulsivity outcomes.

Sleep

Anthropological insight into human sleep has been primarily restricted to cross-cultural work on typical sleep environments and childcare practices (Worthman and Melby 2002). Aside from a few notable exceptions, relatively little work has been done by evolutionary anthropologists on sleep ecology and associated behavioral and psychological outcomes (Ferreira de Souza Aguiar, et al. 1991; McKenna 1986; McKenna and McDade 2005; Worthman 2008; Worthman and Brown 2007). Anderson explains that this bias, at least among primatologists, is presumably due to persistent research interests in daytime behavioral profiles (1998). As such, a large gap exists in our understanding of sleep and associated behavioral and psychological outcomes among humans and other primates.

Sleep is commonly viewed as a daily anabolic state of repair and maintenance. The circadian sleep rhythm, linked to the biological twenty-four hour clock in humans, regulates our sleep-wake states partially through melatonin and partially through a homeostatic drive. The
rhythm plays roles in regulating bodily process and functions including body temperature, hormone secretion, urine production, blood pressure and the sleep-wake cycle (Arendt 2006). There are two independent pathways whereby adequate species-specific sleep improves physiological functions, either through sleep quality or sleep quantity. In humans, adequate sleep offers physiological restoration (Siegal 2005), memory consolidation and learning (Maquet 2001; Payne and Nadel 2004), neuronal synaptic maintenance (Krueger, et al. 1995) and energy conservation (Capellini, et al. 2008). An overarching biological perspective details the role of sleep in homeostatic drive which ultimately optimizes all biological and neurological functions and systems (Benington 2000). Conversely, inadequate sleep quantity and quality exhibits significant behavioral and physiological consequences (see Banks and Dinges 2007, for review), including decreased cognitive state regulation (Saper, et al. 2005), diminished immunological functioning (Opp 2009) and impaired executive functioning (Nilsson, et al. 2005). Wake time, by comparison, seems essentially designed to achieve the major evolutionary goals of production and reproduction. These costly sleep deprivation outcomes frequently place individuals at social and ecological risks within their environments.

Indeed, the two states of human existence, awake and asleep, can be thought of as competing systems in which the organism is either breaking down molecules for energy (catabolic and awake) or constructing molecules, organs, and tissues from smaller units (anabolic and asleep) (Rodéhn 1999; Shneerson, et al. 2005). The daily phases can be described in the following ways: the sleeping state exists to rebuild and rejuvenate systems that are catabolized, damaged, or require growth due to wakefulness activities. Because these phases achieve different tasks, and because they are mutually exclusive, it can be observed that due to the principle of time allocation, time used for one state cannot then be used for the other. Thus, if an
organism spends more time sleeping it will have less time for production and reproduction while awake. However, because sleep builds, grows and repairs the body, lack of sleep results in negative physiological and behavioral consequences as documented by countless previous studies.

**Impulsivity and Life History Theory**

Impulsive behaviors include lack of premeditation before action, inability to complete tasks, urgent decision-making and discounting of costs associated with risky choices (Figueredo, et al. 2006). Personality psychologists acknowledge the traditional focus in the study of personality as “understanding the dispositional characteristics of the person that remain invariant across contexts and situations” (Mischel, et al. 2002). An alternative framework has been offered by personality psychologists that acknowledges personality consistencies and contextual (state-dependent) variations (Mischel, et al. 2002). In other words, along the lines of life history theory and extrinsic risk predictions, in the presence of one stimulus, such as a measure of ecological stress, you could expect one expression of a personality trait like elevated impulse inclinations. Yet, in the presence of another stimulus, such as a measure of ecological certainty, you can expect another variant of impulse expression such as reduced impulsive proclivities. In understanding personality variation, this line of reasoning both accounts for a genetic component of personality traits and also their plasticity across situations.

Empirical evidence supports Mischel and colleagues’ dynamic perspective of personality in relation to impulsive inclinations. Impulsivity proneness in women is associated with premenstrual versus menstrual and mid-cycle stages, suggesting a premenstrual impulsivity syndrome (Howard and Mason 1994). Being primed of the possibility of acting impulsive, or
mood awareness, decreases impulsive behaviors in a timed circle-tracing task possibly to consciously mediate impulsive tendencies in males and females (Wingrove and Bond 1997). Similar state-dependent relationships have been found between state measured impulsivity, hunger and increased caloric consumption in women (Nederkoorn, et al. 2009).

It has been posited that personality variation can be interpreted using a life history framework (Quinlan, et al. 2010). Quinlan shows that mortality rates, a proxy of extrinsic risks, correlates with female age at first reproduction, a measure of an individual’s life history decisions. Although personality measurements are not used in his study, he speculates that variation in personality phenotypes can mediate the risks of ecological uncertainty in securing reproductive opportunities (Quinlan 2010). In this way, hypothetically, personality traits such as impulsivity can contribute to and alter individuals’ reproductive choices geared to enhance fitness in uncertain environments. This line of reasoning implies that personality strategies and associated life history behaviors may be understood as a function of ecological risk (Quinlan and Quinlan 2007). By extension of this line of thought, personalities can contribute to life history strategies in the presence of ecological stress not only as traits, but also as a context-dependent states.

Impulsivity has been correlated to future discounting (Ostaszewski 1997) and many other life history variables such as age at first sex, age at first birth (Miller, et al. 2003), number of sexual partners (McCoul and Haslam 2001) and a vast array of risky sexual behavior (Donohew, et al. 2000; Robbins and Bryan 2004). Risky impulsivity, which measures risk-taking without premeditation, is a common cause of same-sex aggression and greater sociosexuality (Cross 2010), important components of a fast life history strategy. It should also be noted that
impulsivity has been found to decrease with age (Eysenck, et al. 1985) and higher impulsive tendencies are found in men (Waldeck and Miller 1997).

Figueredo et al. found that a purified measure (a scale which is drawn from several existing measures to create a scale of both impulse behaviors and impulse control) of impulse control had a high, positive correlation with a slow life history, as measured by the K-factor battery questions (2006). Figueredo’s work also links deviance factor, of which impulsivity is an important component, to reduced executive functioning, a measure of the ability to set goals, plan, sequence, prioritize, and inhibit pace, etc. which are ultimately linked to low K-factor (Figueredo, et al. 2006). Figueredo emphasizes that optimization of executive functioning requires impulsivity inhibition. And, as demonstrated above, sleep quantity and quality lessens executive functioning of which has a strong relationship with impulsivity.

Previous work indicates that lack of sleep also correlates to reduced executive functioning and higher impulsivity among children (Bernier, et al.; Bernier, et al. 2010; Ireland and Culpin 2006). Others have also found a relationship between lack of sleep and impulse control impairments among children, including attention deficit hyperactivity disorder in conjunction with sleep disordered breathing and snoring (Beebe 2006; Chervin, et al. 1997; Moore, et al. 2010; O’Brien and Mindell 2005; O’Brien, et al. 2003). In adults, impaired executive functioning is also linked to sleep deprivation (Stenuit and Kerhofs 2008), even after one night (Harrison and Horne 1999; Nilsson, et al. 2005).

Although there is no single definition of impulsivity, as it is usually understood as an “umbrella term” (Whiteside and Lynam 2001), several studies indicate the relationship between sleep deprivation and related impulsivity concepts of risk taking and delay discounting (Acheson, et al. 2007; McKenna, et al. 2007; Reynolds and Schiffbauer 2004; Sicard, et al. 2001;
Venkatraman, et al. 2007). These studies demonstrate the effects of sleep deprivation on increased impulsivity-related behaviors emphasizing the importance of acting now versus later, even when future larger payouts could be expected. Additionally, Chaumet and colleagues have found an effect of elevated risk propensity in relation to a clinical confined sleeping environment versus those not sleeping in confinement (2009), which presents a relationship between sleep ecology and elevated impulsive inclinations.

While literature indicates associations between sleep and related concepts, Schmidt and colleagues admit that little is known about the effects of sleep on dimensions of impulsivity (2010). Recent research is beginning to contribute to understanding the effects of insomnia on separate impulsivity components. Schmidt et al. have used the UPPS Impulsive Behavior scale (Whiteside and Lynam 2001) in two separate studies investigating the relationship between insomnia, presleep mentatation and daytime functioning. Urgency, elevated insomnia scores, and daytime insomnia-related effects are positively correlated, and lack of perseverance was positively associated with daytime impairments of insomnia (Schmidt, et al. 2008). Additional results indicate that higher levels of insomnia, urgency and a lack of perseverance combined with thought control measures of aggression suppression and worry are positively correlated amongst undergraduate students (Schmidt, et al. 2010). Schmidt and colleagues research implies that urgency and lack of perseverance are positively associated with insomnia impairment. Because these studies indicate that sleep acquisition measurements are differentially associated with facets of impulsivity, future studies can illuminate the importance of adequate sleep in mediating impulsive inclinations.

Further, increased dopamine is strongly correlated to impulsivity and future discounting (Pine, et al. 2010). Therefore, a proximate connection exists in that higher levels of melatonin
from exposure to more darkness at night in part due to fewer nighttime interruptions will cause dopamine to drop thus inhibiting impulsive behaviors. Likewise higher frequency of waking interruptions, particularly with light, will inhibit melatonin resulting in rises in dopamine and concordant impulsive behaviors. This relationship may also support a state context-dependent attribute of impulse.

Some have investigated the impacts of shift-work on health outcomes and have found higher risks of gastrointestinal diseases, cardiovascular diseases, diabetes, worsening of pre-existing health conditions and possibly some cancers than for day shift workers (see Knutsson 2003, for review). Melatonin dysregulation resulting from variable artificial nighttime light exposure may proximally increase estrogen release leading to elevated breast cancer risks (Davis, et al. 2001; Hansen 2001). Further, in a review of sleep deprivation on decision-making, Harrison and Horne conclude that decreased cognitive functioning for sleep deprived individuals working extended work shifts compensates decision making involving unexpected tasks (2000).

Firefighters are typically referred to as shift workers and by extension are exposed to unique occupation-specific environmental risks. Because firefighters are exposed to unique risks, the population has occupation-specific mortality and morbidity threats. Specifically, it has been found that firefighters have increased risks of cardiovascular disease, non-malignant respiratory disease, brain tumors, brain cancers and testicular cancer (Bates, et al. 2001; Demers, et al. 1992; Kales, et al. 2007; Kales, et al. 2003; Rosenstock, et al. 1990). Some have offered this may be due to hazardous smoke inhalation, other dangerous chemical exposures, overall stress and stresses of emergency duty response, obesity and firefighter physical fitness (Hansen 1990; Kales, et al. 2007; Kales, et al. 2003; Rhea, et al. 2004; Soteriades, et al. 2008).
Firefighters are also at risk for on the job injuries and death due to unique hazardous and stressful situations. Some of these hazards include heat stresses and dehydration, immune suppression from extreme firefighting conditions, activities associated with high energy expenditure, such as hiking, lifting, packing and carrying loads, as well as dangerous equipment usage (including vehicles and other heavy equipment) and infectious disease risk (Karter and Molis 2009; Ruby 1999; Sharkey 1999a; Sharkey 1999b; Wood 1999). In 2008, the National Fire Protection Association reported an estimated 79,700 on-shift injuries, half of which occurred during fire operations (Karter and Molis 2009). Sprains, strains and muscle pains account for the leading causes of injury (48.8 percent), and other wound injuries such as cuts and bruises accounted for 15.6 percent (Karter and Molis 2009). Burn injuries are also common amongst fire professionals despite precautionary protective gear and equipment (Rabbitts, et al. 2004). Mangan reports that firefighters are especially subject to vehicle, tool use, and slipping/falling accidents during wildland firefighting (1999). Fabio et al. show the number of stories in a structure and the prevalence of civilian injuries increase the rate of firefighter injuries during structure fires (2002).

It has been reported that firefighters have a three times greater risk of fatal job incidents than all (other job sectors) (Clarke and Zak 1999). Sudden cardiac death accounts for 45 percent of firefighter on-the-job deaths (Fahy 2005). Kales and colleagues highlight on the job deaths for firefighters in association to heart disease. They offer that although firefighters typically spend 1 to 5 percent of their time fighting fire, they are up to 100 times more likely to die of cardiovascular disease during firefighting than nonemergency situations (2007). Fire-related suppression cardiovascular deaths may result from preexisting conditions or inadequate physical fitness, as examples (Kales, et al. 2007). The second and third most common cardiovascular
related deaths are during alarm returns and fire station duties overall amongst professional firefighters (Kales, et al. 2007). Data regarding the time of day injuries occur for firemen is underrepresented, yet presumably nighttime emergency response presents unique dangers versus daytime response resulting from visibility limitations during nighttime darkness.

This research investigates the behavioral variation in dimensions of impulsivity scores amongst firefighters, both as a trait and as a state dependant upon environmental circumstances. Life history theory supposes that increases in impulsivity and future discounting should be expected in risky, resource poor and unpredictable environments, ultimately resulting in a switch from a slow to fast life history strategy which may be partly caused by the negative melatonin-dopamine relationship that exists in the presence of sleep loss. We can imagine that during hominid evolution poor sleep was likely a reflection of more environmental danger and unpredictability. Thus, disturbed sleep is a proxy of local danger and uncertainty. As such, as demonstrated by several previous studies, life histories should alter as a function of environmental unpredictability and danger.

In a recent study Cross shows a path model relationship between risky impulsivity, aggression and sociosexual openness (2010). Along the lines of evolutionary theory, her outcomes suggest that higher impulsivity evolved in males to promote competition with other males (aggression) and the pursuance of mating opportunities (sociosexual openness). This finding is consistent with the hypothesis that impulsivity should be higher when more time is traded off from sleeping to waking in environments where there is greater risk and low resource quality. Humans require adequate sleep to rejuvenate and repair the body and should only take away from their sleep time if waking hours require more time and energy for production and
reproduction, which will be more likely in response to ecological uncertainty and potential danger.

Therefore, it is expected that nightly variation in sleep quantity and quality act as cues regarding local environmental circumstances about the resource richness and relative safety or danger of the productive and reproductive ecology. Such risky and stressful environments indicated by poorer overall sleep should result in faster life history strategies as measured by variations in impulsivity inclinations by particular domains of higher urgency and risk taking and lower premeditation and perseverance. Firefighters exhibit highly variable fluctuations in sleep patterns resulting from random waking events due to unpredictable calls that require decisions and action related to emergencies and fire-related events. Thus they are a good study population because external measures of ecological risk such as call volumes and quantity and quality of sleep vary unpredictably.
CHAPTER TWO

METHODS AND MATERIALS

Participants

Research was conducted amongst a population of firefighters in Riverside County, California. CAL FIRE- Riverside Unit and Riverside County Fire Department is the largest fire Unit in California with over 1,600 employees, primarily represented by career emergency response fire personnel. The Riverside Unit is located in inland Southern California. Employees defend approximately 7,300 square miles of land and respond to emergency calls for over 2.1 million residents. The coverage area for the Unit spans west to east from the eastern border of Orange County to the Arizona border. From north to south it is located between San Bernadino and San Diego counties, respectively. The vast expanse of Riverside County includes mountainous, desert, rural and densely populated town and city environments.

For preparedness Riverside firefighters are required to engage in a tremendous amount of training to meet the needs of their individual job titles and for the wide variation each emergency response call has the potential of offering. In 2009, the Unit responded to 115,718 emergency calls. Rates for emergency responses increased 1.9 percent from the previous year, a typical pattern matching shifts in local demographics according to the Riverside Fire Emergency Command Center (personal communication, 2010). Personnel at each of the Unit’s 91 locations respond to a variety of emergency situations including: medical aids, traffic collisions, rescues, false alarms, and hazardous materials. In addition to local emergency call response, personnel are responsible for responding to major wildfire incidents throughout the entire State. Wildland incidents, which may last several months at a time, are especially common during late summer and early fall months due to extreme heat and wind conditions. Need-based fire crew coverage
at other stations within the Riverside Unit, or in other CAL FIRE Units is also unreported in response data, but considerably contributes to the mobility of firefighters.

Sleep ecologies vary greatly across the Unit by individual station. This is due to station-specific variance in the number of assigned personnel, call type frequencies and overall call volume. Furthermore, each station has different sleeping arrangements where rest occurs in either open-barrack, semi-private barrack or solitary sleep rooms. Sleep room acoustics, other distractions from room-sharing, bed-type comfort levels and room temperatures also differ.

Although most firefighters in the Unit have fixed weekly shifts, there is some variation. Staffing patterns, for example, are designed to hold staff on-shift to ensure minimum coverage is met for local hazardous weather or other emergency events. Vacation schedules also alter shift schedules. Typical shifts commence at 8:00 am and are seventy-two hours long creating susceptibility to variable nighttime wakeful events for several consecutive nights. It is most common that a single crew, specializing in different call responses such as those in wildland firefighting, in structure fires, or those with a paramedic on crew for medical calls, are responsible for responding to calls depending on its nature during both the day and night. Some stations, however, sleep more than one crew and since nighttime alarms and dispatch information are heard station-wide, sleep interruptions can occur even for those who are not called for response.

Not all personnel assigned to fire stations, however, consider themselves firefighters partially due to differences in job rank. For simplicity, this paper will use the terms “firefighters” or “firemen” as a general term to represent all emergency response employees, including paramedics, working for a fire department.
**Materials and Design**

Researchers were randomly escorted by battalion chiefs to fire stations over a period of five weeks during June and July 2010. At each station, on-shift personnel were invited to participate in a “sleep study” as part of a larger life history project. Willing subjects were instructed to log onto www.surveymonkey.com and answer a series of online surveys including demographics, the Brief UPPS Impulsive Behaviors Scale (Keye, et al. 2009), and an occupationally targeted sleep survey that included questions regarding quantity and quality of average sleep at the station. Data on call volume and call type frequency by station were provided by the Riverside Unit Emergency Command Center for their use as proxies for environmental stress and, by extension, environmental quality. Informal interviews were also conducted with several Chief Officers to better understand sleep quantity and quality within the Unit and its related implications.

<table>
<thead>
<tr>
<th>Table 1. Sample descriptive statistics</th>
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<th>mean</th>
<th>s.d.</th>
<th>min</th>
<th>max</th>
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<tr>
<td>Age</td>
<td>115</td>
<td>36.84</td>
<td>7.15</td>
<td>22</td>
<td>54</td>
</tr>
<tr>
<td>Number of years employed in the fire service</td>
<td>114</td>
<td>13.44</td>
<td>7.43</td>
<td>1</td>
<td>32</td>
</tr>
<tr>
<td>Number of biological children</td>
<td>113</td>
<td>1.47</td>
<td>1.17</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Avg. number times awoken for emergency call responses</td>
<td>111</td>
<td>3.18</td>
<td>1.44</td>
<td>1</td>
<td>10</td>
</tr>
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</table>

A random sample of 115 male survey respondents includes fire personnel assigned to stations across the Riverside Unit. As seen in Table 1, the average participant is 36.84 years of age, reports being employed in the fire service for 13.44 years and is awoken 3.18 times per night for emergency response alarms.

Multiple linear regression in STATA v 10 was used to test the hypotheses that sleep quality and number of minutes slept is inversely related to four dimensions of impulsive inclinations. Control variables were used in each analysis to explore the effects of participant
age, number of years employed in the fire service, number of biological children, sex and average number of times awoken for an emergency response call per night on impulsivity proneness.

Keye and colleagues’ Brief UPPS scale was adapted from the larger UPPS developed by Whiteside and Lynam (2009; 2001). The Whiteside and Lynam scale, derived from the Five Factor Model of personality inventory (NEO-PI-R) (Costa and McCrae 1992) reveals four distinct components of impulsivity behaviors: urgency, perseverance (lack of), premeditation (lack of) and sensation seeking. In the brief version of the instrument, Keye et al. also derived the same four components.

Whiteside and Lynam define each dimension of impulsivity. They offer that urgency is a component derived from the FFM neuroticism component, which indicates urgency is emotionally charged to “alleviate” negative emotions and affect regardless of long-term consequences (2001, p. 685). Urgency is the most understudied component of impulsivity (Whiteside & Lynam, 2001). Like urgency, lack of perseverance is also understudied as a component of impulsivity. Whiteside and Lynam, however, interpret the dimension as remaining on task to complete a project, regardless of its mundane nature or level of difficulty (2001). Lack of premeditation describes a situation in which an individual acts with disregarded forethought to the consequences of a behavior (Whiteside and Lynam 2001). The last dimension, sensation seeking, is a measure of excitement and dangerous, risky activity seeking (Whiteside and Lynam 2001). Presumably the components of urgency and perseverance are understudied as they have been overshadowed by research investigating impulsivity as a risky sensation seeking singular concept. By parceling out four different components of impulsivity, more variation
specific to each dimension of impulsive behaviors can be studied. Furthermore, these components suggest that impulsivity is much more complex than one singular concept.

In sum, the four factor components of impulsivity are derived from the NEO-PI-R factors as follows: urgency from neuroticism; lack of perseverance and premeditation from conscientiousness; and sensation seeking from extraversion. While others tend to capture impulsivity as one singular concept, this scale provides a way of measuring several different underlying facets of acting impulsively.

Keye and colleagues’ Brief UPPS instrument measures urgency and sensation seeking in a way that a greater score indicates higher urgency, perseverance, premeditation and sensation seeking. Thus, higher scores on urgency and sensation seeking and lower scores of perseverance and premeditation are indicative of higher impulsivity. The Brief UPPS instrument was used in this research to measure each individual impulsivity component as it relates to measures of sleep quantity and quality.

Dependent Variables

Impulsivity scores were regressed on composite likert-scale self reported measures of sleep quality and on self-reported average number of minutes slept per night. Predictor variables included one variable of sleep quantity: 1). Self-reported average number of minutes slept per night; and three measures of sleep quality: 2). Psychological related insomnia; 3). Physical pain (health) related insomnia; and 4). A sleep disorder frequency score.
Table 2. Dependent variable descriptive statistics

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>mean</th>
<th>s.d.</th>
<th>min</th>
<th>max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avg. number of minutes slept each night at the fire station</td>
<td>113</td>
<td>343.02</td>
<td>95.53</td>
<td>120</td>
<td>568</td>
</tr>
<tr>
<td>Insomnia related to psychological worry</td>
<td>112</td>
<td>9.71</td>
<td>2.35</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>Insomnia related to physical pain</td>
<td>111</td>
<td>15.21</td>
<td>2.77</td>
<td>4</td>
<td>20</td>
</tr>
<tr>
<td>Frequency of sleep disorders</td>
<td>113</td>
<td>0.15</td>
<td>0.50</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>

Two composite variables are used to represent different aspects of sleep quality, whereby a higher score indicates poorer quality. Psychological sleep quality is measured by inability to sleep due to worry, bad dreams and difficulty falling asleep. Variables that make up physical sleep quality measures health related reasons for insomnia such as inability to sleep due to being too hot, snoring, pain, difficulty breathing and a general low overall satisfaction of sleep. An increased score in these variables indicate less psychological related insomnia or less physical pain related insomnia. In other words, higher scores indicate greater sleep quality achievement. The sleep disorder quality measure is an additive measure that scores the number of each participant’s doctor diagnosed sleep disorders.
CHAPTER THREE

RESULTS

The Brief UPPS impulsivity instrument differentiates between four distinct conceptual variables: urgency, perseverance, premeditation and sensation seeking. These four separate dependent variables were used in regression analysis to approximate impulsivity. Four variables measuring of sleep quantity and quality were used in analysis as the independent variables. The sleep quantity variable was defined and measured as the number of minutes slept on average per night at the station. Three separate sleep quality variables were used in analysis and included; 1.) Insomnia from psychological worry; 2.) Insomnia from physical pain; and 3.) The number of reported sleep disorders. Control variables for the full model included number of biological children, number of years on the job, age, and the average number of station calls per night which is also used as a measure of external ecological risk.

Diagnostic analysis of each model indicates the models did not diverge from the assumptions of multiple linear regression. Descriptive statistics for the independent sleep variables can be found in Table 2.

The full regression models including all predictors on the four measures of impulsivity can be found in Table 4. The additive composite variable measuring psychological worry insomnia is composed of three likert scale questions regarding the intensity of insomnia related to worrying at night, difficulty staying asleep and bad dreams. Regression analysis indicates that increases in insomnia resulting from psychological worry results in higher urgency among firefighters ($\beta=-.60$, $p=.001$). This effect on urgency, however, is not seen with the other measures of sleep quantity or quality when all predictors and controls are used within the same model. However, physical pain related insomnia is predictive of higher urgency in independent
analysis without concurrent psychological insomnia in the model ($\beta=-.41, p=.005$). Because of this result, and the fact that psychological and pain related insomnia are highly correlated ($r=.64, p=.000$), a formal detection tolerance test, otherwise known as variance inflation factor (VIF), was run to test for multicollinearity in Table 4, model 1. The VIF (1.74) did not deviate from regression analysis assumptions indicating an unlikely multicollinearity issue in the model between psychological and physical pain sleep deprivation and all other variables. As an additional precaution test for multicollinearity, variables were mean-centered, which did not improve or significantly change model results. Therefore insomnia from psychological worry accounts for more of the variance in urgency than does insomnia from physical pain.

Perseverance was not directly associated with sleep but it does have some possible relationship with extrinsic ecological risk as measured by call volume. For example, although perseverance was not related to any measure of sleep quantity or quality in the full model (Table 4, model 2). Table 4, model 2 illustrates some marginal relationships between perseverance and average number of nighttime emergency calls. Holding average number of minutes slept per night constant, the number of nighttime waking response calls marginally increases perseverance ($\beta=.41, p=.090$). Indeed, when running each sleep quality measure in independent models without other criterion variables and using the same control variables models indicate similar results in relation to call volume (psychological worry, $\beta=.43, p=.007$; physical pain, $\beta=.47, p=.052$; sleep disorder frequency, $\beta=.46, p=.053$).

More sleep per night results in higher premeditation ($\beta=.01, p=.015$). Conversely, those with more sleep disorders show marginally lower premeditation ($\beta=-1.03, p=.093$). While poorer sleep quality and quantity reduce premeditation as predicted, self-reported average of
nighttime calls, a measure of extrinsic risk, is associated with higher premeditation ($\beta=-.51$, $p=.030$).

Sensation seeking, the final of the four impulsivity scale variables, was not directly related to any of the sleep variables in multiple regression analysis in the presence of the control variable of biological children. As such, having children strongly buffers against sensation seeking impulsive behavior. This finding is consistent when running separate model analysis of each criterion variable in the presence of the same controls independent of both number of minutes slept ($\beta=-.88$, $p=.024$) and all three of the quality of sleep measures (psychological worry, $\beta=-.82$, $p=.041$; physical pain, $\beta=-.86$, $p=.041$; and sleep disorders $\beta=-.77$, $p=.031$).
Table 3. Multiple linear regression testing for effects of sleep quantity and quality as measured by the number of minutes slept on average, psychological worry related insomnia, physical pain related insomnia and sleep disorder frequency on measures of impulsivity components including controls for number of station calls, biological children, years on the job, and age ($\beta$, unstandardized regression coefficient; $p$, two-tailed significance; Std. Err., standard errors; $n$, sample size; $R^2$, adjusted variance accounted for by all predictors.)

<table>
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<th>Predictors</th>
<th>$\beta$</th>
<th>std. err.</th>
<th>$t$</th>
<th>$p$</th>
<th>model statistics</th>
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<td>0.00</td>
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<td>Sleep disorder frequency</td>
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<td><strong>0.00</strong></td>
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<td><strong>Model 4: Sensation seeking</strong></td>
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<td>Avg. number of minutes slept</td>
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<td>25.44</td>
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<td>5.78</td>
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CHAPTER FOUR

DISCUSSION

Sleep is an anabolic state of body maintenance and rejuvenation that is essential to optimum functioning. Waking exists to solve organismal challenges of production and reproduction, generally catabolic activities. A fundamental trade-off therefore exists between the waking and sleeping states. Individuals should only trade-off sleep quantity or quality in the presence of particular ecological constraints requiring greater investment in production and reproduction. Such ecological circumstances may involve social stress, resource depletion or high extrinsic risk. Life-history theory consequently predicts that in the presence of lack of sleep or low sleep quality, individuals should exhibit faster life history traits. One way this may be indicated is through impulsive behavior, which may approximate future discounting behaviors.

The Brief UPPS survey was chosen because it encompasses more than sensation seeking in testing higher impulsivity, specifically adding perseverance, premeditation and urgency. Analysis revealed that there were several observed relationships between sleep quantity or quality variables including the presence of an independent measure of extrinsic risk and the outcome impulsivity measures of urgency, perseverance and premeditation.

Urgency, derived from the neuroticism trait of the FFM, has been argued as a component of impulsivity intended to mediate negative emotions. However, while the UPPS uses questions designed to measure urgency, premeditation, perseverance and sensation seeking, it should be noted that other studies on impulsivity rarely directly measure or evaluate the psychological components of urgency and perseverance. This data indicates that only sleep quality, as measured by insomnia resulting from psychological worry, increases urgent tendencies. Thus, individuals having a difficult time sleeping or sleeping too lightly due to excessive worrying are more likely to behave urgently. If this is indeed a component of impulsivity, it would indicate
that social and ecological stress, translated into nighttime sleep deprivation causes one to overestimate the time costs of waiting before acting, and instead preferring to act more urgently, which is in line with life history theory predictions.

Low sleep quantity and quality measures did not predict changes to perseverance in the full model. Since it is possible that correlational effects between the sleep variables and emergency call volume could make interpretation of independent variable effects in the main model difficult, independent regression analysis was done on each sleep outcome individually to better assess the possible affects of the extrinsic risk factor of call volume. These results highlight marginal, although significant, relationships between the effects of the number of emergency calls on perseverance when combined with each sleep measure in separate regression analyses. In all cases, perseverance was positively affected by emergency call volume. This of course, is opposite of predictions and is addressed further below with consideration of the interpretations of some similar premeditation outcomes.

As predicted, getting more sleep is significantly associated with higher premeditation. Because a decreased number of minutes slept lessens premeditative planning, evolutionary insight offers that it is too costly to premeditate in the presence of a risky circumstances requiring immediate action. As a consequence careful forethought preparations are forgone in favor of instant action to secure immediate survival in the presence of sleep deprivation amongst firefighters. Interestingly and also contrary to predictions, as was similarly found with perseverance, higher emergency call volume was also associated with higher premeditation scores. This highlights a consistent finding, which is that persistent exposure to greater extrinsic risk as measured by call volume, results in both higher premeditation and higher perseverance.
With respect to premeditation, the data results indicate that both the number of minutes slept and call volume independently predict greater premeditation, both in the positive direction.

There may be several interpretations of the contrary results of call volume effects on perseverance and premeditation. One possibility is that neither may be components of impulsivity. Another interpretation could be that firefighters may habituate to risky, dangerous ecologies and adjust to high premeditation and perseverance in those circumstances where doing so saves their lives. An additional possibility is that understanding the exact nature of the reason for the sleep deprivation is essential to predicting either a lack of perseverance or premeditation. This might imply that perseverance and premeditation are measuring something other than impulsivity. For example, perseverance questions asked on such surveys may simply be measuring the ability to task focus over multi-tasking. Or this could simply be a measure of intrinsic conscientious motivation of individuals, which may vary considerably by personality type in the presence of extrinsic risk or lack of sleep. Indeed, the ability to ignore extraneous circumstances in order to achieve end goals to the exclusion of tangential tasks would be expected of most people in dangerous circumstances. Such a reexamination of this variable, given evolutionary theory may require reinterpretation of general hypotheses. For example, dangerous environments, requiring one to focus on the task at hand to the exclusion of other distractions, would predict higher perseverance scores in the presence of greater emergency call volumes, but insomnia due to psychological worry may not necessarily be so predicted. No support however that the number of years on the job increases perseverance independent of all predictor variables, but holding all control variables constant, either in \( \beta = -.03, p = .657 \) or apart \( \beta = -.04, p = .585 \) from the number of nightly calls, therefore it appears that the circumstance of why one loses sleep is a key to understanding perseverance. But where number of years on the
job may not result in habituation, residing at a station with higher call volumes at the time you took the survey does have some affect. This may be because these firefighters have increased opportunities to engage in premeditation. For example, firefighters tend to use transportation time in their emergency response vehicles before arriving to a call for information gathering and possibly premeditation for the event they are responding to.

Yet, perseverance may not be intuitively derived from evolutionary theory. The variable generally refers to sticking to a task to completion, where a high score is task focusing until completion, but a low score is what exactly? It is suspected that a lower perseverance results in a higher likelihood of multitasking. We can imagine, derived from evolutionary ecological theory, that there may be circumstances where sleep loss due to different reasons may actually result in multi-tasking (or frequent task switching) versus task focusing. For example, frequent waking due to immediate survival threats should produce higher perseverance, because the identified survival tasks must be completed upon identification, for obvious reasons.

The lack of any significant relationship between sleep variables and sensation seeking was surprising in the context of life history theory; the only important variable in this analysis being the control variable of biological children. It could be that sleep has no effect on one’s inclination to seek out sensations. The data is restricted to men who tend to self select into positions with the fire service, high risk jobs that appeal best to individuals that are already at the high end of sensation seeking. On the contrary, lack of variation in the sensation-seeking scale is unlikely to be the answer to this puzzle. The answer may lie in the nature of the typical questions used to assess inclination for sensation seeking. For instance, one firefighter commented after taking the survey, why would I want to go skydiving, I risk my life every day for this job?
Impulsivity components are variably associated with environmental uncertainty. Nightly average sleep acquisition signals environmental certainty, and individual firefighter behavioral strategies alter according to variations in time spent asleep and quality of sleep one is able to achieve. As predicted by life history theory, lack of sleep minutes resulted in increased impulsivity, specifically in the lack of premeditation component. Lower psychological related worry buffers against urgent impulse and lower sleep disorder frequencies increase premeditation. Thus, better sleep quality in these measures suggests a decrease in impulsive strategies for on-shift firefighters. And as a corollary to this, better and more sleep aligns with a slower life history strategy.

Not predicted, however, were the positive associations with increasing perseverance and premeditation with ecological risk. Extrinsic risk, measured by frequency of nighttime calls, elevates perseverant and premeditative for on-the-job firefighters. Although sensation seeking was not related to sleep variables, analysis shows demonstrates a significant affect from number of biological children. Results imply that as individuals are able to invest into higher quality sleep events and sleep more minutes, they are less likely to act with urgency and premeditation. However, as the average number of nighttime emergency response calls increase individuals become more perseverant and premeditative.

Because a decreased number of minutes slept lessen premeditative planning, evolutionary insight offers that it is too costly to premeditate in the presence of a risky circumstance requiring immediate action. As such, careful forethought preparations are forgone in favor of instant action to secure immediate survival in the presence of sleep deprivation amongst firefighters. We can imagine that during hominid evolution a dangerous environmental encounter, such as
that with predators, premeditating before acting would increase the risks of morbidity and mortality. Alternatively, immediate action would allow for quicker escape.

However, when the numbers of emergency awakening events are higher for firefighters, premeditation increases. This supposes that premeditation becomes increasingly important for immediate survival when repeated risk is in the environment, queuing alternative behavioral strategies. Since sleep deprivation has been shown to decrease executive functioning in a variety of ways across the life course, repeated exposure to risk in the presence of compromised sleep during one nighttime sleep event requires a strategy to mediate compensated executive function as a buffer for an individual’s safety. Response time during transportation to emergency events offers time to invest in preparation and premeditation for forthcoming emergencies. Increased premeditation becomes especially critical as repeated exposure to danger is experienced during the night, or it may be that extreme levels of risk select for premeditation.

No age effects on impulsivity components were observed. This is contrary to previous work particularly in the area of sensation seeking. This analysis, however, is more finely tuned to pick up evolutionary effects than some of these other studies, because a control is used for the very important variable of number of children, which is known to dampen risk inclination because of the costs to offspring quality. Since both age and biological children are in the model, when either is significant it is almost always biological children, because the real theoretical reason that age is significant in previous studies is probably because it tends to correlate quite strongly with biological children. Still because biological children is clearly the more important of the two variables, given theory and outcomes. Consequently, future studies should pay much greater attention to this control variable.
CHAPTER FIVE

CONCLUSION

In sum, firefighters are a unique population for sleep research due to variable ecological risk and exposure to sleep deprivation, both of which are measurements of ecological uncertainty. Although life history theory provides a framework for interpreting the associations disclosed in this study, outcomes are correlational and not causal. But life history theory, however, offers an explanation whereby local ecological signals queue behavior to optimize immediate survival for later reproductive opportunities.

In essence, to achieve the ultimate goal of reproductive success, individuals subtly alter personality types in response to environmental cues, like sleep, as a way to maximize current outcomes and eventual fertility. Overall, these results generally align with life history theory predictions in investigating the relationship between ecological uncertainties. Yet inconsistencies still exist indicating that the Brief UPPS may not be a good measure in predicting impulsivity in relation to sleep variables, or that the measure is not evolutionarily oriented. To the contrary, firefighters may be a unique population who are able to mediate the outcomes of inadequate sleep in relation to impulsive inclinations, especially in relation to perseverance and premeditation. It is possible that a larger sample size from several different fire Units in future investigations may be helpful in parceling out the effects of sleep quantity and quality components on dimensions of impulsivity. Although not intuitively derived from evolutionary theory, this may also shed light in understanding whether perseverance can be understood as a component of impulsivity that can be further extended as a strategy in individual life histories. A larger sample size may also illuminate conclusions of the inconsistent premeditation findings. Further, since this sample includes men only, future studies could investigate the impact of sleep
deprivation on impulsivity amongst women. Future research is also necessary to explain other proximate and causal relationships between sleep and impulsivity.

This research overall contributes to understanding human sleep across behavioral and ecological contexts. Evolutionary oriented future sleep research is necessary to understand the implications of nightly sleep acquisition on behavioral strategies. Furthermore, life history theory derived from evolutionary ecology is a theoretically informed way of interpreting the relationship of sleep quantity and quality acquisition as a proximate indicator of behavioral strategies.
REFERENCES

Acheson, Ashley, Jerry B. Richards, and Harriet de Wit

2007  Effects of sleep deprivation on impulsive behaviors in men and women.

Physiology & Behavior 91:579-587.

Anderson, James R.

1998  Sleep, sleeping sites, and sleep-related activities: Awakening to their significance.


Arendt, J.


Banks, Siobhan, and David F. Dinges

2007  Behavioral and physiological consequences of sleep restriction. Journal of

Clinical Sleep Medicine 3(5):519-528.


2001  Is testicular cancer an occupational disease of fire fighters? American Journal of

Industrial Medicine 40(3):263-270.

Beebe, D. W.

2006  Neurobehavioral morbidity associated with disordered breathing during sleep in


Benington, J. H.

2000  Sleep homeostasis and the function of sleep. Sleep 23(7):959-966.

Relations Between Physiological and Cognitive Regulatory Systems: Infant Sleep Regulation and Subsequent Executive Functioning.


Capellini, I., et al.


Chaumet, Guillaume, et al.

2009 Confinement and sleep deprivation effects on propensity to take risks. Aviation, Space, and Environmental Medicine 80(2):73-80.

Chervin, R. D., et al.


Clarke, C., and M. J. Zak


Costa, P.T. Jr., and R.R. McCrae


Cross, C.P.

Davis, S., D. K. Mirick, and R. G. Stevens


Demers, P. A., N. J. Heyer, and L. Rosenstock


Donohew, L., et al.


Fabio, A., et al.


Fahy, R. F.


Ferreira de Souza Aguiar, G., H. Periera da Silva, and N. Marks


Hansen, E. S.


Hansen, J.


Harrison, Y., and J. A. Horne

1999 One night of sleep loss impairs innovative thinking and flexible decision making. Organizational Behavior and Human Decision Processes 78(2):128-145.

—


Howard, R. C., and P. A. Mason


Ireland, Jane L., and Vicki Culpin


Kales, S. N., et al.

—


Karter, M. J., and J. L. Molis


Keye, Doris, Oliver Wilhelm, and Klaus Oberauer


Knutsson, A.


Krueger, James M., et al.


Mangan, R. J.


Maquet, P.

2001  The role of sleep in learning and memory. Science 294(1048).

McCoul, M. D., and N. Haslam

McKenna, B. S., et al.


McKenna, J.J.


McKenna, J.J., and T. McDade


Miller, J., et al.

2003 A test of the four-factor model of impulsivity-related traits. Personality and Individual Differences 34(8):1403-1418.

Mischel, W., R. Mendoza-Denton, and Y. Shoda


Moore, M., et al.

Nederkoorn, C., et al.  


O'Brien, Erin M., and Jodi A. Mindell  


Opp, M. R.  
2009 Sleeping to fuel the immune system: mammalian sleep and resistance to parasites. BMC Evolutionary Biology 9(8):1-3.

Ostaszewski, P.  

Payne, J. D., and L. Nadel  

Pine, Alex, et al.

Quinlan, R.


Quinlan, R., and M. Quinlan


Quinlan, R., M. Quinlan, and M. Flinn


Rabbitts, A., et al.


Reynolds, B., and R. Schiffbauer


Rhea, M. R., B. A. Alvar, and R. Gray


Robbins, Reubin N., and Angela Bryan

Rodéhn, M.


Rosenstock, L., et al.


Ruby, B.C.


Saper, C. B., G. Cano, and T. E. Scammell


Schmidt, Ralph E., et al.


Schmidt, Ralph E., Philippe Gay, and Martial Van der Linden


Sharkey, B. J.

1999b Heat stress

Shneerson, J. M., M. M. Ohayon, and M. A. Carskadon

Sicard, B., E. Jouve, and O. Blin

Siegal, Jerome M.

Soteriades, E. S., et al.

Stenuit, Patricia, and Myriam Kerhofs

Venkatraman, V., et al.

Waldeck, T. L., and L. S. Miller

Whiteside, S.P., and D.R. Lynam


Wingrove, J., and A. J. Bond


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Worthman, Carol M., and Ryan A. Brown


Worthman, Carol M., and Melissa K. Melby
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<tr>
<td>Perseve.</td>
<td>-0.174</td>
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<td>Premed.</td>
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<td>0.120</td>
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<tr>
<td>Sensation Seeking</td>
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<td>0.101</td>
<td>-0.088</td>
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<tr>
<td>Avg. min. slept</td>
<td>-0.075</td>
<td>-0.139</td>
<td>0.121</td>
<td>-0.149</td>
<td>1.000</td>
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<tr>
<td>Sleep disorders</td>
<td>0.077</td>
<td>-0.104</td>
<td><strong>-0.179</strong></td>
<td>0.109</td>
<td>0.064</td>
<td>1.000</td>
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<td>Night calls</td>
<td>0.030</td>
<td>** 0.214**</td>
<td>** 0.183**</td>
<td>** 0.199**</td>
<td><em>-0.283</em></td>
<td>-0.054</td>
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<tr>
<td># children</td>
<td>-0.064</td>
<td>0.080</td>
<td>0.022</td>
<td><strong>-0.286</strong></td>
<td>-0.028</td>
<td>-0.099</td>
<td>-0.077</td>
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<td>Years employed</td>
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<td>-0.109</td>
<td>-0.051</td>
<td><strong>-0.244</strong></td>
<td>0.126</td>
<td>0.047</td>
<td><strong>-0.221</strong></td>
<td><strong>0.313</strong></td>
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<td>Age</td>
<td>-0.106</td>
<td>-0.098</td>
<td>-0.020</td>
<td><strong>-0.284</strong></td>
<td>0.091</td>
<td>0.129</td>
<td><strong>-0.198</strong></td>
<td>0.376</td>
<td>0.723</td>
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*p > 0.01*,  *p > 0.05*
APPENDIX B. URGENCY ADDED VARIABLE PLOTS
APPENDIX C. PERSEVERANCE ADDED VARIABLE PLOTS
APPENDIX D. PREMEDITATION ADDED VARIABLE PLOTS

\begin{itemize}
\item \begin{align*}
\text{coef} &= 0.00779174, \text{se} = 0.00354737, t = 2.2 \\
\text{coef} &= 1.048501, \text{se} = 0.15025568, t = 0.67 \\
\text{coef} &= 0.05511928, \text{se} = 0.14322371, t = -0.38 \\
\text{coef} &= -1.2035944, \text{se} = 0.92196688, t = -1.1 \\
\text{coef} &= 0.51351917, \text{se} = 0.23271606, t = 2.2 \\
\text{coef} &= 2.744531, \text{se} = 0.29097126, t = 9.2 \\
\text{coef} &= -0.02727705, \text{se} = 0.06595938, t = -4.1 \\
\text{coef} &= 0.01471405, \text{se} = 0.07407981, t = 2 \\
\end{align*}
\end{itemize}