

ASSOCIATIONS BETWEEN PERSONALITY TRAITS AND SLEEP QUALITY AND
QUANTITY AMONG YOUNG ADULTS

Master's Thesis in Psychology (40 p)

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Tiivistelmä - Referat - Abstract <p>This thesis examines the associations between personality traits and sleep quantity and quality in young adults. Additionally the possible effects of birth status on these associations are examined. The data used in this thesis is part of a birth cohort study (Helsinki Study of Very Low Birth Weight Adults). The personality traits are based on the five-factor model of personality. The sleep quantity and quality are based on actigraphy assessments.</p> <p>Four hypothesis were made about the personality and sleep associations: (1) neuroticism is related to a lesser quality of sleep, (2) there will be more significant associations between personality traits and sleep quality than between personality traits and sleep quantity, (3) the Very Low Birth Weight (VLBW) as well as, (4) the Small for Gestational Age (SGA) status will affect the associations. Linear regressions were used to study the associations between personality traits and sleep quality and quantity. Whenever an association was significant, it was tested whether this association was moderated first, by the VLBW and second, by the SGA status of the participant.</p> <p>The results were mostly in line with previous research especially demonstrating the negative association between neuroticism and the quality of sleep and suggesting that vulnerability to stress decreases sleep quality. Also it was found that agreeableness and conscientiousness were associated with better sleep quality and extraversion was associated with lower sleep quantity. In addition SGA status moderated the personality and sleep associations. It is proposed that there are two factors behind the interaction. First, prenatally developing mechanisms have an effect on the development of sleep as well as personality. Second, differences in the postnatal environment, for instance the parenting practices, can account for this finding. Future research could focus especially on what kind of prenatal disturbances SGA infants have in the development of mechanisms related to sleep and personality. Also focusing on the differences in parental interaction might shed more light on the results.</p>		
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<p>Tiivistelmä - Referat - Abstract</p> <p>Tässä tutkielmassa selvitetään persoonallisuuspieriteiden ja unen määrän sekä laadun välisiä yhteyksiä nuorilla aikuisilla. Lisäksi tutkitaan onko syntymäpainolla vaikutusta näihin yhteyksiin. Tutkimusaineisto on osa Pikkukeskosen terveys aikuisiässä (Pikku-k) -tutkimusta. Persoonallisuuspieriteet perustuvat viiden faktorin persoonallisuusteoriaan. Unen laatua ja määrää kuvaavat muuttujat on mitattu aktigrafialla.</p> <p>Persoonallisuuden ja unen yhteyksistä tehtiin neljä hypoteesia: (1) neuroottisuus on yhteydessä heikompaan unen laatuun (2) persoonallisuuspieriteiden ja unen laadun väliltä löytyy enemmän tilastollisesti merkitseviä yhteyksiä kuin persoonallisuuspieriteiden ja unen määrän väliltä (3) pikkukeskosuus (VLBW) sekä (4) vastasyntyneen “Small for Gestational Age” (SGA) –status vaikuttavat persoonallisuuden ja unen yhteyksiin. Yhteyksiä tutkittiin lineaarisella regressiolla. Kun yhteys havaittiin tilastollisesti merkitseväksi, selvitettiin, onko ensiksi VLBW ja toiseksi SGA -statuksella vaikutusta yhteyteen.</p> <p>Tulokset olivat suurelta osin samansuuntaisia aikaisempien tutkimusten kanssa. Neuroottisuus oli yhteydessä heikompaan unen laatuun viitaten siihen, että stressiherkkyys heikentää unen laatua. Lisäksi sovinollisuus ja tunnollisuus olivat yhteydessä parempaan unen laatuun ja ekstraversio oli yhteydessä pienempään unen määrään. SGA-status vaikutti persoonallisuuden ja unen välisiin yhteyksiin. Tämän yhdysvaikutuksen taustalle ehdotettiin kahta tekijää: ensiksi, ennen syntymää vaikuttavat tekijät saattavat muokata sekä unen että persoonallisuuden kehitystä ja toiseksi, eroavaisuudet syntymänjälkeisessä ympäristössä, kuten vanhempien toiminta, saattavat selittää tuloksia. Jatkotutkimuksissa tulisi keskittyä esimerkiksi siihen minkälaisia syntymää edeltäviä muutoksia juuri SGA-lapsilla voidaan havaita uneen ja persoonallisuuteen vaikuttavien mekanismien kehityksessä. Lisäksi erilaisten lapsen ja vanhemman välisten vuorovaikutustekijöiden vaikutusta persoonallisuuden ja unen välisiin yhteyksiin tulisi tutkia tarkemmin.</p>		
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1. INTRODUCTION

Associating personality and the quality and quantity of sleep has gained only little attention in research thus far. Some evidence exists showing that distinct personality traits are somewhat associated to sleep. However, research results do not show a clear structure of these associations or provide a theoretical framework explaining the relationships (e.g. Gray & Watson, 2002; Haack & Mullington, 2005; Soehner, Kennedy & Monk, 2007; Lemola & Räikkönen, 2009, in press).

The main objective of this thesis is to examine the associations between personality traits and sleep quantity and quality in adults. We will also focus on the possible differences in these associations among subjects born with very low birth weight (VLBW) and normal birth weight subjects.

We will discuss the underlying influences that might account for the results. These include especially the stress mechanisms (Mecacci & Rocchetti, 1998; Williams, Rau, Cribbet & Gunn, 2009) and parental factors (Barratt, Roach & Leavitt, 1992; Feldman, 2007).

The data used in this thesis is part of a birth cohort study (Helsinki Study of Very Low Birth Weight Adults) comprised of VLBW (N=89) and term born (N=84) subjects born between 1978 and 1985. The personality traits described here are based on the five-factor model of personality (Costa & McCrae, 1985). The sleep quantity and quality are assessed by actigraphy.

The first chapter of the thesis will focus on the current findings and theories that are important for discussing personality and sleep relationships. The second chapter will present the methods used in this study for gathering and analysing the data. The third chapter presents the results and the fourth discusses these results and evaluates them in the light of the recent findings, the limitations and strengths of the study. Suggestions for future research on this topic are also discussed in the fourth chapter.

1.1 Personality

The measures used in personality research are typically based on a trait view of personality, even though the theoretical frameworks on personality structure and development can vary between the studies (McCrae & Costa, 1989 p. 20).

In this thesis the personality measures are based on the five-factor model of personality (the big-five model) (Costa & McCrae, 1985). This theoretical framework is widely used in current research. It describes personality as a composition of five different traits existing in different combinations within each individual. These traits include neuroticism, extraversion, openness to experience, agreeableness and conscientiousness.

The trait neuroticism describes the level of emotional stability. A person high in neuroticism is characterised by low emotional stability and vulnerability to psychological stress, which is manifested in different types of negative affect (e.g. anxiety, anger, depression). Neuroticism includes the facets of anxiety, depression, hostility, self-consciousness, impulsiveness and vulnerability (Costa & McCrae, 1985).

Extraversion is described by a predisposition to positive emotions, preference for social interaction and dominance. This trait includes the facets of warmth, gregariousness, assertiveness, activity, excitement-seeking and positive emotion (Costa & McCrae, 1985).

Openness to experience is described by such traits as imaginativeness, depth of feeling, curiosity, receptiveness to new ideas and need for variety. Openness includes the facets of fantasy, aesthetics, feelings, actions, ideas and values (Costa & McCrae, 1985).

The last two traits, agreeableness and conscientiousness do not include any further facets. Agreeableness is described by a positive style of interaction, trust, concern for others, cooperation and altruism. Conscientiousness is described by a need for achievement, organization, persistence, ambition and self-discipline (Costa & McCrae, 1985).

1.2 Sleep

Thus far not a lot of data has been presented about the personality and sleep associations. The existing results are inconclusive. In the following sections we will concentrate on sleep development and circadian rhythms, which are important for hypothesising about personality and sleep associations. We will also discuss the current findings on personality and sleep.

1.2.1 The development of sleep

Even though our primary focus is on the relationship between personality and sleep in adults, understanding sleep development is important for theorizing about the possible underlying mechanisms linking personality and sleep together.

Sleep consolidation, the ability to sustain sleep through the night, develops during the first years of life and it is prerequisite for the development of good sleep (Sadeh & Anders, 1993; Scher, Epstein & Tirosh, 2004). Sleep development in childhood proceeds as an increase in quiet sleep and decrease in active sleep (rapid eye movement sleep). However, variability between subjects is high (Hoppenbrouwers, Hodgman, Arakawa, Geidel & Sterman, 1988).

It has been stated that factors influencing sleep development can be divided into three groups (Sadeh & Anders, 1993). First, the factors resulting from child characteristics, for example temperament, are proposed to have an effect on sleep quality. Infants having the so-called easy temperament are higher in rhythmicity, sleeping more regularly and easily (Spruyt et al., 2008). Second, the parental factors have an effect on sleep. These include for example, parental knowledge and attitudes towards the child. Third, the interaction factors, including the quality of the parent child relationship and activities carried out at bedtime affect development of sleep (Sadeh & Anders, 1993).

Additionally these factors might also interact together. For example, distinct child characteristics combined with parents' individual ways of interacting with the child can result in different outcomes in sleep development.

1.2.2 The Circadian Rhythms

Circadian rhythms describe physiological functioning occurring in cycles of approximately 24 hours. The most visible circadian rhythm is the sleep-wake cycle, but biological circadian rhythms can also be seen in the changes of other activity levels, hormone secretion, immune functions, body temperature as well as moods and behaviour during the course of the day (Vink, Groot, Kerkhof & Boomsma, 2001; Refinetti, 2006). These rhythms are both endogenously and exogenously regulated.

One of the most important mechanisms accounting for the regulation of circadian rhythms is the suprachiasmatic nucleus (SCN) in the hypothalamus. The SCN is located above the optic chiasm at the base of the brain. The cells in SCN are able to create an endogenous, approximately 24 hours long, cycle of activity (Earnest, Liang, Ratcliff & Cassone, 1999). The accurate timing of the cycle is maintained by exogenous factors, most importantly light hitting the retinal receptor cells (Hannibal et al., 2004; Refinetti, 2006). Also other signals such as hunger, anxiety and pain regulate the working of the endogenous clock (Sadeh & Anders, 1993).

SCN is referred as the "pacemaker" of the rhythms of sleep, cortisol secretion and body temperature. This can be seen for example in cortisol secretion and body temperature showing the same circadian pattern of activity in the same individual (Bailey & Heitkemper, 2001 p. 2).

Circadian rhythms are proposed to be related to personality factors. This notion is based on the studies assessing individual morning / evening preference, which refers to an individual's biological predisposition to wake up early (the morning type) or stay up late (the evening type) (Cavallera & Giudici, 2007). The same differences between the

morning and evening types can also be seen in biological circadian rhythms other than sleep as mentioned earlier.

According to this typology the evening types exhibit a more inconsistent pattern of sleep (Bailey & Heitkemper, 2001), and have otherwise more irregular life habits (Park, Matsumoto, Seo, Shinkoda & Park, 1997). Greater eveningness is proposed to be related to depression (Chelminski, Ferraro, Petros & Plaud, 1999), whereas the morning types are shown to be lower in novelty seeking and impulsivity and higher in persistence (Caci, Robert & Boyer, 2004).

1.2.3 Personality and sleep

The existing research on personality and sleep associations is based on sleep deprivation experiments, actigraphy based sleep measurements and personality and sleep questionnaires. The importance of sleep to such matters as optimism and mood states in general has been pointed out in the studies assessing the quantity and quality of sleep (Bonnet, 1985; Pilcher & Huffcutt, 1996; Haack & Mullington, 2005), whereas studies associating big five traits to sleep are rare.

When comparing results connecting sleep deprivation with mood variables, motor or cognitive skills, the detrimental effect has been shown to be highest with the mood variables and lowest with the variables assessing motor performance (Pilcher & Huffcutt, 1996). Additionally the possibility to sleep for only four hours per night is associated with decreased optimism and sociability (Haack & Mullington, 2005). Children, who slept an average amount, were reported to have a more positive approach to themselves, more positive expectations about life events and also more socially competent behaviour (Lemola & Rääkkönen, 2009, in press).

In a study by Gray and Watson (2002) associations between the big five personality traits and sleep in a group of undergraduate students were investigated using sleep questionnaires: (PSQI; Buysse, Reynolds, Monk, Berman, & Kupfer, 1989 and SPAS:

Gray and Watson, 2002). Sleep variables were divided into three categories: sleep quality, sleep quantity and sleep schedule. These three categories were expected to represent separate phenomena. Personality traits were assessed by the NEO Personality Inventory (NEO-PI; Costa & McCrae, 1985). In addition to assessing the big-five traits, they also assessed the negative and positive affectivity, which they assumed to be closely related to neuroticism and extraversion (Gray & Watson, 2002).

Gray and Watson (2002) found that sleep quantity was not related to the personality traits whereas positive affectivity significantly predicted sleep quality. Neuroticism as well as negative emotionality was associated with lower sleep quality. Conscientiousness and extraversion made modest contributions to sleep quality. In the case of sleep schedule Gray and Watson (2002) found that conscientiousness predicted earlier rising and retiring times. No significant associations were found between any sleep measures and the personality traits agreeableness or openness to experience (Gray & Watson, 2002).

Similar results have been reached in other studies as well. Soehner et al. (2007) also assessed extraversion and neuroticism as well as sleep using sleep questionnaire data. They found that neuroticism was associated with poorer sleep quality, whereas extraversion was not associated with sleep. Sleep duration was not associated with personality according to Soehner et al. (2007), whereas another study by Gau (2000) found that neuroticism was negatively related to both sleep quality and sleep quantity.

As a conclusion current research on personality and sleep does not give basis for strong hypothesis about our results, except in the case of neuroticism, where studies have associated this trait especially with poorer quality of sleep (Gau, 2000; Gray & Watson, 2002; Soehner et al., 2007). Even though sleep deprivation is related to lower well-being in general, it has been suggested that personality parameters are mostly related to sleep quality and not to sleep quantity (Gray & Watson, 2002; Soehner et al., 2007).

The trait neuroticism is considered as predicting individuals' vulnerability to stress (Costa & McCrae 1985) and some findings seem to link stress processes to personality

and sleep (e.g. Matthews, 1988; Mecacci & Rocchetti 1998; Williams et al., 2009). Thus in order to hypothesise further about our results and the background factors, we will describe how findings on stress research might contribute to our focus.

1.3 Stress

Stress mechanisms are a prominent biological link explaining the personality and sleep associations. The activity of stress mechanisms has been related to personality development in many studies (e.g. Gray, 1987; Edwards, 1991; Mecacci & Rocchetti, 1998; Williams et al., 2009). As was stated before, stress mechanisms also show a circadian pattern of activity (Bailey & Heitkemper, 2001). The following paragraphs further describe these mechanisms and how they are assumed to be linked with sleep and personality.

1.3.1 The HPA axis

The hypothalamic-pituitary-adrenocortical axis (HPAA) forms an important part of the physiological stress processes. HPAA is activated relatively slowly in stressful situations and it is often related to prolonged stress reactions (Toates, 1995 p. 11).

Through a net effect of hormone secretion, the HPA axis functioning leads to the release of corticosteroids from the adrenal cortex of the adrenal glands. The corticosteroids are often referred as “stress hormones” (Toates, 1995 p. 8). The most important corticosteroid in humans is cortisol. Cortisol secretion has been shown to be high in unpredictable and possibly stressful situations and thus it has been hypothesized to be related to the anticipation of stressful events (Arthur, 1987).

1.3.2 Stress and sleep

Stress and sleep are biologically interconnected. The functioning of the HPA axis follows a circadian pattern of activity (Swaab, Bao & Lucassen, 2005). The SCN gives input to the paraventricular nucleus in the hypothalamus, which forms a part of the HPA axis, thus resulting in the rhythmic changes of cortisol secretion.

However, because the cortisol levels change during the course of the day, the connections between cortisol levels and stress are not clear-cut and the assessment time of the cortisol levels affects the results. Typically cortisol levels in humans are highest at the time of waking up (Toates, 1995 p. 45). Studies have shown that high cortisol levels in the evening as well as low cortisol levels in the morning are related to poor self-rated health and symptoms of stress (Dahlgren, Kecklund, Theorell, & Åkerstedt, 2009). Also the studies on circadian types show similar results. In these studies the evening types, with cortisol levels peaking later, have been proven to be prone to such stress related diseases as the cardiovascular syndrome (Mecacci & Rocchetti 1998).

1.3.3 Stress and personality

Various studies exist linking the HPA axis functioning to personality traits, but the results have often been inconclusive (Pruesser, Gaab, Hellhammer, Lintz, Schommer & Kirschbaum, 1997). Also the personality variables assessed are often different making the comparisons between the studies problematic. However, research typically connects high neuroticism as well as low extraversion and openness to experience to altered HPA axis functioning (e.g. Wang et al., 1997; Oswald et al., 2006; Williams et al., 2009).

Some recent studies have focused especially on the associations of stress with sleep quality and quantity. Stressful life events increase the variability in individuals' sleep quality (Mezick et al., 2009). Personality also seems to mediate the associations between stress and sleep. Williams et al. (2009) found that especially openness to experience moderated the associations between stress and sleep; stressful life-events were associated with poorer sleep quality only in subjects with low openness to experience.

Oswald et al. (2006) investigated how the differences in responses to psychological stress were associated with the big five personality traits. They found that lower openness to experience was associated with weaker cortisol responses in a stressful situation, indicating lower stress adaptation. Low cortisol responses were also related to higher

neuroticism in women and lower extraversion in men (Oswald et al., 2006). These results are in line with the fact that the trait neuroticism is characterised by low emotional stability and vulnerability to psychological stress, by definition, in the big five theory (Costa & McCrae, 1985).

1.4 Research questions and hypotheses about personality and sleep relationships

The first objective of this thesis was to investigate, whether significant associations can be found between personality and sleep quality and quantity, and what is the structure of these associations. Because research associating big five personality factors with sleep is not conclusive at this point, not many hypotheses can be made based on the former research. The research questions and hypotheses are presented below.

The first research question is related to the trait neuroticism. How does neuroticism effect sleep? Based on existing research (Gau, 2000; Gray & Watson, 2002; Soehner et al., 2007) and the fact that this trait is related to higher vulnerability to stress (Costa & McCrae, 1985) and thus probably more variation in sleep (Mezick et al., 2009), our hypothesis is that neuroticism is related to a lesser quality of sleep.

Our second research question is: what is the pattern of associations between personality and sleep among the other personality traits? We will investigate the associations between sleep quality and quantity and the traits extraversion, agreeableness, conscientiousness, and openness to experience. However, we will not make hypothesis about the results because there is not enough consistent data about the associations.

Our third research question concerns, whether sleep quality rather than quantity has stronger associations with the personality parameters. Based on the former research (Gau, 2000; Gray & Watson, 2002; Soehner et al., 2007) our hypothesis is that there will be more significant associations between personality traits and sleep quality than between personality traits and sleep quantity.

Before moving on to analysing the data, another possible factor influencing personality and sleep will be reviewed. This is the effect of premature birth and very low birth weight (VLBW). We discuss VLBW especially because it is related to both the biological and environmental factors, which are important to the development of sleep and personality. We will study whether birth status moderates the personality and sleep associations.

1.5 Very low birth weight

The average birth weight of Finnish infants born after the gestational age of 37 weeks (considered as full-term birth) is 3620 grams for boys and 3473 grams for girls based on Finnish birth weight charts (Pihkala, Hakala, Voutilainen & Raivio, 1989). Earlier studies state that approximately 1.5 percent of newborn infants are born with VLBW, weighing less than 1500 grams at birth (Martin et al., 2005). Because pregnancy and neonatal care has been improved in the past decades, the VLBW infants have a much higher survival rate as compared to earlier years (Järvenpää, Virtanen & Pohjavuori, 1991). Through this development it has become possible to investigate the developmental outcomes of infants born with VLBW more thoroughly.

A typical classification of the VLBW newborns is based on whether they are small for gestational age (SGA) or appropriate for gestational age (AGA, appropriate size for gestational age, birth weight $\geq -2SD$). Being born SGA is typically a sign of abnormal intrauterine environment, and thus SGA infants form the most vulnerable risk group for various developmental conditions (Hack, Klein & Taylor, 1995).

Even though many of the very low birth weight infants do not show major developmental impairments they do occur, including mental retardation, poorer school performance, cerebral palsy, blindness, deafness, psychomotor problems, subnormal growth and other health problems (Hack et al., 1995).

VLBW has also been associated with the development of sleep, personality and stress mechanisms (e.g. Kennaway, 2002; Strang-Karlsson et al., 2007; Pesonen et al., 2008). The following paragraphs will discuss these interconnections.

1.5.1 VLBW and Sleep

VLBW conditions can affect sleep functions through the development of the circadian rhythms. The programming of the suprachiasmatic nucleus is vulnerable prenatally; specific conditions such as intrauterine growth retardation, maternal stress, nutrition or use of drugs can affect its development (Kennaway, 2002). Kennaway, Goble & Stamp (1996) showed that intrauterine growth retardation might also affect melatonin rhythms causing them to develop more slowly, thus implying different sleep quality and quantity for VLBW infants.

Research shows that some minor differences do exist in sleep quality between VLBW and term-born subjects. Adults born with VLBW have similar quality and quantity of sleep as compared to those born full term (Strang-Karlsson et al., 2007), but VLBW adults go to bed earlier, and adults with lower gestational age at birth have longer sleep latency (Strang-Karlsson et al., 2007). VLBW has also been linked to sleep disordered breathing in young adulthood (Paavonen et al. 2007). This refers to intermittent upper airway breathing obstructions that lead to hypoventilation, disrupted sleep architecture, and decrease in blood oxygen saturation (Arens & Marcus, 2004), possibly resulting in a lesser quality of sleep.

Hoppenbrouwers et al. (2005) concluded that infants can be divided into three groups when analysing the development of sleep: the term-born infant, the asymptomatic preterm infant, and the preterm infant needing ventilatory support. No major differences can be found in the development of sleep between the term-born and the asymptomatic preterm infants. However, the infants who needed ventilatory support and the ones born very young showed a delayed development of sleep architecture.

1.5.2 VLBW and Stress Mechanisms

The functioning of the HPA axis is related to the length of pregnancy. This has been indicated by assessing the maternal plasma concentrations of corticotropin releasing

hormone (CRH), which is part HPA. The CRH levels both predict the length of pregnancy and their concentration increases exponentially towards the end of pregnancy (McLean et al., 1995).

Small body size has been linked to altered HPA functioning and higher cortisol levels. (Szathmari, Vasarhelyi, Reusz, & Tulassay, 2000; Kajantie, 2006). Maternal stress has been connected to preterm birth (Rondo, 2007). These results together imply that premature birth is related to altered HPA axis functioning in both the mother and the child.

Gestational age also determines the interaction between birth weight and cortisol levels. In women born with low birth weight, at 40 weeks or more of gestational age, the cortisol levels were down regulated, indicating weaker cortisol responses. Whereas, with women born before 40 weeks of gestation the relation was reverse. It is hypothesized that gestational age at birth is actually an indicator of the differences in the fetal or maternal glucocorticoid metabolism (Kajantie et al., 2003).

Räikkönen et al. (2008) hypothesize that the actual reason for depressive symptoms in the SGA group could be intrauterine growth retardation seen in SGA infants and the differences in the intrauterine programming of the HPA axis. The results by Kajantie et al. (2003), about the differences in the up- or down regulation of the HPA axis within different gestational ages, could be related to these findings. This suggests that especially the SGA infants are susceptible to altered HPA functioning.

1.5.3 VLBW and personality

The personality characteristics more common in VLBW group, than in the term born controls, include less negative emotionality, being more dutiful and cautious, and displaying more warmth in social relationships (Pesonen et al., 2008). In general the VLBW infants were less prone to negative emotions and were more cautious in many aspects of their lives (Pesonen et al., 2008, Kajantie et al., 2008)

The study by Pesonen et al. (2008) showed no differences between the SGA and AGA infants' personality variables. However, other differences have been found. For example, a study by Räikkönen et al. (2008) showed that VLBW infants born SGA showed more depression, whereas AGA infants actually showed less depressive symptoms in young adulthood. These results reflect the expectation that especially SGA born individuals have an altered HPA functioning, and that they form a developmentally distinct group from other VLBW born individuals.

1.6 Research questions and hypothesis

Our fourth research question is: Does VLBW status affect the associations between personality and sleep? Our hypothesis is that interaction effects will be found.

We base this hypothesis on the results reviewed above; conditions related to VLBW might have an effect on personality as well as on sleep variables (e.g. Kennaway, 2002, Pesonen et al., 2008). Biological mechanisms as well as parental interaction might result in differences between VLBW and fullterm infants.

As discussed earlier such biological mechanisms as the HPA axis and SCN have effects on both the sleep and personality variables (e.g. Wang et al., 1997; Bailey & Heitkemper, 2001; Williams et al., 2009) and furthermore, their functioning is interconnected (e.g. Swaab et al., 2005). In addition the development of these mechanisms is vulnerable during the end of pregnancy.

The parental interaction factors may cause variation in the two groups based on the assumption that parents treat VLBW infants differently from the term born infants (e.g. Barratt et al. 1992; Feldman, 2007). This might have simultaneous effect on sleep and personality development.

In addition to assessing the moderating effects of being born with VLBW we wanted to assess whether the newborn's SGA or AGA status has a moderating effect on the

associations. Our fifth research question is: does being born SGA mediate the association between personality and sleep?

Our hypothesis is that SGA status will mediate the relationships. This hypothesis is based on similar findings as the earlier hypothesis. Because SGA born individuals are particularly vulnerable to developmental impairments during pregnancy, we expect that the moderating effect is more profound within this group (e.g. Hack, Klein & Taylor, 1995; McLean et al., 1995; Kennaway, 2002; Räikkönen et al., 2008).

2. METHODS

2.1 Participants

As described earlier (Hovi et al. 2007) the study cohort comprised of 335 consecutive very low birth weight infants born between January 1978 and December 1985, who were discharged alive from the neonatal intensive care unit (NICU) of the Hospital for Children and Adolescents at Helsinki University Central Hospital, the only tertiary neonatal care center in the province of Uusimaa, Finland.

The term born group of children was selected from the records of all consecutive births at each birth hospital. For each VLBW survivor was selected the next available singleton of the same sex, born at term (gestational age ≥ 37 weeks) and not small for gestational age (SGA).

At the first follow-up study of the cohort in 2004 95.1% of the VLBW subjects and 96,8% of the term born subjects were traced from the Population Register Centre in Finland. After excluding those living outside greater Helsinki area, 255 young adults born with VLBW and 314 adults, who were born at term were invited to the study. 166 of the VLBW subjects (65.1 %) and 172 of the subjects born at term (54.8 %) agreed to participate. Among the participants with complete self-reports on personality (94% of the participants), there were 158 VLBW subjects and 168 subjects born at term.

Because chronic disability may affect personality, subjects with serious medical conditions (n=17) were excluded from the analysis. Also the subjects using sleep medication were excluded to control for the confounding effects on sleep (n=7). From the follow-up study participants, the ones having one or more nights of analysed sleep by actigraphy, were included in the further analysis of the data. One participant in this group not having records from the personality variables was also excluded resulting in 173 subjects in total. This data included 89 subjects born VLBW and 84 subjects born at term. The VLBW group comprised of 32 men and 52 women and the term born group included 30 men and 59 women.

The study protocol was approved by the Ethics Committee for Children's and Adolescents' Central Hospital, and all participants gave their written informed consent.

2.2 Background variables

The perinatal measures were obtained from the hospital records. The neonatal characteristics were converted into standard-deviation scores according to Finnish birth weight charts. The SGA and AGA were based on Finnish birth weight standards (Pihkala, Hakala, Voutilainen, & Raivio, 1989). Parental educational attainment was defined as the highest level of education achieved by either parent, as reported by the participant.

2.3 Personality assessment

For assessing the big five personality traits we used the NEO-Personality Inventory (NEO-PI; Costa & McCrae, 1985), which is a 180-item personality inventory designed to assess the big five personality traits. As discussed earlier, the first three scales (neuroticism, extraversion and openness) consist of 48 items each and are subdivided into six facets. Agreeableness and conscientiousness comprise 18 items each and have no facets. The responses vary between 0 (*untrue*) and 5 (*extremely true*). The participants received the questionnaire during the clinical examination (Hovi et al., 2007) and were asked to complete the items at home and return the survey by mail or during a clinical revisit. Cronbach alphas, assessing the internal consistency of the measure, ranged from 0.76 to 0.91 (Hovi 2007).

2.4 Sleep quantity and quality

Sleep quality and quantity were estimated from actigraphy data by automatic scoring (Actiwatch AW4, Cambridge Neurotechnology Ltd, UK) and subsequent manual verification. The wrist actigraph is approximately the same size as a standard wristwatch and it is a non-intrusive instrument to measure sleep quality and quantity by assessing body movement (Sadeh, Hauri, Kripke & Lavie, 1995). The AW4 model used in this study has been validated against polysomnography in adults, showing a 90% correspondence between the methods (Kushida et al., 2001).

To score the nocturnal activity data the Actiwatch Activity & Sleep Analysis V 5.42 software was applied using the previously validated sleep algorithm provided by the manufacturer. It separates sleep from wakefulness by analyzing activity in a specific epoch taking into account the surrounding epochs. The epoch is scored as sleep unless the activity exceeds a certain threshold, which in turn is determined by the selected sensitivity.

The participants were asked to wear the actigraph on their nondominant wrist continuously for a minimum of 3 days except when taking showers, swimming, or going to a sauna. Medium sensitivity and one minute epochs were used. The participants wore the actigraphs on their non-dominant wrist continuously for an average of four consecutive nights ($M = 3,6$, $SD = 1,5$; range 1 to 9 nights).

Four different sleep measurements were used based on the actigraphy data: (1) Sleep duration, defined as the estimated total sleep length minus wake time, (2) sleep latency, defined as the time it takes to fall asleep after going to bed, (3) sleep efficiency, defined as the percentage of minutes asleep while in bed, thus including sleep latency, and (4) fragmentation index, an indicator of restlessness, measuring the amount of micro-awakenings during the night.

2.5 Statistical analyses

We assessed the group differences between the VLBW and term-born groups first by using the T-test or Chi-square test. Pearson’s correlation coefficients were calculated to assess the internal correlations between sleep and personality.

We used linear regressions to study the associations between personality traits and sleep quality and quantity. All the associations were adjusted by the subject’s age and gender. Whenever an association between personality and sleep was significant, we tested whether this association was moderated first, by the VLBW and second, by the SGA status of the participant. Furthermore, when a significant interaction was found between distinct sleep and personality measures, the associations between these measures were calculated separately inside the specific birth status groups.

3. RESULTS

3.1 Characteristics of the cohort

The clinical, sleep and personality characteristics of the participants are shown in Table 1. The VLBW group scored significantly lower in the neonatal characteristics of birth weight, length and head circumference (all p values <0.001). The term-born group had significantly higher level of parental education ($p=0.012$). No differences between groups were found for the subjects’ gender.

Extraversion was significantly lower among the individuals born with VLBW ($p=0.023$), whereas openness was significantly higher for these subjects ($p<0.001$). These results are in line with previous research (Pesonen et al. 2008). We found no differences between groups in conscientiousness, neuroticism and agreeableness (all p values > 0.55).

Additionally VLBW individuals did not differ from term-born group in sleep duration, sleep efficiency, fragmentation index, or sleep latency (all p values > 0.32).

Table 1. Clinical and sleep characteristics of the Young Adults Born with Very Low Birth Weight (VLBW; $<1,500\text{g}$) and at Term

Variable	VLBW (n=89)	Term (n=84)	p -value
	Mean (SD)	Mean (SD)	

Sleep measured by actigraphy			
Sleep efficiency (%)	81.85 (5.37)	82.69 (5.60)	0.321 **
Sleep latency (min:s)	16:40 (16:00)	14:25 (13:37)	0.322 **
Fragmentation index	30.68 (9.655)	30.13 (8.66)	0.537 **
Sleep duration (hr, min)	7.21 (0.86)	7.14 (0.84)	0.631 **
Personality variables (SD scores)			
Neuroticism	-0.06 (0.98)	-0.07 (0.88)	0.905 *
Extraversion	-0.14 (1.05)	0.22 (1.01)	0.023 *
Conscientiousness	0.06 (0.94)	0.00 (1.07)	0.723 *
Agreeableness	0.15 (0.92)	0.07 (0.92)	0.554 *
Openness	-0.21 (0.96)	0.31 (0.89)	<0.001 **
Neonatal characteristics			
Birth weight SD score	-1.35 (1.48)	0.02 (0.91)	<0.001 *
Length at birth SD score	-1.34 (1.71)	-0.04 (0.81)	<0.001 *
Head circumference SD score	-0.95 (1.32)	0.01 (0.91)	<0.001 *
Gestational age (weeks)	29.31 (2.31)	40.19 (1.18)	<0.001 *
SGA a)	29 (34.5)	0 (0.0)	<0.001 **
Men, n (%)	32 (38.1)	30 (33.6)	0.548 **
Age at examination (years)	21.92 (2.12)	21.93 (2.24)	0.962 *
Parent's educational d)			
Elementary school, n (%)	9 (10.7)	4 (4.5)	0.012 **
High school level, n (%)	22 (26.2)	13 (14.6)	
Intermediate level, n (%)	31 (36.9)	29 (32.6)	
University degree, n (%)	22 (26.2)	43 (48.3)	

* T-test; ** Chi-square test

a) Small for gestational age (birth weight SD score <-2)

d) Highest level of more educated parent

3.2 Correlations between sleep variables

As Table 2 shows the majority of the sleep variables were somewhat intercorrelated.

Even though they do assess different sleep phenomena, these intercorrelations should be kept in mind while further analysing the results.

Table 2. Pearson's correlation coefficients between sleep duration, sleep latency, sleep efficiency and fragmentation index

	Sleep duration	Sleep latency	Sleep efficiency	Fragmentation index
Sleep duration	1	.06	.20**	-.08
Sleep latency		1	-.61**	.27**
Sleep efficiency			1	-.63**
Fragmentationindex				1

* $P < 0.05$ ** $P < 0.01$

3.3 Correlations between personality variables

Table 3 shows the internal correlations between the measured personality parameters. Extraversion was positively correlated to conscientiousness and openness to experience and negatively correlated to neuroticism. Conscientiousness was also negatively correlated to neuroticism and positively correlated to agreeableness. Neuroticism and agreeableness were negatively correlated to each other. These intercorrelations are similar to the ones reported previously (e.g. Hämäläinen, Pulkkinen, Allik & Pulver, 1994) and should be taken into consideration while further analysing the results.

Table 3. Pearson's correlation coefficients between extraversion, conscientiousness, neuroticism, agreeableness and openness to experience

	Extraversion	Conscientiousness	Neuroticism	Agreeableness	Openness
Extraversion	1	.31**	-.41**	-.01	.26**
Conscientiousness		1	-.30**	.18*	-.05
Neuroticism			1	-.30**	.01
Agreeableness				1	.10
Openness					1

* $P < 0.05$ ** $P < 0.01$

3.4 Personality and sleep relationships

Table 4 shows the multiple regression analysis between personality and sleep quality and quantity. Sleep duration, sleep latency and sleep efficiency were associated with the

personality traits. According to the results higher extraversion was associated with shorter sleep duration, conscientiousness was associated with shorter sleep latency. Neuroticism was associated with longer sleep latency. Agreeableness was associated with shorter sleep latency as well as with higher sleep efficiency.

Table 4. Multiple linear regression analyses demonstrating the associations between personality traits and sleep quality and quantity adjusted by subject's age and gender

Parameters	Standardized regression coefficient Beta	<i>p</i> - value
Extraversion		
Sleep duration	-0.26	0.001
Sleep latency	-0.01	0.886
Sleep efficiency	-0.10	0.205
Fragmentation index	0.13	0.097
Conscientiousness		
Sleep duration	0.05	0,557
Sleep latency	-0.21	0.006
Sleep efficiency	0.14	0.063
Fragmentation index	0.01	0.856
Neuroticism		
Sleep duration	0.01	0.871
Sleep latency	0.25	0.003
Sleep efficiency	-0.13	0.110
Fragmentation index	0.02	0.800
Agreeableness		
Sleep duration	0.12	0.107
Sleep latency	-0.23	0.003
Sleep efficiency	0.19	0.011
Fragmentation index	-0.14	0.057
Openness		
Sleep duration	-0.08	0.293
Sleep latency	0.15	0.063
Sleep efficiency	0.03	0.713
Fragmentation index	-0.11	0.177

3.5 Birth status as a moderator in the associations between personality and sleep

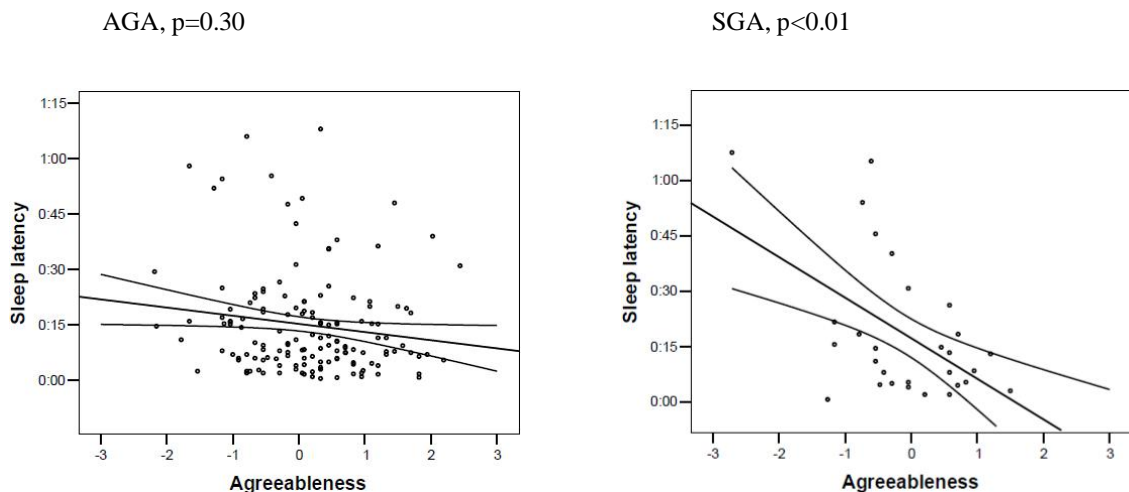
We conducted a multiple linear regression analysis to investigate the interactions caused by VLBW birth status in the personality-sleep variable pairs that had a significant association with each other. We did not find any significant interactions caused by VLBW (all p values > 0.42).

We also investigated the interactions caused by SGA status. We found that the associations between agreeableness and sleep latency as well as sleep efficiency depended on the SGA status (P values for interaction SGA x Agreeableness were 0.007 and <0.001). Additionally the association between conscientiousness and sleep latency was dependent on the SGA status (P value for the interaction SGA x Conscientiousness was 0.01). The other associations were not dependent on the SGA status.

Figure 1 illustrates associations that were dependent on the SGA status, for the SGA and AGA groups separately. It can be seen that the associations in the SGA group are significant whereas they are not significant in the AGA group.

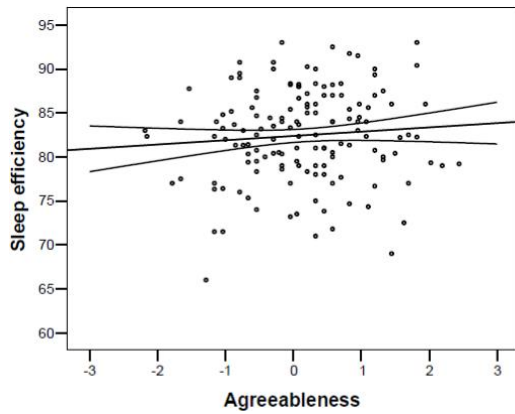
Figure 1 Regression slopes and 95 % confidence intervals as well as the R-square and P -values for the regressions representing the associations between (A) agreeableness and sleep latency, (B) agreeableness and sleep efficiency and (C) conscientiousness and sleep latency, in the SGA and AGA groups.

A

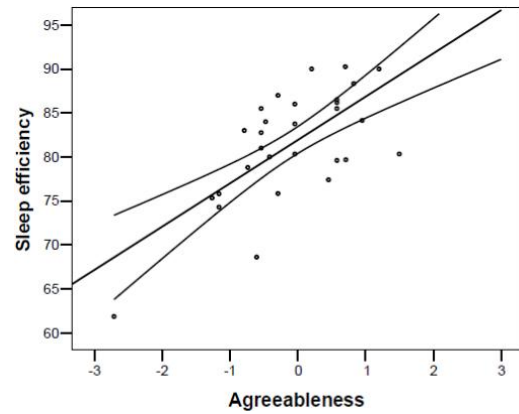


B

AGA, $p=0.30$

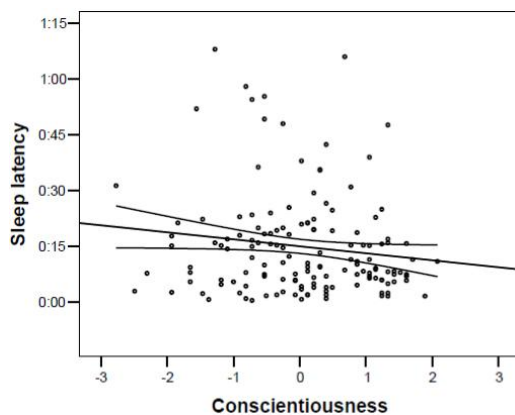


SGA, $p<0.01$

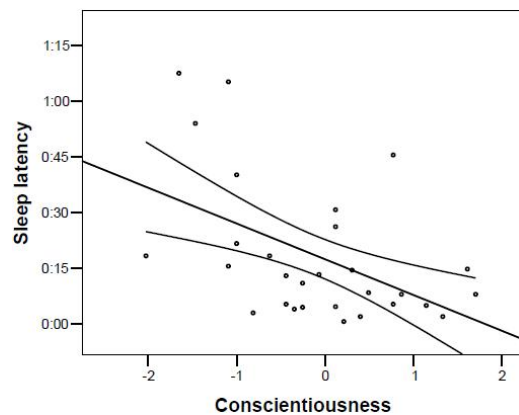


C

AGA, $p=0.07$



SGA, $p<0.01$



4. DISCUSSION

4.1 Associations between personality traits and sleep quantity and quality

The main objective of the thesis was to investigate the associations between personality traits and sleep quantity and quality. According to previous research we assumed that neuroticism is related to worse sleep quantity and quality (Bonnet, 1985; Pilcher & Huffcutt, 1996; Haack & Mullington, 2005). We did not make a strong hypothesis about the other personality traits, but wanted to assess their associations to sleep (Gray & Watson, 2002). We wanted to examine whether sleep quality rather than sleep quantity is related to personality traits as found by Gray and Watson (2002).

Additionally we assessed the moderating effect caused by birth status to the significant associations. Our findings concerning the research questions are discussed in detail below.

4.1.1 Findings concerning the 1st research question

We found that neuroticism was related to longer sleep latency. This result is in line with our hypothesis. It is also in line with previous research focusing on sleep deprivation (Bonnet, 1985; Pilcher & Huffcutt, 1996; Haack & Mullington, 2005) as well as on personality and sleep associations in normal settings, where the subjects' sleep is not restricted by the study protocol (Gau, 2000; Gray & Watson, 2002; Soehner et al., 2007).

Neuroticism is by definition a trait related to higher vulnerability to stress (Costa & McCrae, 1985). Our result adds to the recent research suggesting that higher vulnerability to stress has negative effects on sleep (Mezick et al., 2009; Williams et al., 2009).

4.1.2 Findings concerning the 2nd research question

We found that *conscientiousness* is related to shorter sleep latency. Previous reports showed that conscientiousness predicts sleep quality only modestly but it contributes significantly to maintaining consistent sleep schedules (Gray & Watson, 2002).

Gray and Watson's (2008) study was conducted with a population of undergraduate students and sleep measurements were carried out by sleep questionnaires (PSQI: Buysse et al., 1989 and SPAS: Gray & Watson, 2002) that have been proved valid in assessing sleep quality and quantity. However, we should be cautious when comparing the results to each other because the measurements and study populations are not similar.

Agreeableness was associated to shorter sleep latency as well as higher sleep efficiency. This result was not reached in the research reviewed earlier in this thesis. For example

Gray and Watson (2002) found that agreeableness was not significantly related to any of their sleep measures.

It is worth mentioning that conscientiousness and agreeableness are somewhat intercorrelated traits, thus similar reasons for the association with sleep may play a role for both of the variables, but also some distinct mechanisms may exist behind these associations. Agreeableness was also significantly related to better sleep efficiency, a result not found in the case of conscientiousness. Because previous research has not focused on agreeableness and sleep this still remains a question to be investigated in future research.

In our study *extraversion* was associated with shorter sleep duration but not with lower sleep quality. This is a new finding. Gray and Watson (2002) found that extraversion, like conscientiousness, contributes moderately to better sleep quality, but not to sleep quantity. And Soehner (2007) did not find associations between extraversion and sleep in a sample of working adults. Both of these studies used sleep questionnaires in measuring sleep.

The associations in our study and in the study by Gray and Watson (2002) links extraversion with sleep parameters that describe different aspects of sleep. Thus there might be some other factors related to the trait extraversion that account for the negative association between extraversion and sleep quantity found in our study.

For example, in our study the negative association between extraversion and sleep duration might be caused by less consistent sleep schedules, whereas in Gray and Watson (2002) the positive association between sleep quality and extraversion might be related mostly to variables measuring a positive effect than the other facets of extraversion. Indeed Gray and Watson (2002) note that the extraversion only made a modest contribution in predicting subjective sleep inefficiency, whereas a positive effect significantly predicted sleep quality in all assessed aspects. Thus it is possible that

extraversion has different kinds of influences on sleep: improving sleep quality but also reducing sleep quantity.

Openness to experience was not related to any sleep parameters, this result is in line with Gray and Watson (2002). However, as discussed before, it has been suggested that openness moderates the link between sleep and stress, thus making an individual low in openness more susceptible to sleep disturbances caused by stressful life-events. We did not measure stressful life events within our data, but this topic could be an interesting focus of future research.

4.1.3 Findings concerning the 3rd research question

Finally, we found that both sleep quantity and sleep quality were associated with personality traits, even though the only trait associated with sleep quantity was extraversion. We expected that personality traits would show more associations with sleep quality than quantity, thus these results are in line with our hypothesis.

In the case of extraversion our results are different from research stating that sleep quantity does not have associations with personality traits (Gray & Watson, 2002; Soehner et al., 2007). This might be due to the fact that our results are based on sleep data measured by actigraphy and not by sleep questionnaires like the other studies. When answering questionnaires individuals' perceptions of their sleep are not always reliable, hence our data actually gives more accurate results on the subjects' sleep duration.

4.2 Birth status as a moderator in the associations between personality and sleep quality and quantity

4.2.1 Findings concerning the 4th and 5th research question

Against our expectations, we found no significant interaction effect in the association between personality and sleep created by being born with VLBW (interaction VLBW x personality).

However, the SGA – AGA status (interaction SGA x personality) moderated the personality and sleep association in three cases. These significant interactions were found in the associations between agreeableness and sleep efficiency as well as sleep latency and also between conscientiousness and sleep latency. Thus in our study SGA status moderates the personality and sleep associations within these personality traits.

When comparing the associations in the SGA and AGA groups separately, we found that in the SGA group there were significant connections between conscientiousness and sleep latency as well as between agreeableness and sleep latency, and agreeableness and sleep efficiency. Furthermore, the group born AGA did not show significant associations between these variables in our study.

The fact that SGA status moderates the associations between personality and sleep is important while comparing our results to other studies. Data based on normal population does not include as many VLBW or SGA subjects as our data. Thus if SGA moderates the personality and sleep associations it can be expected that our results are different from other research, if we include both the SGA and AGA subjects in our analysis. Indeed, if only the results based on the AGA subgroup were analysed our results would have been in line with the earlier study by Gray and Watson (2002), with regard to the negative association between neuroticism and sleep quality, and the fact that traits other than neuroticism are not associated with sleep quality.

4.3 Explaining the findings

Our results suggest that SGA birth influences the personality and sleep associations in a distinct way. These influences are probably caused by the specific factors related to SGA birth. The most prominent candidates explaining the results are especially the biological mechanisms developing prenatally as well as parental factors. These are discussed in more detail below.

4.3.1 Biological mechanisms

There are various differences in child development linked to SGA birth. For example, individuals born SGA show more depression, whereas AGA individuals born with VLBW actually show less depression than term born controls (Räikkönen et al., 2008). Thus, SGA born individuals have distinctively different developmental environments compared to the AGA group. Additionally the development of sleep might be different for the group of SGA VLBW children from the early phases onwards. For instance, a study by Hoppenbrouwers et al. (2005) found that asymptomatic preterm infants show normal development of sleep architecture, whereas preterm infants with early gestational age and morbidity show a delayed development of sleep architecture (Hoppenbrouwers et al., 2005).

It is possible that stress mechanisms operate differently especially for the SGA infants as compared to other children. As noted before stress functions have been associated to sleep and personality factors (e.g. Mecacci & Rocchetti, 1998; Williams et al., 2009) as well as to prenatal development (e.g McLean et al., 1995).

Small body size has been linked to altered HPA functioning and higher cortisol levels. (Vasarhelyi, Reusz, & Tulassay, 2000; Kajantie, 2006; Szathmari), and maternal stress has been connected to preterm birth (Rondo, 2007). As noted before it has also been hypothesized that gestational age at birth is an indicator of the differences in the fetal or maternal glucocorticoid metabolism (Kajantie et al., 2003) suggesting that especially the SGA infants suffer from altered HPA functioning.

However, we did not have a measure of stress such as cortisol level measurements in our data and thus the importance of stress in explaining personality and sleep relationships in SGA and AGA born adults will remain a question for future research.

4.3.2 Parental factors

The role of parental interaction in personality development has been stated important in various studies (e.g. Reti et al., 2002). Additionally it has been shown that parents of low-

and high-risk children interact differently with their child, even though the results have been somewhat controversial. Parents of VLBW children have been shown to be more attentive in the early phases of infancy, but at the age of 20 months these parents became less vocally responsive to the child as compared to the parents of term born children (Barratt, Roach & Leavitt, 1996). Additionally, even though some studies have shown parents of 4-months-old VLBW infants being more responsive to their children (Barratt et al. 1992), other studies show that parents of the same age VLBW infants show poorer performance in interaction when compared to the controls (Feldman, 2007).

It has been proposed that the amount of risk caused by prematurity might affect the parental behaviours. A study comparing parents' perceptions about their VLBW infants (Estroff, Yando, Burke and Snyder, 1994) suggested that parents who perceived their infants vulnerable, also behaved differently towards the child (a phenomena referred as the syndrome of nonoptimal development, Green & Solnit, 1964). Whereas Estroff et al. (1994) found that parental perception of a child's vulnerability was not dependent for example on such factors as child's gestational age or birth weight and the children did not differ in their overall cognitive capacity either. Consequently Estroff et al. (1994) hypothesized that parental representations of the child's vulnerability are not always in line with the actual conditions; moreover this is especially true when parents consider their children as more vulnerable.

Consequently, an important question regarding the results of this study is: in which conditions do parents consider their child being at risk? For example, do parents treat SGA children differently from AGA children? It is possible that this affects their attitudes, rearing practices and interaction with the child thus modifying also the personality and sleep outcomes.

Following this line of research it would be interesting to investigate whether a child's SGA status actually affected the parents' perceptions of vulnerability. If this is the case, more evidence about parental practices modifying the link between personality and sleep would be attained.

4.4 Strengths and limitations of the study

Our data comprised of 158 VLBW subjects and 168 subjects born at term, which is enough to make reliable hypothesis based on the results. However, when analysing the interaction effects, the small number of subjects in the SGA subgroup makes the results less reliable, the number of subjects was only 27. Thus the results should be interpreted with caution. A study including a larger dataset of especially SGA born subjects is needed in order to verify the results.

In addition, the data used in this study is part of the Helsinki Study of Very Low Birth Weight Adults and it consists of approximately 50 % of adults born with VLBW. Although the control subjects are selected from the normal population, the nature of the design is clinical, which may restrict the external validity of the results.

As was discussed before, our study probably gave more reliable results concerning sleep than studies using sleep questionnaires. However, in some cases our measurements are based on data derived from only one night of analysed sleep, which may not be considered as sufficient time to register a reliable sleep pattern.

4.5 Suggestions for further research

We will now move on to discuss the variables that were not assessed in our study as well as important concepts that could be focused in future research. The following themes could be focused in future research in order to further develop the theoretical framework concerning personality and sleep associations.

4.5.1 Sleep schedules

We did not assess the waking up and going to bed times of our subjects, thus we do not know how the sleep schedules might be related to our results.

One reason for the association between extraversion and lower sleep duration might be related to the expectation that extroverted people have less regular sleep patterns and they

typically go to bed later (Cavallera & Giudici., 2007) thus the amount of sleep is also shorter. In our study it was not tested whether the duration of sleep was caused by not being able to sleep or by not following a consistent sleep schedule. Additional data on the subjects' sleep schedules would shed more light on these questions.

4.5.2 Stressful life events and cortisol levels

We hypothesized that some of the personality and sleep relationships might be due to greater susceptibility to stress caused by distinct personality traits such as neuroticism in accordance to the proposition that stress increases variability in an individual's sleep (Mezick et al., 2009). However we did not measure the possible stressful life experiences in our data. Thus we can only propose that this kind of link is possible but we cannot prove its existence. Assessing the amount of stressful events would help to determine whether this expectation is true.

Additionally we have noted that the HPA functioning might play a role in explaining our results. Altered HPA functioning in SGA children might account for the different associations between personality and sleep caused by the birth status. However we have not included a measure of cortisol levels in our data and thus we cannot reliably make hypotheses about the HPA functioning within different subgroups in our data. It would be interesting to investigate whether cortisol levels moderate the personality and sleep relationships and whether distinct subgroups show different patterns in these influences.

4.5.3 Parental factors

We also proposed that parental factors might account for the differences between the SGA and AGA groups respectively. However we do not have data about the parental factors.

It would be interesting to study whether the child's SGA status actually affects the parents' perceptions of the child's vulnerability and whether it alters the parenting

practices. It would also be important to see how parenting changes and what kind of influences (if any) these changes have on the sleep variables. This would allow for investigating the effects of parenting in personality and sleep associations.

4.5.4 Sleep stages

This analysis focuses on the sleep data based on actigraphy measurements. However, there are also other sleep processes that cannot be assessed with the methods used in this study. Mainly these include the variations between different sleep stages characterised by two types of sleep, the REM (Rapid Eye Movement) and NREM (Non Rapid Eye Movement) sleep (Sejnowski & Destexhe, 2000).

The sleep stages give important information about the quality of sleep that cannot be tested in this study. Consequently, further research focusing on the possible linkages between personality variables and sleep stages is called for. Also the possible differences in the sleep structures within the VLBW and term born subjects would be an interesting focus of further research. Currently not many studies have focused on these issues.

4.5.5 Temperament

Personality development is connected to temperament. Temperament describes the highly inheritable individual styles of reacting to different situations (Chess & Thomas, 1986). The temperament features are fairly consistent over time, but they do not predict personality in any straightforward way. As Chess and Thomas (1986) describe, the goodness-of-fit between child's temperament and parent's behaviour is crucial for personality development. Consequently, with different combinations of parent-child interactions there can be very different personality outcomes within similar temperamental structures.

It is commonly accepted that personality is preceded by temperament, which is considered as the biological basis of personality, and it has also been suggested that

infant temperament has an effect on the development of sleep (Hoppenbrouwers p. 1434). Because temperament is more biologically based than personality it would be interesting to compare the temperamental structure with sleep quality and quantity. This would shed more light on the understanding of the shared biological mechanisms in personality development and sleep.

4.5.6 Circadian preference

Circadian rhythms have been proposed to be related to certain personality factors. This notion is based on the studies assessing individual morning / evening preference. The morningness / eveningness scale refers to an individual's biological predisposition to wake up early (the morning type) or stay up late (the evening type) (Cavallera & Giudici, 2007).

The differences between the morning and evening types can be seen in other biological circadian rhythms as well. These include the cortisol level in blood and body temperature that both peak earlier in the morning types. The evening types also exhibit a more inconsistent pattern of sleep, sleeping more on the weekends as compared to the morning types (Bailey & Heitkemper, 2001). Evening types have also otherwise more irregular life habits (Park et al 1997).

Circadian preference links personality and temperamental factors to sleep. Even though it is clear that environmental factors mediate the effects of biological mechanisms on personality it can be hypothesized that the individual phase of the circadian clock is related especially to such personality factors as novelty seeking, impulsivity and extraversion on the other hand and consciousness and persistence on the other. This hypothesis should be tested in future research.

4.6 Conclusion

In conclusion our results are mostly in line with previous data especially demonstrating the negative association between neuroticism and the quality of sleep and suggesting that

vulnerability to stress decreases sleep quality (Costa & McCrae, 1985; Gau, 2000; Gray and Watson, 2002; Soehner et al., 2007; Mezick et al., 2009; Williams et al., 2009). We also found that agreeableness and conscientiousness were associated with better sleep quality and extraversion was associated with lower sleep quantity. We propose that personality traits are mostly associated with sleep quality and not quantity, except in the case of extraversion.

We also found that SGA status moderated the personality and sleep associations. We propose that there are two factors behind the interaction. First, prenatally developing mechanisms have an effect on the development of sleep as well as personality. Second, differences in the postnatal environment, for instance the parenting practices, can account for this finding. However, it can be expected that many different phenomena have an effect on the development of personality and sleep simultaneously.

Future studies could give more profound explanations to the links found in this study. Future research could focus especially on what kind of prenatal disturbances SGA infants have in the development of mechanisms related to sleep and personality. Also focusing on the differences in parental interaction might shed more light on the results. In addition, such variables as temperament, circadian preference, cortisol levels, sleep states and sleep schedules could be assessed in order to investigate further the reasons behind our findings. This line of study could provide important information on the early development of sleep and personality and the interconnections of biologically based mechanisms behind them.

5. REFERENCES

- Arens R., Marcus C. L. (2004) Pathophysiology of upper airway obstruction: a developmental perspective. *Sleep*, 27, 997–1019
- Arthur, A. Z. (1987) Stress as a State of Anticipatory Vigilance. *Perceptual and Motor Skills*, 64, 75–85
- Bailey, S.L.; Heitkemper, M.M. (2001) Circadian Rhythmicity of Cortisol and Body Temperature: Morningness-Eveningness Effects. *Chronobiology International*, 18, 249–261
- Barratt, M. S., Roach, M. A., Leavitt, L. A. (1992) Early Channels of Mother-Infant Communication: Preterm and Term Infants. *Journal of Child Psychology and Psychiatry*, 33, 1193–1204
- Barratt, M. S., Roach, M. A., Leavitt, L. A. (1996) The Impact of Low-risk Prematurity on Maternal Behaviour and Toddler Outcomes. *International Journal of Behaviour and Toddler Development*, 19, 581–602
- Bonnet, M. H. (1985) Effect of Sleep Disruption on Sleep, Performance, and Mood. *Sleep*, 8, 11–19
- Caci, H., Robert, P., & Boyer, R. (2004). Novelty seekers and impulsive subjects are low in Morningness. *European Psychiatry*, 19, 79–84
- Cavallera, G. M., Giudici, S. (2007) Morningness and eveningness personality: A survey in literature from 1995 up till 2006. *Personality and Individual Differences*, 44, 3–21
- Chelminski, I., Ferraro, F. R., Petros, T. V., Plaud, J. J., (1999) An analysis of the “eveningness-morningness” dimension in “depressive” college students. *Journal of Affective Disorders*, 52, 19–29

- Chess, S. & Thomas, A. (1986) *Temperament in Clinical Practice*. The Guilford Press, New York
- Costa, P., & McCrae, R. (1985). *The NEO personality inventory manual*. Odessa, FL: Psychological Assessment Resources Inc.
- Dahlgren, A., Kecklund, G., Theorell, T., Åkerstedt, T. (2009) Day-to-day variation in saliva cortisol – Relation with sleep, stress and self-rated health. *Biological Psychology*, 82, 149–155
- Earnest, D. J., Liang, F.-Q., Ratcliff, M., & Cassone, V. M. (1999) Immortal time: circadian clock properties of rat suprachiasmatic cell lines. *Science*, 283, 693–695
- Edwards, J. R (1991) The Measurement of Type A Behavior Pattern: An Assessment of Criterion-oriented Validity, Content Validity, and Construct Validity. In Cooper, C. L. & Payne R. (Edts) *Personality and Stress: Individual Differences in the Stress Process*. John Wiley & Sons Ltd, West Sussex
- Estroff, D.B., Yando, R., Burke, K., & Snyder, D. (1994). Perceptions of preschoolers' vulnerability by mothers who had delivered preterm. *Journal of Pediatric Psychology*, 19, 709–721
- Feldman, R. (2007). Maternal versus child risk and the development of parent–child and family relationships in five high-risk populations. *Development and Psychopathology*. 19, 293–312
- Gau S F. (2000) Neuroticism and sleep-related problems in adolescence. *Sleep*; 23: 495–502

Gray, E., K. & Watson, D. (2002) General and Specific Traits of Personality and Their Relation to Sleep and Academic Performance. *Journal of Personality*, 70, 177–206

Haack, M. & Mullington, J. M. (2005) Sustained sleep restriction reduces emotional and physical well-being. *Pain*, 119, 56–64

Hack, M., Klein, N. K., Taylor, H. G. (1995) Long-Term Developmental Outcomes of Low Birth Weight Infants. *The Future of Children: Low Birth Weight*, 5, 19–34. Los Altos, CA: Center for the Future of Children. The David and Lucile Packard Foundation.

Hämäläinen, M., Pulkkinen, L., Allik, J., Pulver, A. (1994) Nestä-persoonallisuustestin (NEO-PI) standardointi “viiden suuren” persoonallisuuden piirteen arvioimiseksi. *Jyväskylän yliopiston psykologian laitoksen julkaisuja*, 327

Hannibal, J., Hindersson, P., Ostergaard, J., Georg, B., Heegaard, S., Larsen, P. S. & Fahrenkrug, J. (2004) Melanopsin Is Expressed in PACAP-Containing Retinal Ganglion Cells of the Human Retinohypothalamic Tract. *Investigative Ophthalmology & Visual Science*, 45, 4202–4209

Hoppenbrouwers T., Hodgman J., Arakawa K., Geidel S., Sterman M. (1988) Sleep and waking states in infancy: normative studies. *Sleep*, 11, 387–401

Hoppenbrouwers, T., Hodgman, J. E., Rybine, D., Galina, F., Corwin, M., Crowell, D., Weese-Mayer, D. E. (2005) Sleep Architecture in Term and Preterm Infants Beyond the Neonatal Period: The Influence of Gestational Age, Steroids and Ventilatory Support. *Sleep*, 29, 1428–1436

Hovi, P., Andersson, S., Eriksson, J. G., Järvenpää, A. L., Strang-Karlsson, S., Mäkitie, O., Kajantie, E. (2007) Glucose Regulation in Young Adults With Very Low Birth Weight. *The New England Journal of Medicine*, 356, 2053–2063

Järvenpää, A., Virtanen, M., Pohjavuori, M. (1991) The Outcome of Extremely Low Birthweight Infants. *Annals of Medicine*, 23, 699–704

Kajantie, E., David I. W. Phillips, D. I. W., Andersson, S., D. J. P., Leo, D., Forsén, T., Osmond, C., Tuominen, J., Wood, P J., & Eriksson, J. (2003) Birthsize, gestational age and adrenal function in adult life: studies of dexamethasone suppression and ACTH1–24 stimulation. *European Journal of Endocrinology*, 149, 569–575

Kennaway, D. J. (2002) Programming of the fetal suprachiasmatic nucleus and subsequent adult rhythmicity. *Trends in endocrinology & Metabolism*, 13, 398–402

Kennaway, D. J., Goble, F. C. & Stamp, G. E. (1996) Factors Influencing the Development of Melatonin Rhythmicity in Humans. *Journal of Clinical Endocrinology and Metabolism*, 81, 1525–1532

Kushida, C. A., Chang, A., Gadkary, C., Guilleminault, C., Carrillo, O., & Dement, W. C. (2001). Comparison of actigraphic, polysomnographic, and subjective assessment of sleep parameters in sleep-disordered patients. *Sleep Medicine*, 2, 389–396

Lemola, S., Räikkönen, K, et al (2009) Sleep quantity, quality and optimism in 8-year-old children. In press

Martin, J. A., Hamilton, B. E., Sutton, P. D., Ventura, S. J., Menacker, F., Munson, M. L., (2005) Births: Final data for 2003. *National Vital Statistics Reports*, 54. Hyattsville, MD: National Center for Health Statistics

McCrae, R. R., Costa, P. T. (1989) Reinterpreting the Myers-Briggs Type Indicator from the perspective of the five-factor model of personality. *Journal of Personality*, 57, 17–40

McLean, M., Bisits, A., Davies, J., Woods, R., Lowry, P & Smith, R. (1995) A placental clock controlling the length of human pregnancy, *Nature Medicine*, 1, 460–463

Mecacci, L., Rocchetti, G. (1998) Morning and evening types: stress-related personality aspects. *Personality and individual differences*, 25, 537–542

Mezick, E. J., Matthews, K. A., Hall, M., Kamarck, T. W., Buysse, D. J., Owens, J. F., Reis, S. E. (2009) Intra-individual variability in sleep duration and fragmentation: Associations with stress. *Psychoneuroendocrinology*, 34, 1346–1354

Oswald, L. M., Zandi, P., Nestadt, G., Potash, J. B., Kalaydjian, A. E. & Wand, G. S. (2006) Relationship between Cortisol Responses to Stress and Personality. *Neuropsychopharmacology*, 31, 1583–1591

Paavonen, E. J., Strang-Karlsson, S., Räikkönen, K., Heinonen, K., Pesonen, A. K., Hovi, P., Andersson, S., Järvenpää, A. L., Johan, G. (2007) Very Low Birth Weight Increases Risk for Sleep-Disordered Breathing in Young Adulthood: The Helsinki Study of Very Low Birth Weight Adults. *Pediatrics*, 120, 778–784

Park, Y. M., Matsumoto, K., Seo, Y. J., Shinkoda, H., & Park, K. P. (1997). Scores on Morningness–eveningness and sleep habits of Korean students, Japanese students and Japanese workers. *Perceptual and Motor Skills*, 85, 143–154

Pesonen, A. K., Räikkönen, K., Heinonen, K., Andersson, S., Hovi, P., Järvenpää, A. L., Eriksson, J. G., Kajantie, E. (2008) Personality of young adults born prematurely: Helsinki study of very low birth weight adults. *Child Psychology and Psychiatry*, 48, 609–617

Pihkala, J., Hakala, T., Voutilainen, P., Raivio, K. (1989) Characteristics of recent fetal growth curves in Finland. *Duodecim*, 105, 1540–1546 (In Finnish)

Pilcher, J. J. & Huffcutt, A. I. (1996) Effects of Sleep Deprivation on Performance: A Meta-Analysis. *Sleep*, 19, 318–326

Pruesser, J. C., Gaab, J., Hellhammer, D. H., Lintz, D., Schommer, N., Kirschbaum, C. (1997) Increasing Correlations Between Personality Traits and Cortisol Stress Responses Obtained by Data Aggregation. *Psychoneuroendocrinology*, 22, 615–625

Räikkönen, K., Pesonen, A. K., Heinonen, K., Kajantie, E., Hovi, P., Järvenpää, A. L., Eriksson, J. G., Andersson, S. (2008) Depression in Young Adults With Very Low Birth Weight - The Helsinki Study of Very Low Birth Weight Adults. *Archives of General Psychiatry*, 3, 290–296

Refinetti, R. (2006) *Circadian Physiology*. Taylor & Francis Group, London

Reti, I. M., Samuels, J. F., Eaton, W. W., Bienvenu, J., Costa, P. T. & Nestadt, G. (2002) Influences of parenting on normal personality traits. *Psychiatry Research*, 111, 55–64

Rondo, P. (2007) Maternal Stress / Distress and Low Birth Weight, Preterm Birth and Intrauterine Growth Restriction - A review. *Current Women's Health Reviews*, 3, 13–29

Sadeh A., Hauri P. J., Kripke D. F., Lavie P. (1995) The role of actigraphy in the evaluation of sleep disorders. *Sleep* 18, 288–302

Sadeh, A. & Anders, D. F., (1993) Infant Sleep Problems: Origins, Assessment, Interventions. *Infant Mental Health Journal*, 14, 17–34

Scher, A., Epstein, R. & Tirosh, E. (2004) Stability and changes in sleep regulation: A longitudinal study from 3 months to 3 years. *International Journal of Behavioral Development*, 28, 268–274

Sejnowski, T. & Destexhe, A. (2000) Why do we sleep? *Brain Research*, 886, 208–223

- Soehner, A. M., Kennedy, K. S. & Monk, T. H. (2007) Personality Correlates with Sleep-Wake Variables. *Chronobiology International*, 24, 5, 889–903
- Spruyt, K., Aitken, R. J., So, K., Charlton, M., Adamson, T. M., Horne, R. S. C. (2008) Relationship between sleep/wake patterns, temperament and overall development in term infants over the first year of life. *Early Human Development*, 84, 289–296
- Strang-Karlsson, S., Räikkönen, K., Kajantie, E., Andersson, S., Hovi, P., Heinonen, K., Pesonen, A. K., Järvenpää, A. L., Eriksson, J. G., Paavonen, J. (2007) Sleep Quality in Young Adults with Very Low Birth Weight - the Helsinki Study of Very Low Birth Weight Adults. *Journal of Pediatric Psychology*, 33, 387–395
- Swaab, D. F., Bao, A-M., Lucassen, P. J. (2005) The stress system in the human brain in depression and neurodegeneration. *Ageing Research Reviews*, 4, 141–194
- Toates, F. (1995) *Stress, Conceptual and Biological Aspects*. Wiley & Sons Ltd, West Sussex
- Vink, J. M., Groot, A. S., Kerkhof, G. A., & Boomsma, D. I. (2001). Genetic analysis of Morningness and Eveningness. *Chronobiology International*, 18, 809–822
- Williams, P. G., Rau, H. K., Cribbet, M. R., Gunn, H. E. (2009) Openness to Experience and stress regulation. *Journal of Research in Personality*, 43, 777–784