The Influence of Chronotype and Intelligence on Academic Achievement in Primary School

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Zusammenfassung

Personen unterscheiden sich im Hinblick auf das Timing des Schlafes (z.B. Schlafenszeiten und Aufstehzeiten) und die Präferenz für Morgen- oder Abendstunden. Frühere Arbeiten hatten sich lediglich auf Sekundarschüler konzentriert. Dies ist das erste Forschungsprojekt weltweit, welches Grundschüler in der vierten Klasse untersucht. Die Studie zielt darauf ab, den Zusammenhang zwischen Chronotyp und schulischer Leistung bei 10-jährige Kindern (n = 1125, 536 Mädchen, 584 Jungen, 5 ohne Geschlechtsangabe) zu untersuchen. Sie unterzogen sich einem kognitiven Test (Culture Fair Intelligenz Test, CFT 20-R) und Fragen zu Aufsteh- und Schlafenszeiten, akademischer Leistung (Schulnoten), Gewissenhaftigkeit und Motivation. Eine Reihe von Fragebögen wurde implementiert. Wir verwendeten Fragen zu Aufwachzeiten und Bettzeiten, akademischer Leistung (gemessen an den Noten in Mathematik, Deutsch, Englisch und Natur & Kultur), die kurze Version des Fünf-Faktoren-Persönlichkeitsinventars für Kinder (FFPI-C), um Gewissenhaftigkeit zu messen, und die Composite Scale of Morningness (CSM) zur Bewertung. Der durchschnittliche CSM-Stand lag bei 37,84 ± 6,66, der Mittelpunkt des Schlafs war um 1:36 ± 0:25 Uhr und die durchschnittliche Schlafdauer (Zeit im Bett) war 10:15 ± 0:48 Stunden. Morgenpräferenz war positiv mit Intelligenz, Gewissenhaftigkeit und Lernwilligkeit assoziiert. Die Ergebnisse zeigten, dass Jungen und Mädchen nicht im Chronotyp abweichen. Es zeigten sich fachspezifische signifikante Unterschiede zwischen den beiden Geschlechtern in der akademischen Leistung: Mädchen hatten bessere Noten in Sprachen (Deutsch, Englisch) und Natur sowie Kultur, Jungen hatten jedoch bessere Noten in Mathematik. Zusammengenommen bzw. im Durchschnitt gab es keine Notenunterschiede zwischen Mädchen und Jungen in den Klassen. Es zeigten sich signifikante geschlechtsspezifische Unterschiede im Mittelpunkt der Schlafenszeit: Mädchen hatten spätere Schlafenszeiten und zeigten einen höheren sozialen Jetlag. Abendpräferenz war mit Vermeidungsverhalten und Arbeitsvermeidung assoziiert. Ein früher Mittelpunkt des Schlafes, Gewissenhaftigkeit und Intelligenz waren mit besseren Noten vergesellschaftet. Multivariate Analyseverfahren zeigten, dass Intelligenz der stärkste Prädiktor für gute Noten war. Gewissenhaftigkeit, Motivation, jüngeres Alter und ein früherer Mittelpunkt des Schlafes waren positiv mit guten Noten korreliert. Dies ist die erste Studie bei Grundschülern und sie zeigt, dass die negative Beziehung zwischen Abendpräferenz und akademischer Leistung in diesem Alter schon weit verbreitet ist, sogar wenn man für wichtige Leistungsprädiktoren korrigiert.

Stichworte: Akademische Leistung, Kinder, Chronotyp, Gewissenhaftigkeit, Intelligenz, Morgen-/Abendpräferenz, Schulleistungen.

Summary

Individuals differ in their timing of sleep (bed times, rise times) and in their preference for morning or evening hours. Previous work focused on the relationship between academic achievement and these variables in secondary school students. The main aim of the study is to investigate the relationship between chronotype and academic achievement in 10-year-old children (n = 1125, 536 girls, 584 boys and 5 sex unspecified) attending 4th grade of primary school. They filled a cognitive test (Culture Fair Intelligence Test, CFT 20-R) and questions about rise times and bed times, academic achievement, conscientiousness and motivation. We implemented questions about wake times and bed times, academic achievement (measured by grades in Mathematics, German, English and Nature & Culture), ‘‘scales for the assessment of learning and performance motivation’’ (SELLMO; Skalen zur Erfassung der Lern- und Leistungsmotivation for motivation), the short version of the Five-Factor Personality Inventory Children (FFPI-C) to measure conscientiousness, and the Composite Scale of Morningness (CSM) to assess morningness-eveningness. Mean CSM score was 37.84 ± 6.66, midpoint of sleep was 1:36 ± 00:25 and average sleep duration (time in bed) was 10:15 ± 0:48. Morningness orientation was positively related to intelligence, conscientiousness and learning objectives. Results showed that boys and girls did not differ in chronotype. There were significant differences between girls and boys in academic performance but the direction was subject-specific: Girls did better in languages (German, English) and Nature & Culture, but boys had better scores in Mathematics. Overall, there were no gender differences in grades. There were significant gender differences in midpoint of sleep with girls sleeping later and showed higher social jetlag. Eveningness orientation was related to avoidance performance objectives and work avoidance. Early midpoint of sleep, conscientiousness and intelligence were associated with better grades. The multivariate model showed that intelligence was the strongest predictor of good grades. Conscientiousness, motivation, younger age and an earlier midpoint of sleep were positively related to good grades. This is the first study in primary school pupils, and it shows that the negative relationship between evening orientation and academic achievement is already prevalent at this age even when controlling for important predictors of achievement.

Keywords: academic achievement, children, chronotype, conscientiousness, intelligence, morningness-eveningness, school performance.

Abbreviations

CFT 20-R	Culture Fair Intelligence Test
CSM	The Composite Scale of Morningness
M-Type	Morning types
E-Type	Evening types
N-Type	Neither types
FFPI-C	Five-Factor Personality Inventory-Children
MeNuK	Science & Culture
MS	Middle between bed time and wake up time
MSF	Midpoint of the sleep period on free days
MSFsc	$MSF - 0.5*(SD_F - (5*SD_W + 2*SD_F)/7)$
SELLMO	Skalen zur Erfassung der Lern- und Leistungsmotivation (scales for the assessment of learning and performance motivation)

1. Introduction

Numerous studies have shown that late chronotype (or evening preference) is linked with poor school or academic performance (Diaz-Morales & Escribano, 2013b; Preckel et al., 2013; Randler & Frech, 2006; Vollmer et al., 2013), but all of these studies have been carried out in secondary schools or in University settings. The present study is the first to investigate this relationship in primary school pupils. In addition, the study aims at declaring the incremental validity of chronotype on grade that goes beyond the well-established predictors of school achievement as intelligence, conscientiousness, achievement motivation, age and sex.

1.1. Chronotype

Chronotype is instrumental for the daily rhythms of multiple physiological and biological functions that lead to cognitive, physical activity and mental stability. This representative of circadian preference categorizes individuals as morning types, evening types or intermediate types (Horne & Östberg, 1976).

Morning types, or sometimes called ‘‘larks’’, prefer morning hours for intellectual and physical activities. They have no problems with early rising and soon achieve their maximum of mental and physical activity but become tired early in the evening. In contrast, evening types, or ‘‘owls’’ feel and perform best at late afternoon or in the evening. They tend to have late sleep schedules, irregular bedtime, sleep time and waking time, and are more often dissatisfied with their sleep (Sukegawa et al., 2009; Wittmann et al., 2006). They have difficulties to get out of bed in the morning and need longer time to have their senses cleared. However, owls are able to work till late evening and often achieve their high physical and mental activities during late afternoon and evening hours (Cavallera & Giudici, 2008; Cofer et al., 1999; Gaina et al., 2006; Kramer et al., 1999; Matthews, 1988; Natale & Cicogna, 2002; Randler & Bausback, 2010; Tankova et al., 1994; Werner et al., 2008). Horne & Östberg (1976) reported that larks go to bed between 20:00 and 22:15 and get up between 5:00 and 7:45; but owls go to bed between 00:30 and 3:00 and get up between 09:45 and 12:00.

Among the general population, most people fall within the range categorized as intermediate types which are between the morning types and evening types (Roenneberg et al., 2004).

Variations in sleep time are the reflection of differences in timing of circadian factors which regulate sleep. Lack et al. (2009) reported that morning types experience their minimum core body temperature 2 hours and 25 minutes before evening ones. Thus, morning type people wake up on the rising phase of their core body temperature rhythm when the drive for sleep has already dramatically decreased. Evening types, on the other hand, wake up shortly after their body temperature minimum, when the biological pressure to sleep is high and the levels of alertness and performance are low (Duffy et al., 2001). Also Baehr et al. (2000) showed that the average body temperature minimum is at 03:50 for morning types, 05:02 for intermediate types and 06:01 for evening types.

Some studies indicated that morning types have an earlier circadian temperature phase as measured by rectal temperature (Duffy et al., 1999; Kerkhof, 1991; Kerkhof & Dongen, 1996; Lack & Bailey, 1994) and oral temperature (Horne & Östberg, 1976; Horne & Östberg, 1977; Kerkhof & Lancel, 1991; Neubauer, 1992; Vidaček et al., 1988). Morning types showed lower alertness at 11 p.m., while evening types showed lower alertness at 8 a.m., intermediate types showed higher alertness at 2 p.m. (see Fig. 1; Natale & Alzani, 2001).

The explains why morning types are alert shortly after waking time; while evening types need some hours to become fully alert (Table 1; Adan et al., 2012; Smolensky, 2001; Yu et al., 2015).

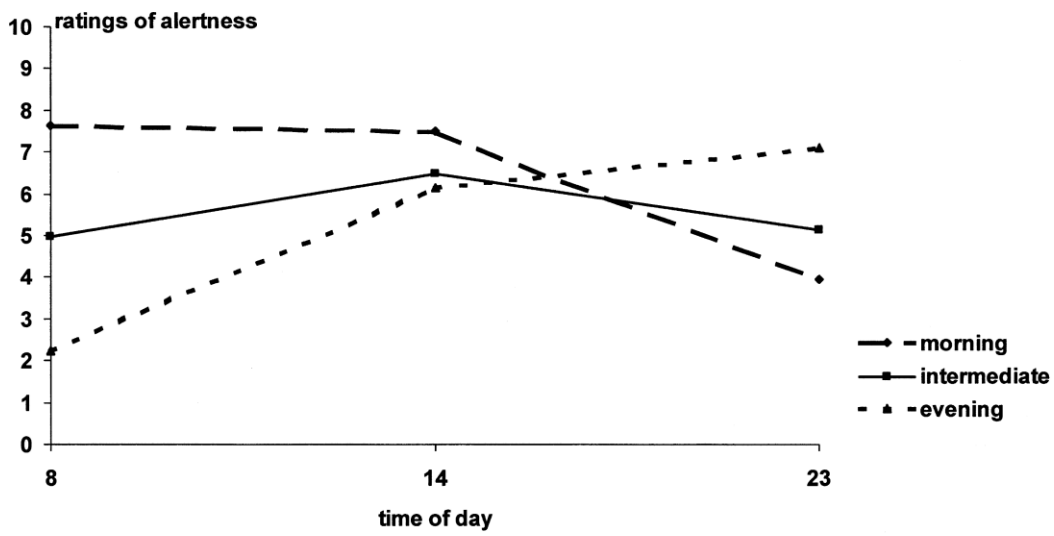


Fig. 1: Mean values of ratings of subjective alertness during the day for morning, intermediate and evening types (Natale & Alzani, 2001).

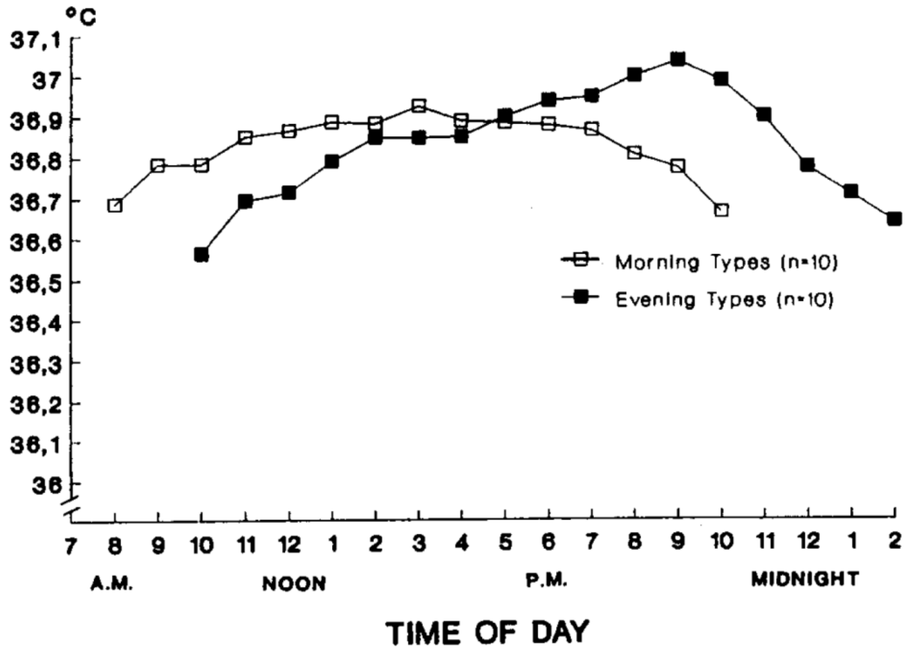


Fig. 2: The relationship between time of day and oral temperature for morning and evening types.

Oral temperatures were analysed by dividing up the waking day from 8 a.m. to 2 a.m. A cross-over happens around 5 p.m. Higher body temperatures in morning types occur before 5 p.m., while higher temperatures in evening types occur after 5 p.m. (Neubauer, 1992).

Table 1: Differences between larks and owls.

Characteristic	Larks	Owls
Most alert (self-report)	Around noon	Around 6 P.M.
Most productive (self-report)	Late morning	Late morning and late evening
Most active	Around 2:30 P.M.	Around 5:30 P.M.
Best mood	Between 9 A.M. and 4 P.M.	Steady rise from about 8 A.M. to 10 P.M.
Temperature highest	Around 3:30 P.M.	Around 8 P.M.
Temperature lowest	Around 3:30 A.M.	Around 6 A.M.
Age	Most persons over age 60	Most college students
Photoperiod at birth	short photoperiod (autumn-winter)	long photoperiod (spring-summer)
Bedtime	Go to bed 2 hours earlier than owls; fall asleep faster	More variable bedtimes; stay up later on weekends and holidays
Waketime	Awaken at desired time	Awaken about same time as larks on workdays,1–2 hours later on days off
Use of alarm clock	Don't need it	Need multiple alarms
Quality of sleep	Lifelong: sleep more soundly; wake up more refreshed, usually 3.4 hours after temperature minimum, daily low point on body clock	Lifelong: get less sleep; wake up sleepier, usually 2.5 hours after temperature minimum
Nap	Rarely	Take more and longer naps; fall asleep more easily in daytime
Mid-sleep time	Around 3:30 A.M.	Around 6 A.M.
Favorite exercise time	Morning	Evening
Peak heart rate	Around 11 A.M.	Around 6 P.M.
Lowest heart rate	Around 3 A.M.	Around 7 A.M.
Mood	Mood declines slightly over day	Mood rises substantially over day
Morning behavior	Chatty	Bearish
Evening behavior	Out of steam	Full of energy
Meal times	Eat breakfast 1–2 hours earlier than owls	Often skip breakfast; eat other meals at same times as larks on work days, 90 minutes later on days off
Favorite meal	Breakfast	Dinner
Daily caffeine use	Cups	Pots
Shift work adaptability	Work best on day shifts	Work best on evening shifts; tolerate night and rotating shift work better
Travel	More jet lag, cope with eastward travel more easily	Adapt faster to time zone changes, particularly going west
Partner's report (If well-matched)	We like to get an early start	We are the last to go home
Partner's complaint (If mismatched)	He/she stays up too late	She/he won't let me sleep late on weekends
Gender	Women and girls	Men and boys
Peak melatonin secretion	About 3:30 A.M.	About 5:30 A.M.
various hormones	Higher cortisol	Higher testosterone
Performance at school	Better grades	Worse grades
Cognitive styles	Lower intelligence scores Lower verbal ability Left-thinking style	Higher intelligence scores Higher verbal ability Right-thinking style
Personality characteristics	Conscientiousness, motivation, agreeableness, self-directedness, cooperativeness, introversion	Neuroticism, extroversion, openness, self-transcendence,

Psychiatric disorders	Lower depressive symptoms, proactivity, energy, caution	Depression, anxiety, eating disorders, menstrual symptoms, diabetes, metabolic syndrome, sarcopenia, hypertension and vascular disease
Addiction	Lower consumption of drugs	Higher consumption drugs
Peak times of oral temperature	Peaks at 19:30 h	Peaks at 20:40 h

Zavada et al. (2005) showed that mid-sleep may be the best marker for sleep-based assessments of chronotype. Mid-sleep is the exact middle between bed time and wake up time. For example when you go to bed at 00:09 a.m. and wake up at 8:18 a.m., mid-sleep is at 4:14 a.m. (Roenneberg et al., 2004, 2007; Zavada et al., 2005). The mid-sleep on free days (MSF) is the midpoint of the sleep period only on free days. Roenneberg et al. (2004) used MSFsc which is the average sleep need on both school days and free days. It is defined as: $MSFsc = MSF - 0.5*(SD_F - (5*SD_W + 2*SD_F)/7)$ where SD_F is sleep duration on free days and SD_W is sleep duration on work days. $(5*SD_W + 2*SD_F)/7$ indicates the average weekly sleep duration or need.

In Fig. 3, Zavada et al. (2005) reported the results of an internet survey of sleeping habits in a Dutch population using the Munich Chronotype Questionnaire (MCTQ) and the Horne-Östberg Morningness-Eveningness Questionnaire (MEQ).

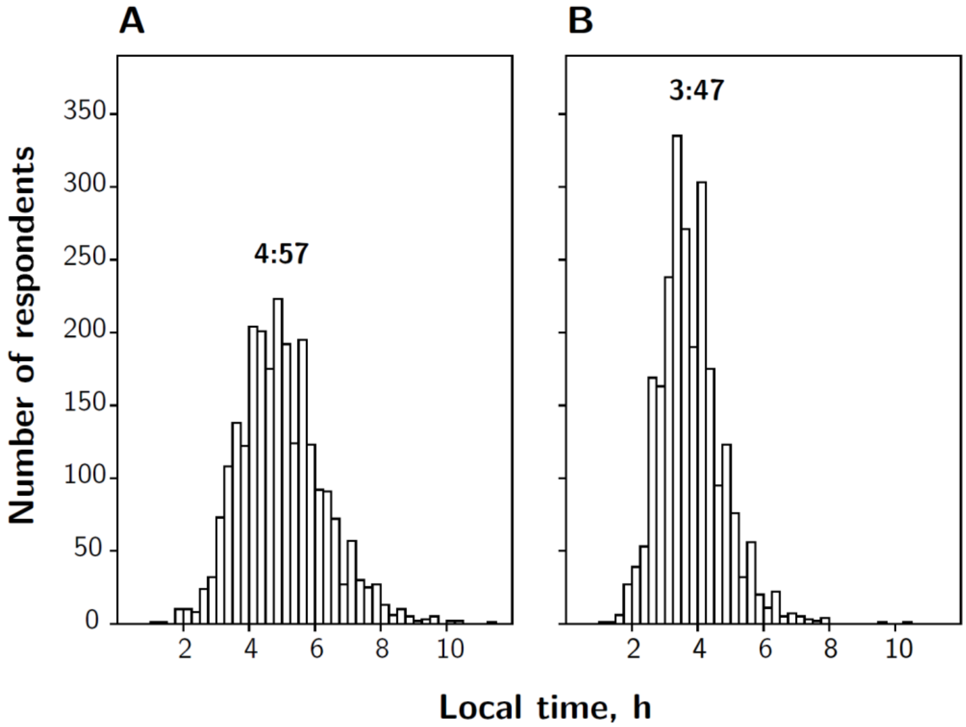


Fig. 3: Distribution of mid-sleep time on free days (A) and workdays (B). Clock times near peaks are means of mid-sleep times (Zavada et al., 2005).

The difference between work and free days, between social and biological time, is called 'social jetlag' (Wittmann et al., 2006). Over 40% of population suffers from social jetlag of 2 hours or more, and over 15% about 3 hours or more (Popova, 2012). Eveningness showed larger social jetlag than morningness means a larger difference in sleep timing between weekdays and weekends (Popova, 2012; Taillard et al., 1999). Fig. 4 shows a gradual reduction of sleep duration on workdays for eveningness compared to free days (Foster & Wulff, 2005; Roenneberg et al., 2007; Wittmann et al., 2006).

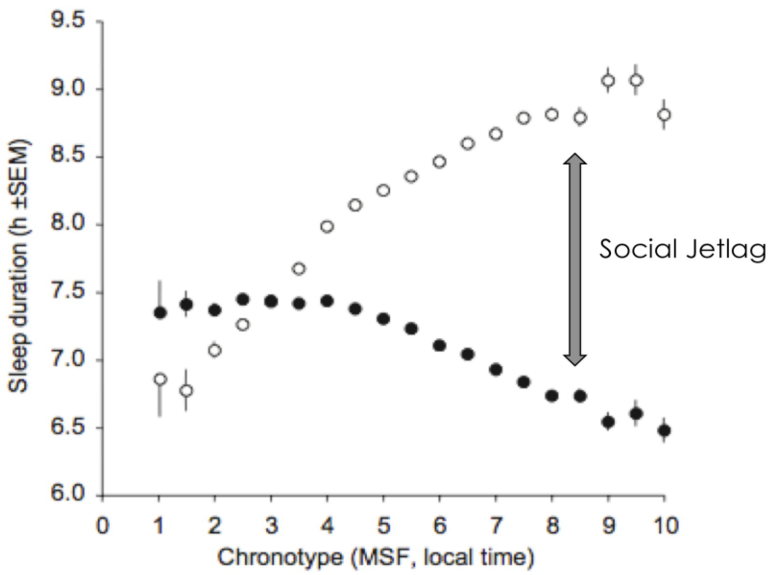


Fig. 4: Analyses of chronotype (MSF) and sleep duration on work and free days.
The filled black circles are for work days and white circles are for free days (N = 60,000). Morningness people are sleep deprived on weekend while eveningness ones sleep less than their weekly average on workdays. Social jetlag in early chronotype is not so large, only 45 min, when compared free days with workdays (modified graph, literature: Roenneberg et al., 2007).

1.2. Sleep duration and chronotype

Regarding to sleep duration, people have different sleep schedule on work and free days. Roenneberg et al. (2007) investigated the epidemiology of the human circadian clock with the Munich ChronoType Questionnaire (MCTQ) and Horne-Östberg Morningness-Eveningness Questionnaire (MEQ). The results of more than 55,000 participants, mainly from Germany, Switzerland, the Netherlands and Austria, with the average age of 12–60 years old showed that about 41% of population sleeps shorter than 7 and 7.5 hours on workdays but 50.5% sleeps even longer than 7.5–8 hours on free days (Fig. 5; Roenneberg et al., 2007).

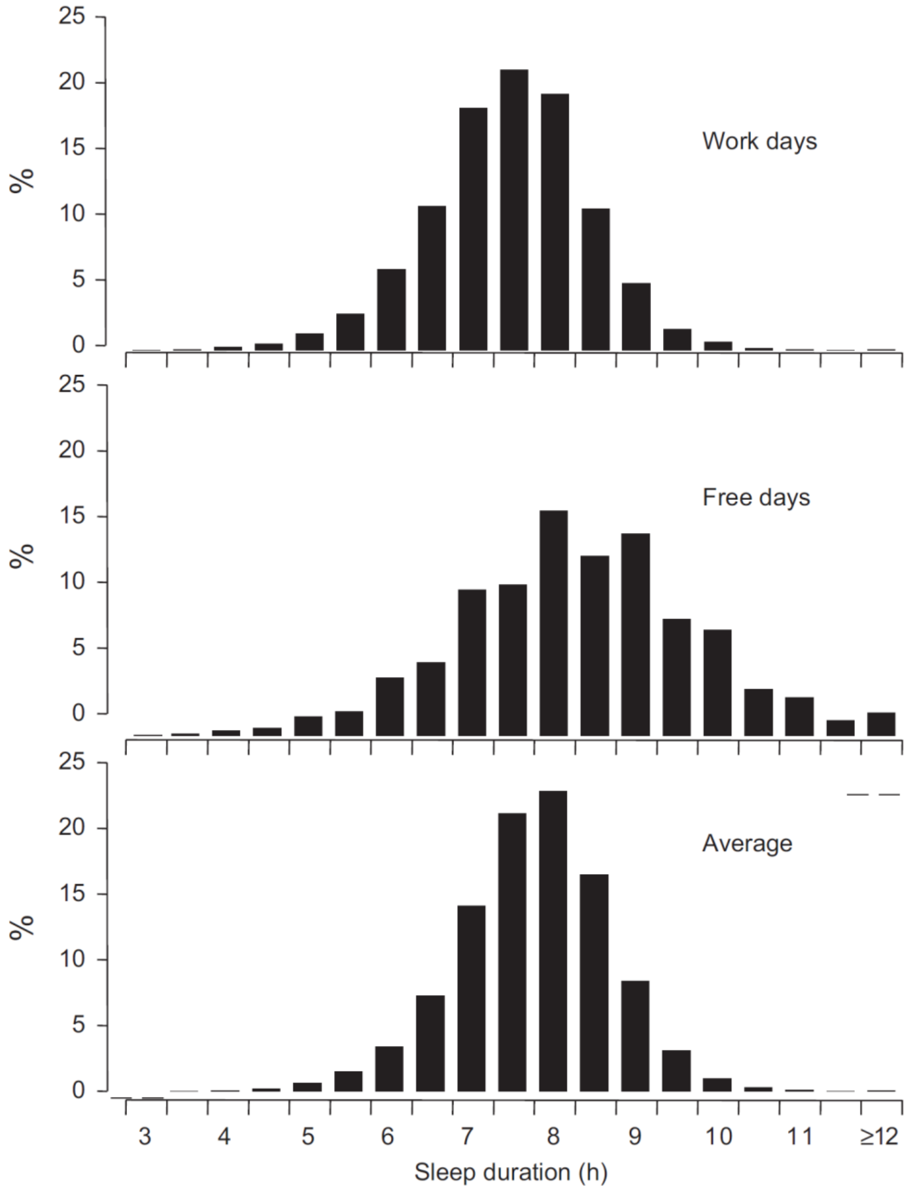
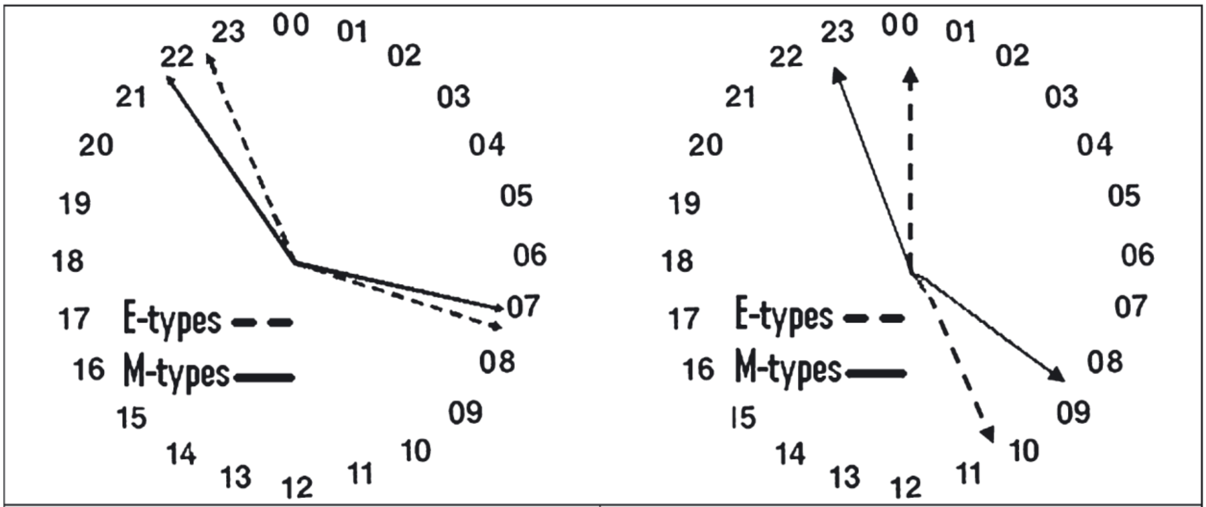


Fig. 5: Distribution of sleep duration on workdays, free days and weekly average (Roenneberg et al., 2007).

Fig. 6 shows that evening types wake up 94 min later than morning types in the weekend and only 17 min later during school days therefore have shorter sleep durations during school days (mean difference = -27.8 min) but sleep longer in the weekend (mean difference = 13.5 min).



School Days	E-types	M-types
Bed time	22:29	21:48
(SD in min)	(49.5)	(50,0)
Rise time	7:19	7:02
(SD in min)	(27.8)	(33.1)
Total sleep duration	530.2	558.0
(SD in min)	(53.2)	(57.6)

Weekend	E-types	M-types
Bed time	00:03	22:44
(SD in min)	(73.1)	(56.4)
Rise time	10:20	08:46
(SD in min)	(80.6)	(72.1)
Total sleep duration	614.7	601.2
(SD in min)	(74.8)	(82.7)

Fig. 6: Sleep habits in extreme evening and morning types during school days [left] and weekend [right] (Russo et al., 2007).

While lots of studies have been done on adolescents and adults, little is known about prepubertal children (Giannotti et al., 2005; Liu, 2005; Owens et al., 2000; Russo et al., 2007). Childhood sleep problems, such as bedtime resistance, sleep onset delay and difficulties waking in the morning, are common parental complaints, affecting approximately 25% of children during the first 10 years of life (Beltramini & Hertzig, 1983; Bruni et al., 1999; Butler & Golding, 1986; Jenni et al., 2005; Kataria et al., 1987; LeBourgeois et al., 2013; Lozoff et al., 1985; Mindell & Durand, 1993; Owens, 2007). However, sleep is important and accounts for approximately 40% of a child's typical day. When children and adolescents do not get sufficient sleep, aspects of their physical, emotional, social development (Meltzer & Mindell, 2008), cognitive/academic performance, for instance, learning, memory consolidation, executive function (Keren et al., 2001; Meltzer & Mindell, 2008; Pilcher & Walters, 1997; Sadeh et al., 2002), attention and behavior (e.g., aggressiveness, hyperactivity, poor impulse control), mood regulation (e.g., chronic irritability, poor modulation of affect), as well as health (e.g., metabolic and immune function, accidental injuries) are negatively affected (Keren et al., 2001; Meltzer & Mindell, 2008; Pilcher & Walters, 1997; Sadeh et al., 2002). Therefore, Getting enough quality sleep can make a correct functioning during the wakefulness period and, thus, to acquire a higher quality of life (Adan et al., 2006).

During puberty there is a sleep debt such that there is a general shift towards eveningness in adolescent sleep patterns and some features of the sleep-wake cycle begin to change (Duarte et al., 2014a; Preckel et al., 2013). These changes in adolescents have a negative impact on school performance (Preckel et al., 2013; Randler & Frech, 2009), which suggests problems in interactions with families and schools (Susman et al., 2007). Several studies showed that more conflicts in the family were associated with extreme eveningness (Diaz-Morales et al., 2014; Vollmer et al., 2011).

Individual differences in chronotype may contribute to the development and maintenance of sleep problems in children and consequently, their poor school performance.

In the following sections, we review the construct of chronotype, first focusing on definition and measurement. Then, we examine the link between chronotype and academic performance; and finally we present a short summary of findings related to predictors of academic outcomes such as intelligence, conscientiousness and motivation.

1.3. Correlates of chronotype

1.3.1. Age

Age plays a main role in chronotype. Researchers reported that morningness-eveningness changes significantly during the life span (Duffy & Czeisler, 2002). At the primary school level (up to the age of 10 years) most children are morning oriented which are active in the morning, even at the weekend (Randler & Truc, 2014; Werner et al., 2009). Adolescents shift from morningness to eveningness around the age of puberty (12–14 years) which has been reported in many studies, e.g. in the USA (Carskadon et al., 1993; Kim et al., 2002), Canada (Laberge et al., 2001), Italy (Russo et al., 2007; Tonetti et al., 2008), Spain (Diaz-Morales & Gutiérrez Sorroche, 2008; Diaz-Morales et al., 2014), Taiwan (Gau & Soong, 2003), Japan (Shinkoda et al., 2000; Ishihara et al., 1990), Croatia (Koscec et al., 2014), Russia (Borisenkov et al., 2010), and Germany (Randler, 2008d, 2011). This change is associated with pubertal development (Carskadon et al., 1993; Randler et al., 2009), and is presumed that the change is associated with increasing sexual hormones (Carskadon et al., 1998; Diaz-Morales, 2007; Diaz-Morales & Randler, 2008; Hur et al., 1998; Laberge et al., 2001; Randler & Bausback, 2010; Russo et al., 2007). However, there is no study in adolescent that backs up the claim that gonadal hormones are responsible for this change. Only one study in adult young men linked eveningness with salivary testosterone levels (Randler et al., 2012a).

Young people turn back towards morningness at the end of adolescence, which occurs around the age of 19.5 in women and 21 years in men (Roenneberg et al., 2004; Tonetti et al., 2008). This has been seen as a marker for the end of adolescence (Roenneberg et al., 2004). During the later years of life, humans gradually orientate towards morningness, see Figs 8 and 9 (Carrier et al., 1997; Paine et al., 2006; Park et al., 2002; Roenneberg et al., 2004, 2007; Taillard et al., 2004; Tonetti et al., 2008). However, it is somewhat contradictory that the turn towards eveningness at the start of puberty should be triggered by gonadal hormones, while the turn back to morningness is addressed by the end of adolescence (and not by hormones). This has to be clarified in future studies, because puberty is the biological aspect while adolescence is a social/environmental/biological conglomerate.

Individual sleep and wake time preferences are fairly diverse due to genetic, environmental and age-related factors, resulting in different individual timings for morning and evening-types (Akerstedt & Fröberg, 1976; Schantz & Archer, 2003). Frey et al. (2009) indicated that adolescent girls have a shift towards eveningness, which reaches its peak shortly after menarche, followed by subsequent return to morning preference at the end of adolescence. The average weekly sleep duration per day was reduced from about 11 h at prepuberty to less than 8 h two years after menarche (Frey et al., 2009).

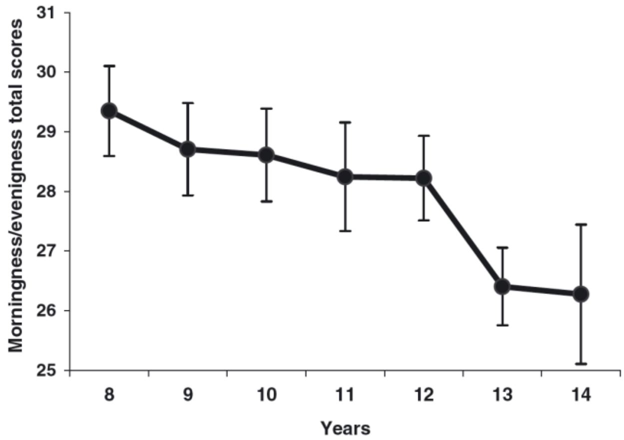


Fig. 7: Total scores of the morningness-eveningness across different age groups (8–14 years old), indicating a trend to eveningness with increasing age.

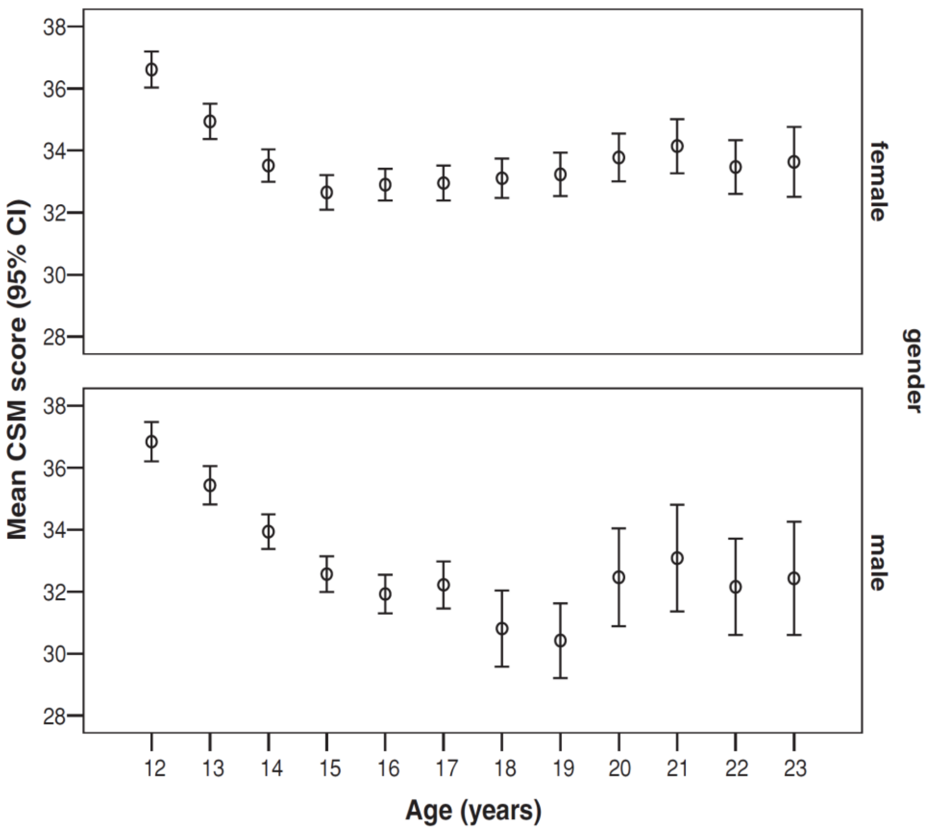


Fig. 8: Morningness-eveningness in boys and males and girls and females, comparing by age. Higher scores on the CSM indicate higher morningness (Randler, 2011).

1.3.2. Gender

For a long time the relationship between sex and chronotype was inconsistent and controversial (as reviewed in Kerkhof, 1985; Tankova et al., 1994). Some studies have reported differences between gender (Natale & Danesi, 2002; Randler, 2007), on average, boys and men are later chronotypes than girls and women, see Figs 8 and 9 (Adan & Natale, 2002; Barclay et al., 2011; Chelminski et al., 1997; Randler, 2007, 2008b, 2011; Reyner et al., 1995; Roenneberg et al., 2004; Roenneberg et al., 2007; Tonetti et al., 2008; Werner et al., 2008). In contrast, Caci et al. (2005), Diaz-Morales & Gutiérrez Sorroche (2008) and Steele et al., 1997 found that women were later chronotype in a sample of American Emergency Medical residents (n = 2047; mean age: 29 years old); but most of studies, which notice on workers and students, reported no significant differences between sex and chronotype (Tankova et al., 1994). For example, Kim et al. (2002) implemented a study on 989 young children aged 8–16 years and observed no significant differences in chronotype and sex. Studies of Adan & Almirall (1991), BaHammam et al. (2011), Carskadon (1993), Gau & Soong (2003), Giannotti & Cortesi (2002), Giannotti et al. (2002), Greenwood (1994), Kim et al. (2002), Mecacci et al. (1986), Neubauer (1992), Posey & Ford (1981), Randler & Frech (2009), Randler & Truc (2014), Russo et al. (2007), Takeuchi et al. (2002) and Wilson (1990) found the same deduction; all concluded that there is not any relationship between chronotype and gender.

Regarding to gender differences in sleep habits, various studies have found no sex differences in bedtime and wake up time (Giannotti et al., 2002; Laberge et al., 2001; Randler et al., 2009), but others reported that boys wake up later on school days but earlier on free days (Diaz-Morales, 2007; Randler, 2008a; Yang, 2005), they go to bed later (Giannotti et al., 2002; Randler et al., 2009; Russo et al., 2007) and have shorter sleep length on free days (Giannotti et al., 2002; Randler, 2008a). Some studies have found that girls and women sleep longer than boys and men (see Olds et al., 2010; Reyner et al., 1995). Girls sleep about 11 min on school days and 28.7 min on free days longer than boys (Laberge et al., 2001). In contrast the other researchers have found no gender differences on weekdays (Giannotti et al., 2002; Laberge et al., 2001; Russo et al., 2007; Yang, 2005).

One idea might be that the gender differences are masked or influenced by age because age is the stronger predictor. Another reason could be simply the sample size of the studies. Also, the variance in age could influence gender difference effects Randler (2007) with large variances in age leading to smaller differences. Also, an interaction between age an gender might be the reason for absence of gender differences (Duarte et al., 2014b). Caci et al. (2009) and Cofer et al. (1999) reported that chronotype remains relatively stable until around 35 years old, and afterwards there is a shift towards morningness. Roenneberg et al. (2007) suggested that women reach the maximum of their eveningness earlier than men and that this gender effect disappears around 50 years old, the average age of menopause but both man and women over 50 years old pursue the same path toward morningness.

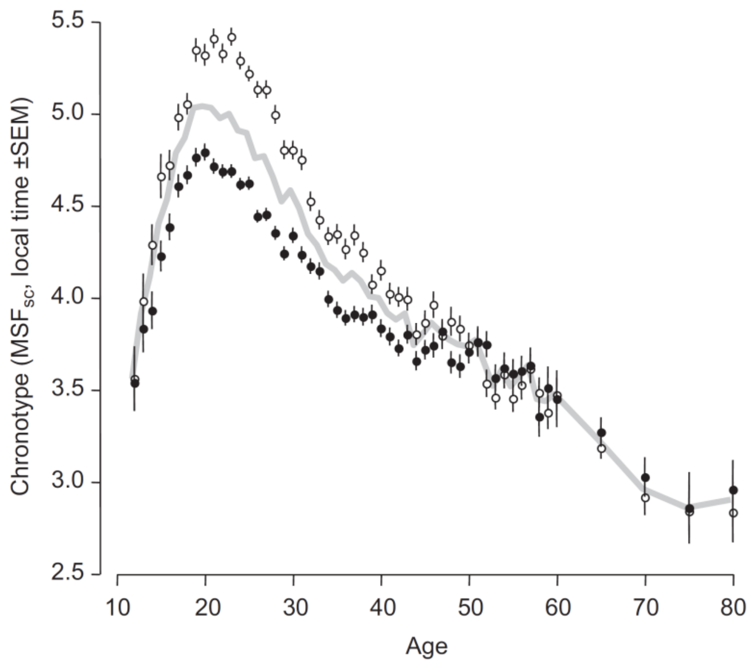


Fig. 9: Relationships between chronotype, age (12–80 years old) and gender (filled circles: females; open circles: males; the grey line: the averages of the population; Roenneberg et al., 2007).

1.4. Measurement of chronotype

Researchers typically employ self-report questionnaires to identify circadian typology. The validity of self-report questionnaires has been demonstrated in various studies by controlling the congruence of questionnaire results with biological measures, e.g.:

- Body temperature: morning types showed a faster increase in temperature in the morning, they reach their peak temperature in the first half of the day, whereas the evening types reach it in the late afternoon (Duffy et al., 1999; Horne & Östberg, 1976; Kerkhof, 1985, 1998; Kerkhof & Dongen, 1996; Natale & Alzani, 2001).
- Hormone profiles: Bailey & Heitkemper (2001) suggested that the peak times of the cortisol (55 min) and temperature rhythms (68 min) happen earlier in the morning types group.
- Sleep diaries (Neubauer, 1992; Torsvall & Akerstedt, 1980), for example: evening types tend to vary considerably in their bed times, wake times and sleep duration compared to morning types (Ishihara et al., 1988; Kerkhof, 1985; Monk et al., 1994) and eveningness is associated with daily sleep debt (Taillard et al., 1999). Therefore they are able-in perfectly normal situation-of sleeping more than 10 hours (the 'sleep extensors'; Violani et al., 1997).
- Actigraph measures or sleep labor research: Ishihara et al. (1987) indicated that only in rapid eye movement (REM) latency did morning types significantly differ from evening types, with reduced REM latency Kupfer (1995); and Carrier et al. (1997) showed that morning types wake in the last 2 hours of sleep and minutes of REM and REM activity, and blood pressure: Eveningness is associated with type 2 diabetes ($p < .01$), faster resting heart rate and lower systolic blood pressure compared to morningness (Merikanto et al., 2013).

In adults, Horne and Östberg's Morningness-Eveningness Questionnaire (MEQ; Horne & Östberg (1976) estimated the morningness-eveningness preference by asking respondents about their preferred timing of sleep and daily activities. It consisted of 19 mixed-format questions on matters such as rising times, bedtimes and preferred times for physical activity or cognitive performance. The MEQ has been validated across a variety of samples (e.g., Chelminski et al., 1997; Posey & Ford, 1981; Taillard et al., 2004) and translated into several languages (Adan & Almirall, 1990; Horne & Östberg, 1976; Ishihara et al., 1986; Mecacci & Zani, 1983).

Adan & Almirall (1991) used MEQ with a large Spanish sample, identified three factors: morning-type and evening-type, rigidity-flexibility, and subjective alertness-fatigue. The items from the morning-type and evening-type factor (1, 7, 10, 18, 19) were extracted to form the rMEQ. The rMEQ has been demonstrated a good psychometric properties and construct validity with the MEQ. The correlation with the MEQ scores ranges among 0.87 and 0.90, (Carciofo et al., 2012; Chelminski et al., 2000). Thun et al. (2012) showed the rMEQ distinguished between morning and evening CT (Circadian Typology) in terms of actigraphy-measured time in bed, wake-up time, and physical activity.

To evaluate morningness-eveningness preference in adolescents, Carskadon et al. (1993) modified adult measures of chronotype (Horne & Östberg, 1976; Smith et al., 1989) into an adolescent-friendly self-report of daily preference. In contrast to these multi-item measures, Roenneberg et al. (2003a) developed the Munich ChronoType Questionnaire (MCTQ), which estimates an individual's circadian preference by a single phase-reference point using the mid-sleep point on free days (MSF).

The self-report MCTQ has been used in adults, adolescents, and children as young as 10 years of age Roenneberg et al. (2003a). The MCTQ's validity in adults and adolescents is evidenced by strong concordance with MEQ scores (MSF: $r = -.73$; Zavada et al., 2005) and CSM (MSF: $r = -.62$; Randler, 2008b; Werner et al., 2009).

Werner et al. (2009) used CCTQ (Children's ChronoType Questionnaire) in study of chronotype on four to eleven year old children. CCTQ is an adaptation of the Munich Chrono-Type Questionnaire (MCTQ; Roenneberg, 2004) and Morningness/Eveningness Scale for Children (MESC; Carskadon et al., 1993). CCTQ includes a short demographics section about age, sex, birth order, family size and education level. Parents respond to a number of open-ended questions about sleep/wake parameters for both scheduled and free days such as bedtime, time of lights-off, sleep latency in minute, wake-up time, get-up time and time fully alert (Werner et al., 2009).

Tonetti et al. (2015a) reviewed different measurements especially developed for children and adolescents. The Morningness-Eveningness Questionnaire for Children and Adolescents [MEQ-CA] Ishihara et al. (1990) is an adjustment for children and adolescents based on the MEQ (Horne & Östberg, 1976). The MEQ-CA has the same amount of items as the MEQ [scores ranging from 16 to 86] (Tonetti et al., 2015a).

The MESC was originally developed and validated by Carskadon & Acebo (1992) and Carskadon (1993). The MESC is an adjustment of the CSM Smith et al., (1989) for use with younger samples. The MESC differs from the CSM regarding the formulation of items (specifically addressed at adolescents) and in the amount of items, 10 instead of 13. Önder & Beşoluk (2013) reported a correlation of 0.64 ($P < 0.001$) between the MESC and the CSM in Turkish adolescents while Kim et al., 2002 indicated a correlation between MESC and the MEQ with these scores ($r = 0.83$; $P < 0.05$) on American adolescents.

1.5. Chronotype and academic performance

The relationship between chronotype and academic performance on adults and adolescents has been examined in numerous researches. Studies showed that eveningness and academic achievements were strongly inversely related; whereas morningness and performance were positively related. These patterns hold for both school children (Giannotti et al., 1997; Giannotti et al., 2002; Randler et al., 2009; Vollmer et al., 2011; Vollmer et al., 2013) and university students (Beşoluk, 2011; Randler & Frech, 2006). Meta-analysis by Preckel et al. (2011) also showed small but significant and homogenous correlations between morningness and academic achievement ($r = 0.16$, $N = 13$); as well as eveningness and weak academic performance ($r = -0.14$, $N = 6$). It means that, morning-oriented students achieved better in academic settings than evening-oriented students (Preckel et al., 2011). However, Preckel et al. (2011) based their study on a two-dimensional conceptualization, where morningness and eveningness are two different constructs. This view is not adopted here in this dissertation. Also researches showed that evening students go to bed later than morning ones, therefore they report shorter sleep duration on the school week. Evening pupils collect a sleep debt over the week and it is obvious that less sleep duration and poor quality of sleep are negatively associated with school achievement (Diaz-Morales & Escribano, 2013b; Gruber et al., 2010; Meijer, 2008; Onyper et al., 2012; Wolfson & Carskadon, 2003).

Tonetti et al. (2015b) reported that 22 studies with a significant positive relationship of morningness with good academic performance, 9 non-significant studies and none with a significant negative relationship. Therefore, there was a relationship of 0.14 between school or university performance and circadian preference, with eveningness being related to a worse academic performance. This study also showed a stronger correlation between eveningness and low academic performance in school pupils compared to university students. This study reached nearly similar results as Preckel et al. (2011), which corroborates their findings with a much higher sample size.

The research of Giannotti & Cortesi (2002) on 6,632 high school students in Italy showed that the students who attended the schools with the earlier start time had more irregular sleep schedules, complained more of daytime sleepiness, tended to fall asleep more in class and reported a lower academic performance than those who attended schools with later start times. The other researchers Curcio et al. (2006), Giannotti & Cortesi (2002), Hansen et al. (2005), Mitru & Millrood (2002), Randler & Frech (2006, 2009), Sadeh (2007), Wolfson & Carskadon (2003) and Wolfson (2007) reported the same conclusion.

Sleep duration has been related with academic performance (Fredriksen et al., 2004). Researchers assessed that, almost 20 to 50 percent of children and adolescents report daytime sleepiness (Pagel et al., 2007; Roehrs et al., 2005). Students with poor grades slept 12 min shorter than students with high grades (Borisenkov et al., 2010). In contrast, Eliasson et al. (2002) showed no relationship between sleep duration and performance at school; and Gau & Soong (1995) showed a negative correlation between the numbers of hours of sleep and academic performance. In overall, most studies have shown a negative correlation between academic performance and sleepiness (Dewald et al., 2010; Drake et al., 2003; Kelly et al., 2001; Lee et al., 1999; Medeiros et al., 2003; Wolfson & Carskadon, 1998). Later chronotypes had more insufficient sleep on school days, showed higher rate of daytime sleepiness (Diaz-Morales & Escribano, 2013b; Randler & Frech, 2006), and had more problems in school and show worse grades (Vollmer et al., 2011; Vollmer et al., 2013).

Extreme evening types showed largest differences in sleep timing among school days and weekend, leading to a considerable sleep debt on school days which they catch up on free days (Carskadon, 2002; Giannotti et al., 2002; Taillard et al., 1999); and this is the reason of increasing social jetlag in eveningness (Eliasson et al., 2002).

Grades were higher in children with more stable bedtimes. Earlier mid-sleep times and earlier chronotypes had better sleep quality and higher level of sufficient sleep (Gomes et al., 2011). Virostko (1983) showed that, 98 percent of children get better grades during the pupils optimal time-of-day. Randler & Frech (2006) also confirmed that academic performance among evening types was worse (Fig. 10).

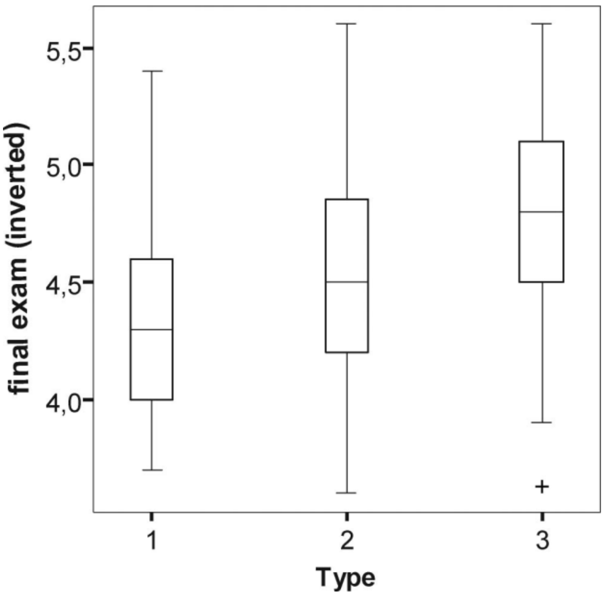


Fig. 10: Comparison of academic performance in (1) evening types, (2) intermediate types and (3) morning types. Note: The score levels were inverted (Randler & Frech, 2006).

1.6. Predictors of academic performance

1.6.1. Intelligence

Individual differences in cognitive ability are a good single predictor of academic performance (Deary et al., 2007; Gottfredson, 2002; Mayes et al., 2009). Meta-analysis by Fraser et al. (1987) showed a correlation of 0.71 between IQ and academic performance; and Strenze (2007) found a corrected correlation of 0.56 between IQ and academic achievement (see also Kuncel et al., 2004). The relationship between measures of intelligence and school achievement is usually around 0.30–0.50 (Gustafsson & Undheim, 1996; Rindermann & Neubauer, 2004; Spinath et al., 2006). In a meta-analysis, Preckel et al.

(2011) investigated the relationship between cognitive ability and chronotype and reported a mean effect size of 0.08 between eveningness and cognitive ability and 0.04 between morningness and cognitive ability; suggesting that evening types are more intelligent. The details studies of Roberts & Kyllonen (1999) also had shown that evening types had better memories and processed things faster. The other researches showed that eveningness scored higher on verbal abilities (Killgore et al., 2007), inductive reasoning Diaz-Morales & Escribano (2013a) and the ability of creative thinking (Giampietro & Cavallera, 2007). In the other hand, morning types coped better with early school start times and, in consequence, achieved higher academic scores (Randler & Frech, 2009). In general, morning types fit better into society because of school and work schedules which are organized in a morning-oriented manner (Epstein et al., 1998; Wittmann et al., 2006). These studies support the other researches which showed evening types are on a higher risk concerning school functioning and academic achievement (Randler & Frech, 2006, 2009; Randler, 2011). In total, Preckel et al. (2011) reported seven positive and four negative correlations between eveningness and cognitive ability. However, the effect size was rather low and the fail-safe number, the number of non-significant, potentially unpublished or missing, studies that are needed to draw the result (effect size) to zero was n = 7, suggesting that further studies are needed to assess this relationship.

Using the Cognitive Failure Questionnaire by Broadbent et al. (1982) and Mecacci et al. (2004) showed that the time of the day had strong effect on both circadian types: morningness had highest alertness in the morning hours, in other words accidents in morningness mostly happened in the evening hours and in eveningness through all the day.

There was a weak difference between the sexes in intelligence but a larger variance among males (Deary, 2003; Hedges & Nowell, 1995; Mackintosh, 2011). Girls generally performed better at school than boys (Burusic et al., 2012; Demie, 2001; Duckworth & Seligman, Martin E. P., 2006; Fergusson & Horwood, 1997; Gibb et al., 2008; Leeson et al., 2008; Steinmayr & Spinath, 2008), especially in languages while boys performed better in mathematics (Jacobs et al., 2002; Lubinski & Humphreys, 1990; Spinath et al., 2008); also one study by Golsteyn & Schils (2014) in elementary school children in the south of the Netherlands showed that boys score higher on the math test and lower on the language test than girls (Figs 11 and 12). The similar studies on gender and cognitive test at age 11 showed no differences in general cognitive ability (Deary, 2003; Strand, 2006).

Students who slept less and had more irregular sleep reported lower grade point average (Kelly et al., 2001; Trockel et al., 2000; Wolfson & Carskadon, 1998, 2003), decrease in sustained attention (Lim & Dinges, 2008; Kamdar et al., 2004), critical thinking (Pilcher & Walters, 1997), problem solving (Campos-Morales et al., 2005; Wagner et al., 2004), and in general cognitive ability (Buboltz et al., 2006). Even one hour decrease in night sleep time could diminish the cognitive performance (Fallone et al., 2005; Randazzo et al., 1998; Sadeh et al., 2003).

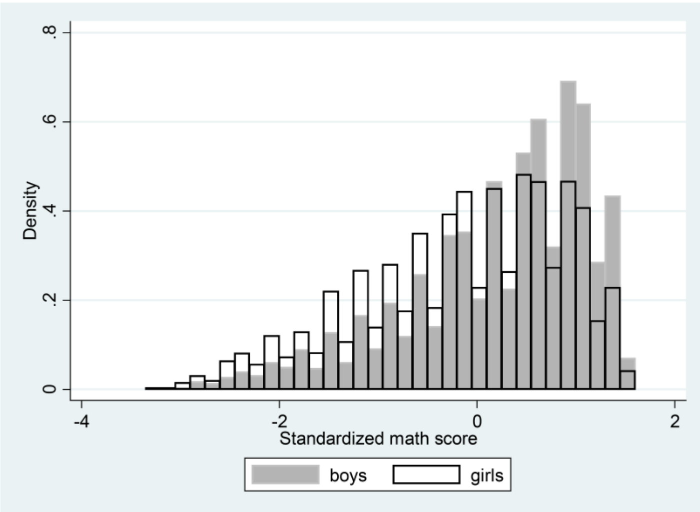


Fig.11: Comparison of math performance across gender (Golsteyn & Schils, 2014).

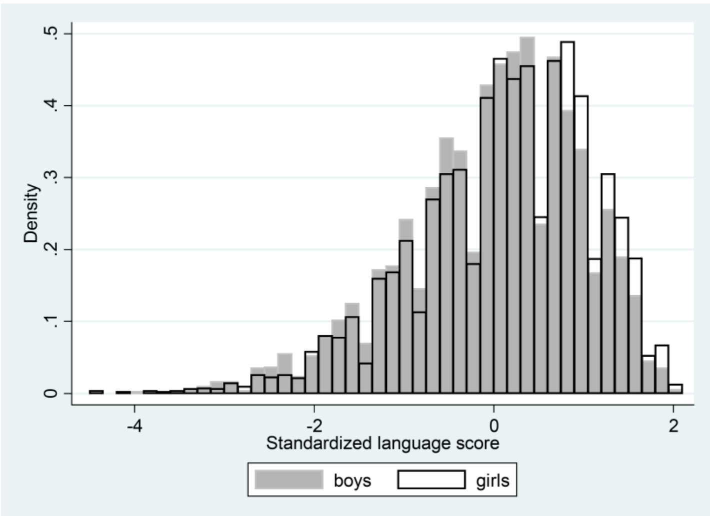


Fig. 12: Comparison of language performance across gender (Golsteyn & Schils, 2014).

1.6.2. Conscientiousness

Conscientiousness is the trait of being painstaking and careful, or the quality of acting according to the dictates of one´s conscience. It include such elements as self-discipline, carefulness, thoroughness, organization, deliberation (the tendency to think carefully before acting), and need for achievement. Numerous studies attest to the important role that conscientiousness plays in academic performance. Raad & Schouwenburg (1996) commented that this factor is ''the main psychological resource in learning and education''. Conscientiousness predicts academic outcomes among school students (Bratko et al., 2006; Heaven et al., 2002; Spinath et al., 2010; Steinmayr & Spinath, 2008; Wolfe & Johnson, 1995), undergraduates (Busato et al., 1998; Diseth, 2003; Furnham et al., 2002; Lounsbury et al., 2002) and postgraduates (Rothstein et al., 1994). Conscientiousness was confirmed as the strongest Big Five predictor of academic performance, faring better in some samples than intelligence (corrected r = 0.22, meta-analysis by Poropat (2009) while others reported that personality and intelligence mediated with each other (i.e., mediation; Noftle & Robins, 2007) or associated with each other (i.e., moderation; O'Connor & Paunonen, 2007).

Moreover, in a young age group (between 3 and 12 years of age), boys were rated less conscientious than girls based on parents statements (De Fruyt et al., 1998). Young et al. (2007) found a low association between big five and chronotype while another studies reported conscientiousness as a strong predictor of chronotype (Hogben et al., 2007). Numerous studies reported that morning people are more conscientious (Adan et al., 2012; Hogben et al., 2007; Randler, 2008a; Tonetti et al., 2009; Young et al., 2007). Soehner et al. (2007) did not find any significant correlations between personality and sleep length but the investigation of Gray (2002) showed that people with higher conscientious went to bed earlier and got up earlier.

Young et al. (2007) showed that morning people are stable people. Other personality inventories have rarely been examined: Only Diaz-Morales (2007) used the Millon personality styles and found associations between morningness-eveningness and thinking and behaving styles. Proactivity might be related with both these models of personality because conscientiousness might also be associated with proactivity

1.6.3. Motivation

Motivation is the attribute that “moves” us to do or not do something (Francis et al., 2005; Gredler, 2001). In any school setting, whether elementary, secondary, or higher education, a student’s motivation for learning is generally regarded as one of the most critical determinants (Gist & Mitchell, 1992). Studying the construct of intrinsic motivation in young children is important, because academic intrinsic motivation in the early elementary years will impact on initial and future school achievement (Gottfried, 1990; Broussard, 2002). Furthermore, differences between boys and girls concerning motivational variables like beliefs or interests can be found (Meece et al., 2006), with a clear interplay between interests and grades in primary school (von Maurice et al., 2014). Sikhwari (2014) presented that girls were more motivated than boys but the result of Emmanuel et al. (2014) showed that boys were more motivated. A lot of studies reported that girls were more intrinsically motivated for languages and boys were more motivated in math (Jacobs et al., 2002).

The predictive validity of achievement motivation for academic performance has been demonstrated in several studies (Hejazi et al., 2009; Meece et al., 1990; Steinmayr & Spinath, 2009; Urhahne, 2008; Sikhwari, 2014; Tella, 2007). It has been shown that, above and beyond intelligence, motivation explains variance in academic achievement (Gose et al., 1980; Kushman et al., 2000; Schicke & Fagan, 1994; Spinath et al., 2006). Pupils who reported higher achievement intrinsic motivation had significantly better school achievement and intellectual function (Boggiano et al., 1992; Busato et al., 2000; Fortier et al., 1995; Gottfried, 1985; Gottfried, 1990), but several studies have found a weak or no significant relationship between motivation and academic performance (Goldberg & Cornell, 1998; Niebuhr, 1995; Stipek & Ryan, 1997). Furthermore, Stipek & Ryan (1997) showed that children’s cognitive performance were better predictors of end-of-the-year achievement than motivation.

Concerning chronotype, there are few studies that show a relationship between motivation and chronotype. Findings indicated that morning oriented were associated with higher scores of motivation performance and lower scores of work avoidance than evening oriented Preckel et al. (2013), and also morning oriented had more achievement motivation and tried more to achieve the goals (Tsaousis, 2010). Cain et al. (2011) showed that average total sleep time increased by improving motivation. Roeser et al. (2013) indicated that the relationship between chronotype and academic achievement was mediated by learning motivation.

1.7. Research objectives of the present study

The main aim of the current study is to investigate the relationship between chronotype and academic achievement during the 4th grade of primary school of the Rhein-Neckar-Kreis in Germany.

To our knowledge, there are no studies that investigated the relationship between chronotype and academic performance of primary school children, and thus, this is a neglected age group. As the change towards eveningness occurs mainly at the ages of 12–14 years, we hypothesize that the correlation between chronotype and achievement might be lower compared to older age groups. First, because the number of evening types in primary school pupils is lower compared to secondary school pupils, but there are already evening types present in primary school. The morningness-eveningness scores are normally distributed, so the scores are generally shifted to morningness in primary school. Second, the internal sleep-wake cycle of primary school pupils better fits the social and school schedules, suggesting a smaller misalignment between their own internal clock and the social clock, and therefore, a weaker correlation between achievement and chronotype. This could also be viewed as a better person-environment-fit. In addition, we simultaneously modeled the interplay of many of the above-mentioned variables that have also been found to influence school achievement.

Research questions

1. Is there a relationship between chronotype and/or sleep behavior on academic achievement during the 4th grade of elementary/primary schools of Rhein-Neckar-Kreis?
2. Is this relationship moderate by cognitive ability, conscientiousness and motivation?
3. Are girls more morning oriented than boys?
4. Do children with higher morningness scores achieve better marks at school as compared to the others with a proclivity towards eveningness?

2. Material and Methods

2.1. Sample material

This thesis is based on 4th grade students at different schools in the South-Western Germany district Rhein-Neckar-Kreis, around the city of Heidelberg. Questionnaires completed on pupils with an average age of 10.22 years (SD = 0.47, n = 1117), with a range from 8.17−12.17 years (see appendix 1–4).

The permission letter was sent to the ministry of education (Regierungspräsidium Karlsruhe) by mail in November 2012 (Appendix 5). They accepted my project at 13th December 2012 with number: Aktenzeichen 71c2-6499.25 (Appendix 6). After that, I found all the elementary/primary schools of Rhein-Neckar-Kreis and I sent the application letters to the schools by both mail and email (Appendix 7). Parental consent letters were mailed to the schools and participation of the pupils was voluntary (Appendix 8). A total of 57 out of 156 schools accepted my application. I called schools and made an appointment for implementing my project. Finally, I could implement my research in 46 schools because the others had no grade for final evaluation of the pupils (Appendix 9).

I performed the pretest at Tiefburg School in Heidelberg (Germany) on 12.04.2013. In total 18 pupils attended the test and the predicted time was sufficient for answering the questions. I printed 1125 questionnaires for pupils and every questionnaire has given a unique number due to avoiding the mistakes and participation was anonymous. In total 1125 pupils (536 girls, 584 boys and 5 sexes unspecified) participated in the research. The present study complied with the tenets of the declaration of Helsinki and the international ethical standards of chronobiological research (Portaluppi et al., 2010). Questionnaires were completed by pupils during the school times from Monday through Friday. The study took place between 15.04.2013 and 02.07.2013 (Appendix 10) and from 8:00 to 12:15. On average schools start at 8:00 in the morning (Appendix 9). Mean testing time was 9:57 ± 1:03, which is situated right in the middle of the school day.

The questionnaire had two parts; the first part of the test was intelligence. This test consisted of four-subtests: 1. series, 2. classifications, 3. matrices and 4. topological reasoning. Four-subtests of intelligence test were explained for children during the normal school time. The first three subtests had 15 items while the fourth one had 11 items. There were various times to complete the items: the first, third and fourth tasks were 2:30 minutes but the second one had four minutes. In total the test took approximately 30 minutes. The second part of the test was consisting of age, gender, academic performance, conscientiousness, chronotype and motivation. This part took 20 minutes. In overall, it took 50 minutes to complete all of the 23 pages with 112 questions.

2.2. Questionnaires and tests

2.2.1. Chronotype and sleep variables

The Composite Scale of Morningness (CSM; Smith et al., 1989) consisted of 13 questions in a different Likert-type formats for questionnaires 1, 2 and 7 with 5-points Likert-scale and the others with 4-points Likert-scale in regard to the time that individuals get up and go to bed, preferred times for physical and mental activity and subjective alertness. Five of the elements of the scale refer to different times of day. The score is obtained by adding the items and ranges from 13 (extreme eveningness) to 55 (extreme morningness) (Appendix1). The CSM score is unaffected by the time of the day one fills in the questionnaire (at least between 7:30 and 19:00). Cronbach's alpha was 0.78. For current study the scale adapted to children used (Vollmer et al., 2012). The German version of the CSM Randler (2008d) was used which is reliable and valid (Randler & Diaz-Morales, 2007; Randler, 2008d, 2009). Additionally, I asked for habitual rise time and bed time on weekdays and on the weekend (Giannotti et al., 2002; Russo et al., 2007). These variables are considered as a proxy of sleep length because they focus on total time in bed (including sleep onset latency and bed time after awakening). From these, I calculated a single phase-reference point, the corrected mid-sleep point (MSFsc; Roenneberg et al., 2004). MSFsc, difference between the sleep length on free days and average of weekly sleep duration (Roenneberg et al., 2007). The self-report MSFsc has been used in adults, adolescents and children as young as 10 years of age (Roenneberg et al., 2003b). Social jetlag was calculated using the method from (Wittmann et al., 2006).

2.2.2. Intelligence

I used the Culture Fair Intelligence Test (CFT 20-R) as a measure of cognitive ability (see Appendix 2). The CFT 20-R is a German adaptation of the Culture Fair Intelligence Test (Weiß, 2008). The paper-and-pencil test assesses fluid intelligence with four types of figural tasks: series (a series of three patterns is to be extended to include a fourth selected from five alternatives; 15 items), classifications (a series of five figures are presented, the one figure that does not belong to the group is to be determined; 15 items), matrices (a matrix is to be expanded to include one of five alternatives; 15 items) and topological reasoning (a figure is presented for which a matching complement is to be selected from five alternatives; 11 items). Tasks were presented in a multiple-choice format. The children only needed the ability to recognize shapes and figures and perceive their respective relationships. Each subtest is timed and the items increase in difficulty and takes about 30 minutes to complete (Preckel et al., 2011; Stoeger & Ziegler, 2010). All subtests were only consisted of non-verbal material (Lu et al., 2011).

The purpose of a culture-fair intelligence test was to minimize any social or cultural advantages, or disadvantages, that a person might have due to their upbringing. The test could be administered to anyone, any age, from any nation, speaking any language. A culture-fair test help identify learning or emotional problems.

The test was reformed in the year 2004 with a sample of 4300 students. The predictive validity of the test was very high as demonstrated in longitudinal studies of 6 and 10 years (Kuhn et al., 2008).

The CFT seems unaffected by time of day, so a synchrony effect was not expected. To our knowledge, this has not been tested. In the present study population, testing be assumed to be valid, since they did not seem to be subject to systematic bias (Dickhäuser & Plenter, 2005).

2.2.3. Conscientiousness

The short version of the Five-Factor Personality Inventory-Children (FFPI-C; McGhee et al., 2007) was used for the measurement of conscientiousness (Appendix 3). The conscientiousness measured for the children and adolescents between 9 years 0 months and

18 years 11 months (McGhee et al., 2007). The scale consisted of 15 bipolar pairs of sentences on 5-points Likert-scale. High scorers on conscientiousness preferred to be organized, achievement-oriented, reliable and hard-working (Jolijn Hendriks et al., 2003). Cronbach's alpha in the present study was 0.73.

I translated the FFPI-C into German using a team approach (TRAPD-method; Harkness, 2003). Four German native speakers proficient in English produced independent draft translations, which were then discussed by them and an adjudicator.

Suldo & Stewart (2007) reviewed the reliability of FFPI-C and found that it had adequate psychometric characteristics for research purposes and support for construct validity.

2.2.4. Motivation

Achievement motivation was measured by SELLMO, the ''Skalen zur Erfassung der Lern- und Leistungsmotivation'' (scales for the assessment of learning and performance motivation (Appendix 4) (Spinath et al., 2002). SELLMO contained of 4 scales and 31 items and test was suitable for using in primary school (Swoboda, 2010). The response scale was a 5-points Likert scale ranging from ''not true at all'' (1) to ''exactly true'' (5). For each scale were various items: eight items for learning objectives (1, 5, 8, 12, 16, 20, 24, 28), avoidance performance objectives (3, 6, 10, 14, 18, 22, 26, 30), and work avoidance (4, 7, 11, 15, 19, 23, 27, 31). Finally there were seven items for approach performance objectives (2, 9, 13, 17, 21, 25, 29).

The ''learning objectives'' scale describes the goal of wanting to expand one's own abilities. e.g., … 'to get new ideas'. The ''approach performance objectives'' scale describes the goal of wanting to demonstrate one's skills in front of others, a property associated with somewhat short-term learning success, but without ensuring adequate long-term learning success. e.g., …'to get better grades than others'. The ''avoidance performance objectives'' scale describes the tendency to try to hide low skills or inability/ignorance due to previous negative experiences; a property associated with poor short and long term benefits. e.g.,…' that other students do not think I am stupid' The ''work avoidance'' behavior is not learning or performance motivated, i.e. the motivation to invest as little effort as possible. This attitude has a particularly negative effect on interest and intrinsic motivation. e.g., …' no difficult tests or have to work'. Cronbach's alpha was 0.68 for ''learning objectives'', 0.75 for ''approach performance objectives'', 0.81 for ''avoidance performance objectives'' and 0.80 for ''work avoidance''.

2.2.5. Academic achievement

School performance was measured by self-reported grades. Students reported their half year grades (February 2013) in Mathematics, German, English and Science & Culture (a combined elementary school subject including fine arts, music, biology and culture) on a 21-point scale from 1.0 = fail, 1.25, 1.5, […] 5.5, 5.75 to 6.0 = outstanding. However, The German grading system is coded into six grades (1 = best, 6 = worst). A high grade average indicates low achievement. To aid interpretation, I inverted the grading for correlations and figures and thus higher numbers indicate higher achievement levels [e.g. 1 was inverted to 6] (Preckel et al., 2011; Randler & Frech, 2009) and thus, higher scores in grades indicate higher achievement. Thus, self-reported grades do not reflect grades from single test but represent accumulations of attainments of a whole school term. Further, school grades are real measurements that have an influence on career decisions. Research suggest that self-reported school grades can be assumed to be valid, since they do not seem to be subject to systematic bias (Dickhäuser & Plenter, 2005). Then it was easier to apply such measurements than to apply a standardized test (as did Goldstein et al., 2007) in such a large-scale study. Most of the other studies were also based on this method (Drake et al., 2003).

2.2.6. Statistical analysis

Several different types of analyses were applied: correlations, regression analysis, partial correlation, t-tests, analysis of variance (ANOVA) and general linear models (GLM). P-value of ≤ 0.05 was considered to be statistically significant. Correlations were calculated by Pearson (r). T-tests and Pearson's correlations were used to analyze the bivariate relationships between all variables under study. To analyze the relationship between different measures and the morningness-eveningness construct, bivariate correlations were used. General linear modeling (GLM) allowed us to test different variables simultaneously (Randler & Frech, 2009). For separating circadian types (morning from evening types), I used the cutoff scores proposed by Randler (2008d); lower than 26 classified as evening types and higher than 43 classified as morning types. Differences between morning types and evening types were assessed by t-tests for independent samples (Randler & Schaal, 2010).

SPSS 21 and AMOS 21 (both IBM, Somers, NY) were used for statistical calculation. Structural equation modeling (SEM) was used to explore associations between variables in context. Gender differences were included in a group analysis to investigate gender as a moderator variable. Specification search in AMOS 21 was used with associations between variables with *ß* < 0.20 specified as optional for best model fit. Missing values were substituted with estimates in the multivariate analyses.

3. Results

3.1. Univariate descriptive statistics

3.1.1. Gender

A total of 1120 pupils [536 girls (47.8%) and 584 boys (52.2%)] attended the survey (Table 2).

Table 2: Frequency distribution for sex.

Gender	N	%
Girls	536	47.8
Boys	584	52.2
Total	1120	100.0

3.1.2. Age

Age ranged from 8 to 12 years; most frequently were pupils between 8 to 10 and lowest frequently between 10.75 to 12 years. There were 307 students in the range of 10.50 to 10.74 years (Table 3). The minimum age was 8.17 and maximum was 12.17 years. There were 8 missing values (Table 4).

Table 3: Frequency distribution for age groups.

Age	N	%
8 to 10	338	30.3
10 to 10.24	251	22.5
10.25 to 10.49	221	19.8
10.50 to 10.74	307	27.5
10.75 to 12	124	11.1
Total	1117	100.0

Age in years and months.

Table 4: Frequency distribution for age.

	N	Mean	Std. Deviation	Minimum	Maximum
Age (years and month)	1117	10.22	0.47	8.17	12.17

3.1.3. Chronotype

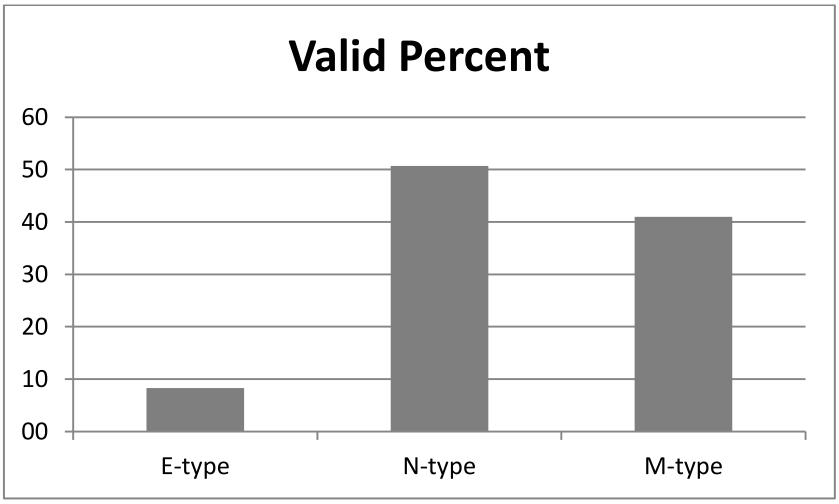
According to the chronotype classification, intermediate types were overrepresented in the group of chronotype with 50.7%, while evening types presented 8.3% and morning types 41.0 % (Table 5 and Fig. 13). Scores on the CSM ranged from 15–55 with a mean of 37.85 [SD = 6.65] (Table 6).

Table 5: Frequency distribution for chronotype.

Choronotype (group)	N	%
Evening type	93	8.3
Intermediate type	568	50.7
Morning type	459	41.0
Total	1120	100.0

Table 6: CSM scores for the different groups of chronotype.

Choronotype (Group)	M	SD	Min	Max
Evening type	25.25	2.65	15	28
Intermediate type	34.74	2.94	29	39
Morning type	44.24	3.31	40	55
Total	37.85	6.65	15	55



Abbreviations: E-type: Evening-type, N-type: Neither-type, M-type: Morning-type.

Fig. 13: Percentage of distribution of chronotype groups.

3.1.4. Midpoint of sleep

Midpoint of Sleep (MSFsc) was distributed with a range from 23:04 to 7:47 am and a mean of 2:58 am [SD = 00:57, n = 1096] (Table 7). Midpoint of sleep during school days ranged from 00:00 to 03:32, while on free days from 00:30 to 08:30. Children had most of midpoint of sleep from 1:30 to 1:39 am on school days (Fig. 14). On average, pupils indicated a later mid-sleep on free days (Table 7 and Fig. 15).

Table 7: Descriptive statistics of mid-sleep.

	N	Mean	Std. Deviation	Minimum	Maximum
Mid-sleep on school days	1115	01:36	00:25	00:00	03:32
Mid-sleep on free days	1099	03:23	00:59	00:30	08:30
Mid-sleep (MSFsc)	1096	02:58	00:57	23:04	07:47

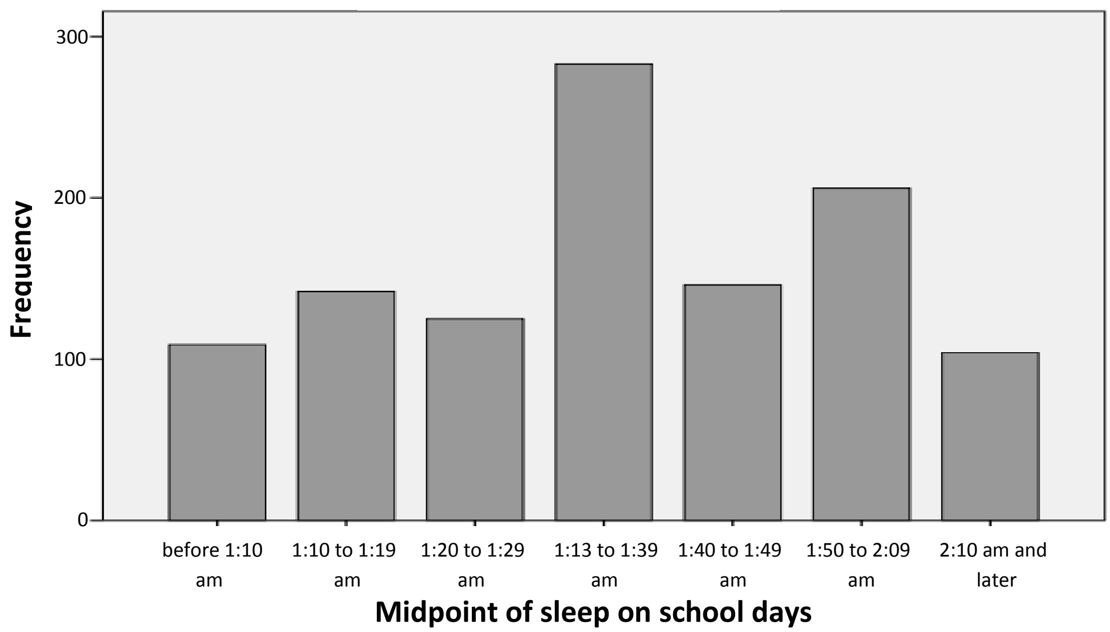


Fig. 14: Frequency of the midpoint of sleep on school days.

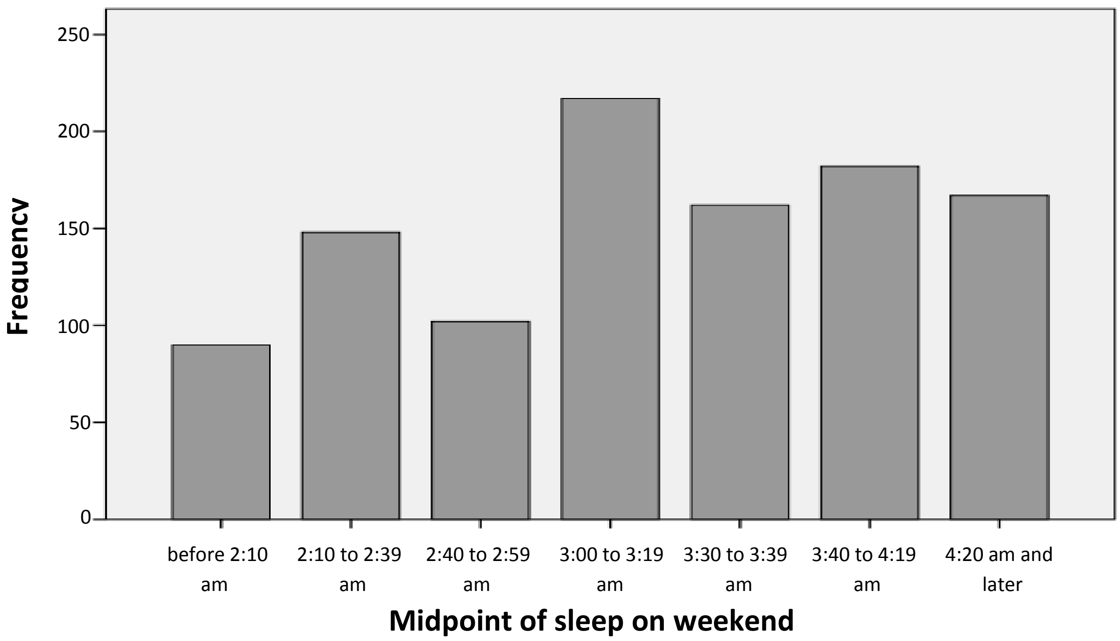


Fig. 15: Frequency of the midpoint of sleep on weekends.

3.1.5. Other sleep variables (sleep-wake, sleep duration, social jetlag and napping)

Pupils went to bed and got up earlier on school days than on free days (see Table 8). Sleep length was distributed with a range from 06.04 hours to 13.08 hours and the mean of 10.15 hours [n = 1096, SD = 0:48]. On average, school days get a mean of 10.10 hours [SD = 0:47] of sleep, compared with a mean of 10.27 hours [SD = 1:32] in free days [17 minutes difference] (see Table 8), which exhibits the longer sleep duration on free days as compared with school days. Social jetlag was with a mean of 1:46 hours [SD = 0:54].

Table 8: Descriptive sleep-wake variables of the samples.

	N	Mean	Std. Deviation	Minimum	Maximum
What time do you get up on school days?	1121	06:42	00:25	05:00	09:10
What time do you get up on free days?	1106	08:37	01:21	03:00	14:00
What time do you go to bed on school days?	1116	20:31	00:42	17:00	00:30
What time do you go to bed on free days?	1103	22:09	01:08	19:00	04:00
Sleep length on school days (time in bed)	1115	10:10	0:47	05:45	14:00
Sleep length on free days (time in bed)	1099	10:27	1:32	03:00	16:00
Average sleep length (time in bed)	1096	10:15	0:48	06:04	13:08
Social jetlag	1096	1:46	0:54	-1:00	06:30
Nap	1112	5.58	0.94	1	6

3.1.6. Intelligence

The mean of intelligence (4 subtests) was .55 [SD .10]. The minimum of intelligence was .16 and maximum was .82.

3.1.7. Achievement

Children had better grades in English 5.18 ± 0.61 (mean ± SD). On average mean of gradings was 4.95 ± 0.52 (Table 9 and Fig.16).

Table 9: Descriptive statistics of gradings.

	N	Mean	Std. Deviation	Minimum	Maximum
Mathematics	1055	4.83	0.77	2.00	6.00
German	1042	4.79	0.72	1.50	6.00
Science & Culture(MeNuK)	1014	5.02	0.58	2.25	6.00
English	1046	5.18	0.61	1.25	6.00
Gradings (total)	1034	4.95	0.52	2.63	6.00

Range of grades was from 1, fail to 6, outstanding.

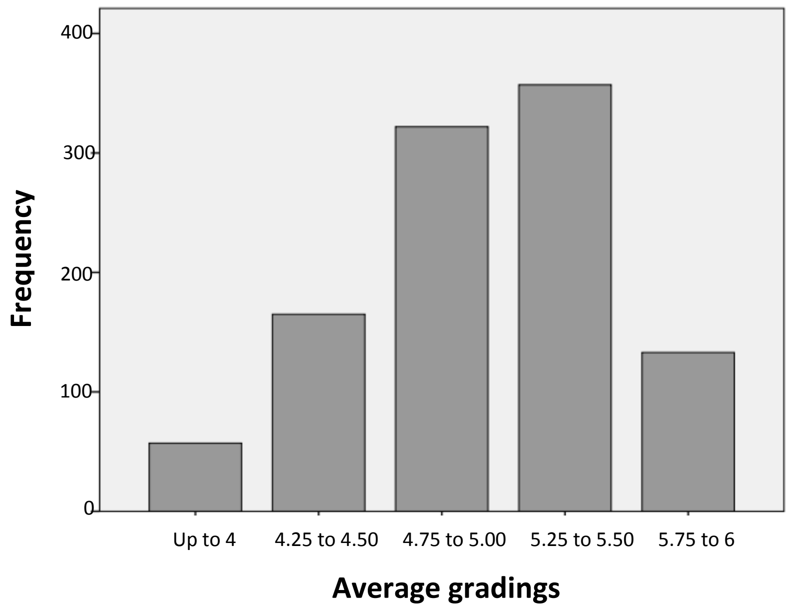


Fig. 16: Frequency of average gradings.

3.1.8. Motivation

The mean and standard deviation of motivation showed for learning objectives 4.20 ± 0.58, approach performance objectives 3.41 ± 0.79, avoidance performance objectives 2.80 ± 0.92 and work avoidance 2.66 ± 0.92 (Table 10).

Table 10: Descriptive statistics of motivation.

	N	Mean	Std. Deviation	Minimum	Maximum
Learning objectives	1121	4.20	0.58	1	5
Approach performance objectives	1120	3.41	0.79	1	5
Avoidance performance objectives	1120	2.80	0.92	1	5
Work avoidance	1120	2.66	0.92	1	5

3.1.9. Conscientiousness

The mean of conscientiousness (15 items) was 3.73 (SD = 0.51). The minimum of conscientiousness was 1.93 and maximum was 5.00.

3.1.10. Descriptive statistics of variables

Table 11 show an overview descriptive statistics of univariate variables.

Table 11: Descriptive statistics of univariate variables.

	N	Mean	Std. Deviation	Minimum	Maximum
Age (years and month)	1117	10.22	0.47	8.17	12.17
Chronotype (CSM)	1122	37.84	6.66	15	55
Midpoint of sleep on school days	1115	01:36	00:25	00:00	03:32
Midpoint of sleep at the weekend	1099	03:23	00:59	00:30	08:30
Average sleep duration on school days	1115	10:10	0:47	5:45	14:00
Average sleep duration at the weekend	1099	10:27	1:32	3:00	16:00
Average sleep duration	1096	10:15	0:48	6:04	13:08
Midpoint of sleep (MSFsc)	1096	02:58	00:57	23:04	07:47
Social jetlag	1096	1:46	0:54	-1:00	6:30
CFT total	1125	.55	.10	.16	.82
Motivation: Learning objectives	1121	4.20	0.58	1	5
Motivation: Approach performance objectives	1120	3.41	0.79	1	5
Motivation: Avoidance performance objectives	1120	2.80	0.92	1	5
Motivation: Work avoidance	1120	2.66	0.92	1	5
Gradings, Mathematics	1055	4.83	0.77	2.00	6.00
Gradings, German	1042	4.79	0.72	1.50	6.00
Gradings, Science & Culture (MeNuK)	1014	5.02	0.58	2.25	6.00
Gradings, English	1046	5.18	0.61	1.25	6.00
Gradings (total)	1034	4.95	0.52	2.63	6.00
Conscientiousness	1121	3.73	0.51	1.93	5.00

3.2. Bivariate analyses (t-tests and correlations)

3.2.1. Bivariate analyses for age by gender

3.2.1.1. Age and gender

Fig. 17 shows that the highest difference between the number of girls and boys are in age groups of 10.75 to 12 years with more boys and girls respectively (Table 12). Mean age was 10.22 years (boys = 10.24 and girls = 10.19) [SD = 0.47, n = 1117] (Table 13).

Table 12: Frequency distribution for age groups and gender.

		Girl (%)	N	Boy (%)	N	Total
Age	8 to 10 years	48.1	162	51.9	175	100.0
	10 to 10.24 years	52.6	132	47.4	119	100.0
	10.25 to 10.49 years	46.4	102	53.6	118	100.0
	10.50 to 10.74 years	50.3	92	49.7	91	100.0
	10.75 to 12 years	35.8	44	64.2	79	100.0
Total		47.8	532	52.2	582	100.0

Table 13: Descriptive statistics for age by gender.

	Min.	Max.	Mean	SD	N
Girls	8.67	12.17	10.19	0.44	532
Boys	8.17	12.08	10.24	0.49	582
Total	8.17	12.17	10.22	0.47	1117

Age in years and months; Min. = minimum; Max. = maximum; SD = standard deviation

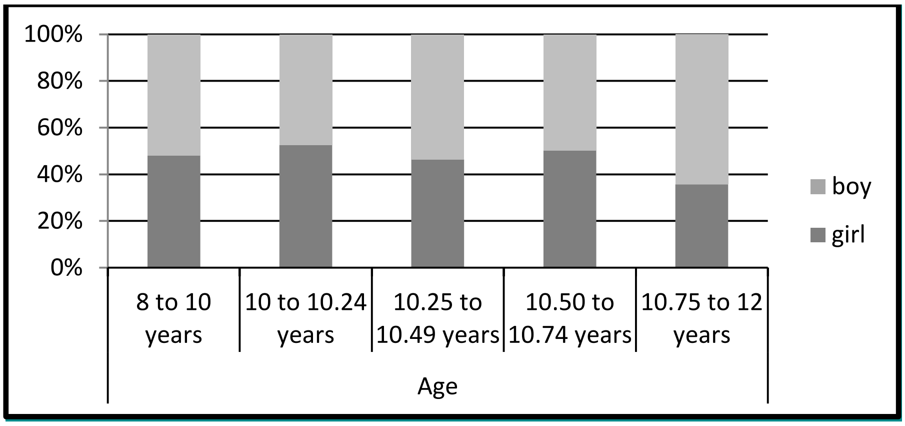


Fig. 17: Percentage of distribution of the pupils by age groups and genders.

3.2.1.2. Chronotype by age and gender

There was no significant correlation between chronotype and age (*r* = -0.011; *p* = 0.706) but younger children were more morning oriented than older ones (Table 14). In the age group of 8 to 10 years, 39.3% were morning and only 8.3% were evening oriented (Table 14 and Fig. 18).

There were no significant differences between gender and CSM scores (girls = 37.99 ± 6.64 and boys = 37.65 ± 6.65; T = 0.862, *p* = 0.389, df = 1115; Table 15). The percentage of morningness/eveningness was similar in girls and boys; girls: 20.0% and 3.9%, respectively; boys: 20.9% and 4.5%, respectively (see Table 16 and Fig. 19).

Table 14: Frequency distribution for chronotype groups by age groups.

		E-type (%)	N-type (%)	M-type (%)	N	Total
Age	8 to 10 years	8.3	52.4	39.3	338	100.0
	10 to 10.24 years	9.2	51.0	39.8	249	100.0
	10.25 to 10.49 years	7.3	52.3	40.5	220	100.0
	10.50 to 10.74 years	8.8	44.0	47.3	182	100.0
	10.75 to 12 years	7.3	52.0	40.7	123	100.0
Total		8.3	50.6	41.1	1112	100.0

Abbreviations: E-type: Evening-type, N-type: Neither-type, M-type: Morning-type.

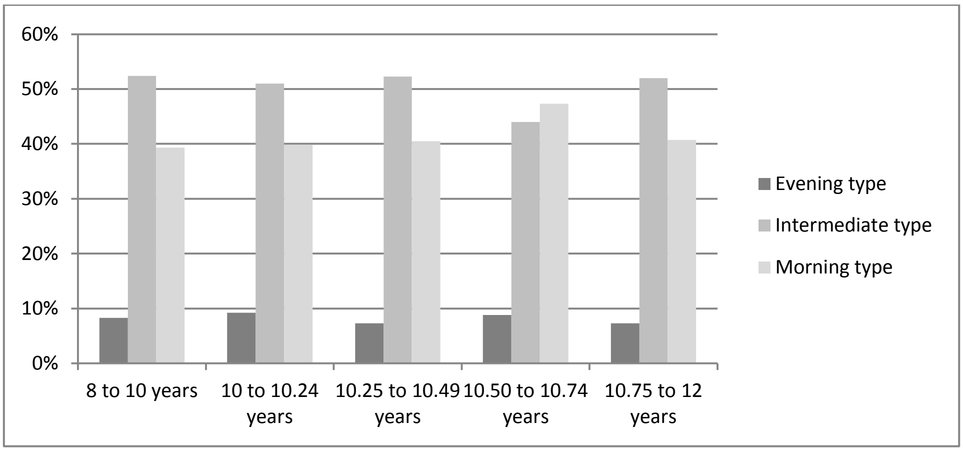


Fig. 18: Percentage of distribution of the pupils by chronotype groups and age groups.

Table 15: Means, standard deviations of chronotype and gender differences (t-test).

	Girls			Boys			t-test		Total		
	Mean	SD	N	Mean	SD	N	T	*p*	Mean	SD	N
Chronotype	37.99	6.64	536	37.65	6.65	581	0.862	0.389	37.81	6.65	1117

Table 16: Frequency distribution for chronotype by gender.

	Girls		Boys		Total	
Chronotype	N	%	N	%	N	%
Evening type	43	8.0	50	8.6	93	8.3
Intermediate type	270	50.4	296	51.1	568	50.7
Morning type	223	41.6	233	40.2	459	41.0
Total	536	100.0	579	100.0	1120	100.0

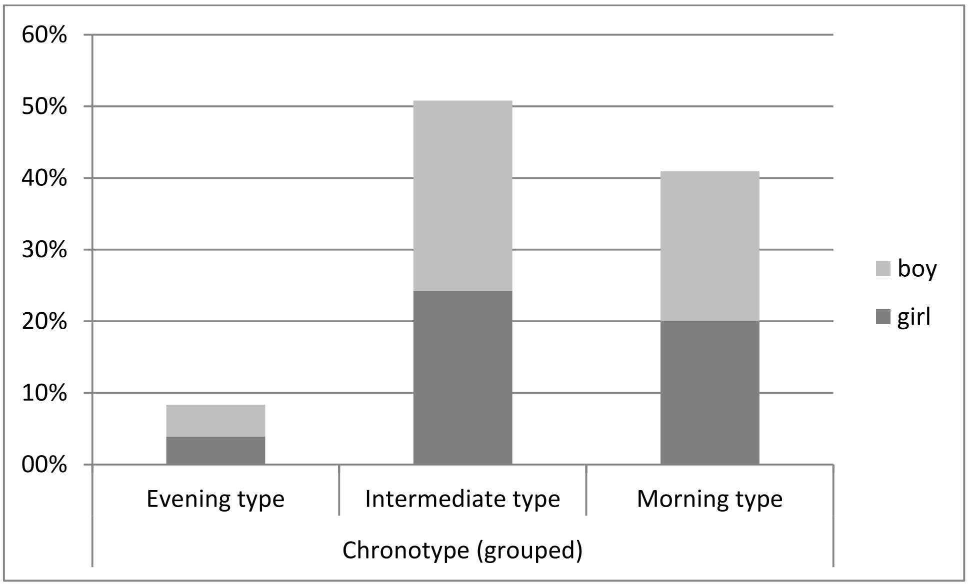


Fig. 19: Percentages by chronotype and gender.

3.2.1.3. Midpoint of sleep by age and gender

Midpoint of sleep was significantly related to age with a later midpoint at an older age [$p < 0.001$] (Table 17). There was a difference of 25 min between the younger group and the older group in mid-sleep (MSFsc), for the age group of 8 to 10 years old [M = 02 hours and 49 minutes; SD = 00:55]; while for the age group of 10.75 to 12 years old M = 03 hours and 16 minutes; SD = 01:00 (see Table 18 and Fig. 20).

Mean of mid-sleep times differed significantly among gender. Mean MSFsc in girls [M = 3:02 am, SD = 53 min, n = 526] was 8 minutes later than in boys [M = 2:54 am SD = 60 min, n = 566, independent samples T = 2.510, $p < 0.12$] and mean mid-sleep on free days was 7 minutes later for girls [M = 3:27 am, SD = 56 min , n = 527] than for boys [M = 3:20, SD = 61 min, n = 568, independent samples T = 1.931, $p < 0.054$] (Table 19 and Fig. 21).

Table 17: Partial correlation of mid-sleep and age groups.

	Age		
	r	*p*	N
Mid-sleep on school days	0.100	0.001	1108
Mid-sleep on free days	0.170	<0.001	1092
Mid-sleep (MSFsc)	0.137	<0.001	1089

Table 18: Means (M) and standard deviations (SD) of mid-sleep and age groups.

Age	8 to 10		10 to 10.24		10.25 to 10.49		10.50 to 10.74		10.75 to 12		Total	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Mid-sleep on school days	01:34	00:23	01:36	00:22	01:37	00:25	01:38	00:25	01:41	00:33	01:36	00:25
Mid-sleep on free days	03:12	00:56	03:21	00:55	03:25	01:01	03:27	03:27	03:48	01:03	03:23	00:59
Mid-sleep (MSFsc)	02:49	00:55	02:58	00.54	02:58	01:00	03:01	00:57	03:16	01:00	02:58	00:57

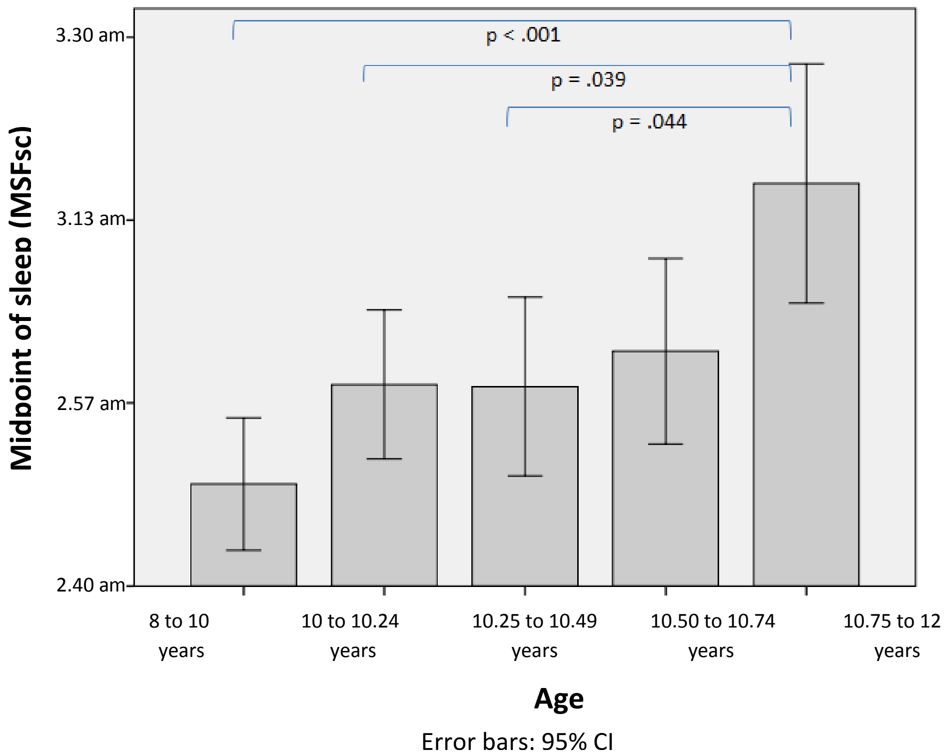


Fig. 20: Bar graph of midpoint of sleep and age.

Table 19: Mid-sleep (mean and standard deviation of study variables) by gender differences (t-test).

	Girls			Boys			t- test		Total		
	Mean	SD	N	Mean	SD	N	T	*p*	Mean	SD	
Mid-sleep on school days	1:35am	25min	533	1:38am	24min	578	-2.188	0.029	01:37	00:25	1111
Mid-sleep on free days	3:27am	56min	527	3:20am	61min	568	1.931	0.054	03:23	00:59	1095
Mid-sleep (MSFsc)	3:02am	53min	526	2:54am	60min	566	2.510	0.012	2.58am	57min	1092

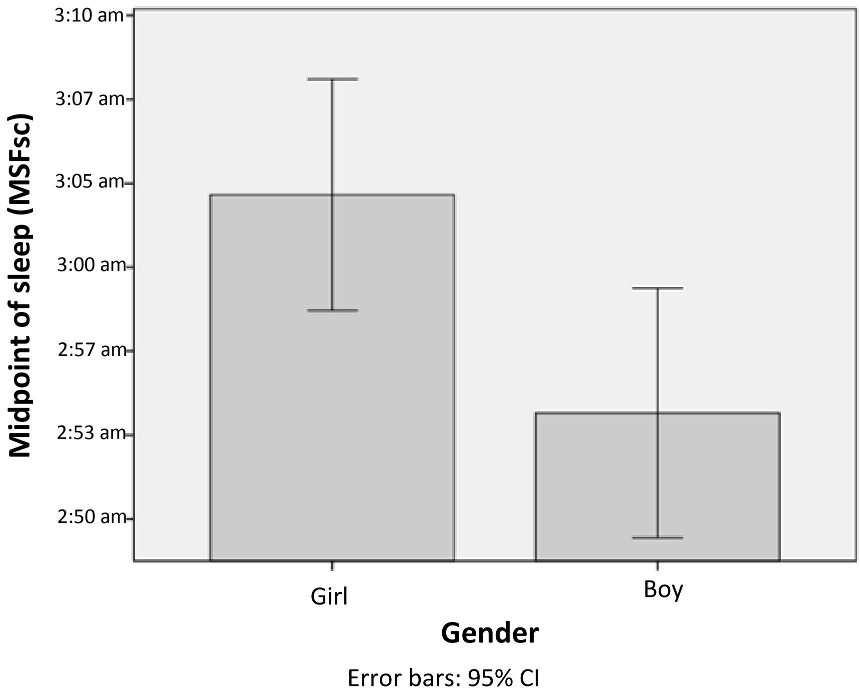


Fig. 21: Bar graph of midpoint of sleep and gender.

3.2.1.4. Other sleep variables (sleep-wake, sleep duration, social jetlag and napping by age and gender)

Age was negatively related with the average sleep length [r = -0.110; p < 0.001]. With decrease in age, students slept longer [p < 0.001] (Fig. 22). Age had positively related with bed times and rise time on free days. Older pupils associated with more sleep during the day [r = 0.621; p = 0.015] (Table 20). Age positively related with social jetlag. The oldest age group had significantly more social jetlag than all younger age groups (8 to 10 years, p < 0.001; 10 to 10.24, p = 0.001; 10.25 to 10.49, p = 0.017; 10.50 to 10.74, p = 0.026) (Tables 20 and 21 and Fig. 23). Younger group had more nap in compare with older group [M = 5.63, SD = 0.858 vs. M = 5.48, SD = 1.093] (Tables 20 and 21).

Concerning gender, boys got up earlier than girls on free days (08:28 vs. 08:47) [t = 3.986, $p < 0.001$] and later on school days (06:44 vs. 06:40) [T = -2.536, $P < 0.001$] but boys went to bed in both free days and school days later than girls (Table 22).

Girls were sharing more social jetlag [M = 1h 51 min, SD = 52 min] than boys [M = 1h 41 min, SD = 56 min] (Table 22 and Fig. 24). In addition, Tables 22, 23, 24 and Fig. 25 show that girls reported more napping than boys.

Table 20: Partial correlation (controlling for gender) of sleep habits and age groups.

	Age		
	r	*p*	df
Rise time on school days	0.001	0.963	1083
Rise time on free days	0.094	0.002	1083
Bed time on school days	0.119	<0.001	1083
Bed time on free days	0.184	<0.001	1083
Sleep length on school days	-0.113	<0.001	1055
Sleep length on free days	-0.057	0.064	1055
Average sleep length	-0.110	<0.001	1055
Social jetlag	0.142	<0.001	1055
Nap	0.621	0.015	1104

Table 21: Means (M) and standard deviations (SD) of sleep variables and age groups.

	8 to 10		10 to 10.24		10.25 to 10.49		10.50 to 10.74		10.75 to 12		Total	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Rise time on school days	06:43	00:23	06:41	00:26	06:41	00:25	06:43	00:26	06:41	00:25	06:42	00:25
Rise time on free days	08:30	01:17	08:32	01:15	08:39	01:29	08:39	01:19	08:55	01:26	08:36	01:21
Bed time on school days	20:25	00:37	20:32	00:37	20:33	00:43	20:33	00:41	20:40	00:58	20:31	00:42
Bed time on free days	21:55	01:03	22:09	01:02	22:11	01:09	22:14	01:09	22:41	01:23	22:09	01:09
Sleep length on school days	10:17	00:41	10:08	00:47	10:08	00:50	10:09	00:47	10:00	00:58	10:10	00:48
Sleep length on free days	10:34	01:25	10:23	01:22	10:26	01:43	10:25	01:32	10:13	01:53	10:26	01:33
Average sleep length	10:22	00:42	10:12	00:46	10:13	00:53	10:13	00:46	10:03	00:58	10:14	00:48
Social jetlag	01:39	00:51	01:43	00:54	01:47	00:57	01:47	00:52	02:06	00:59	01:46	00:55
Nap	5.63	0.858	5.57	0.854	5.65	0.857	5.49	1.099	5.48	1.093	5.58	0.929

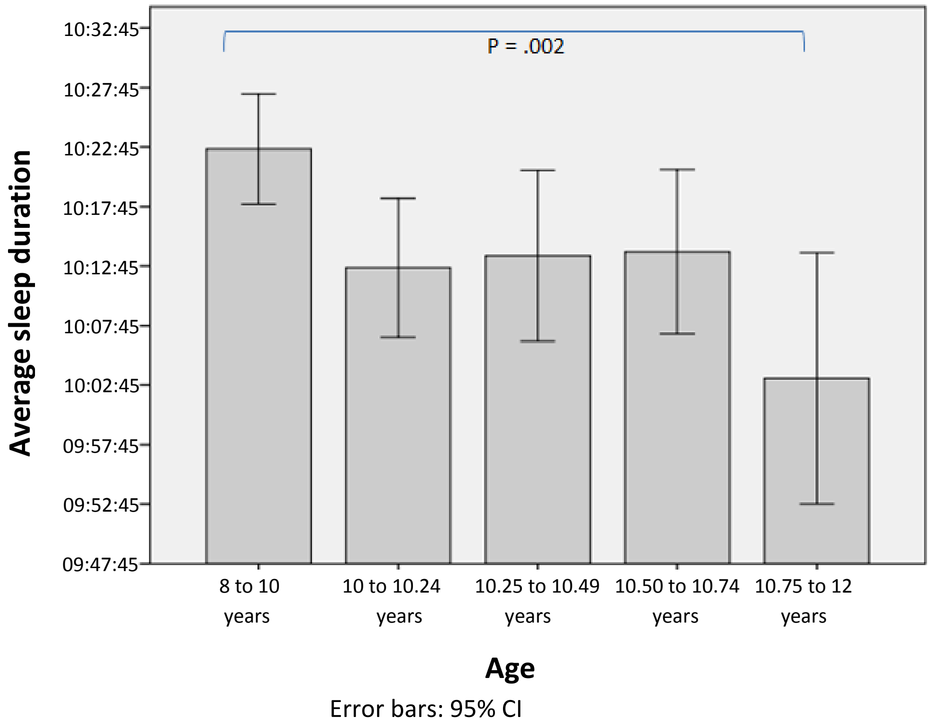


Fig. 22: Bar graph of sleep duration and age groups.

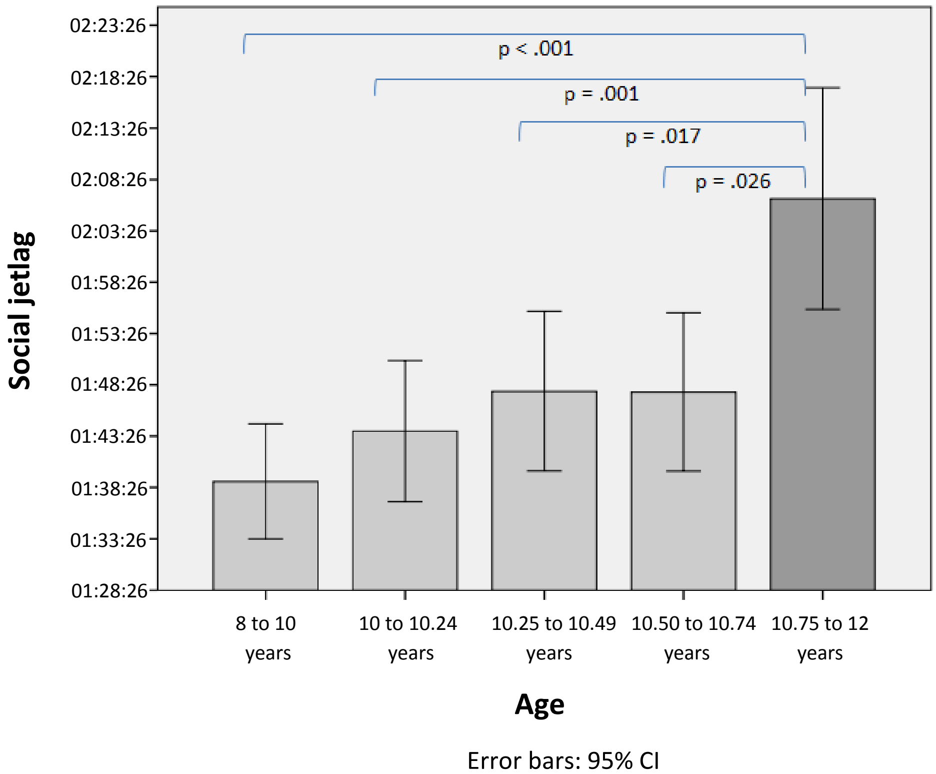


Fig. 23: Bar graph of social jetlag and age groups.

Table 22: Sleep variables (mean and standard deviation of study variables) by gender differences (t-test).

	Girls			Boys			t- test		Total		
	Mean	SD	N	Mean	SD	N	T	*p*	Mean	SD	N
Rise time on school days	06:40	00:25	536	06:44	00:25	581	2.536	.010	06:42	00:25	1117
Rise time on free days	08:47	01:15	531	08:28	01:24	571	3.986	<.001	08:37	01:20	1102
Bed time on school days	20:30	00:43	533	20:32	00:41	579	-0.953	0.34	20:31	00:42	1112
Bed time on free days	22:06	01:04	529	22:12	01:12	570	-1.444	0.14	22:09	01:08	1099
Sleep length on school days	10 h 9 min	48 min	533	10 h 11 min	47 min	578	-0.516	<0.001	10 h 11 min	47 min	1111
Sleep length on free days	10 h 41min	01:22	527	10 h 15 min	01:38	568	4.67	<0.001	10 h 27 min	1 h 31min	1095
Average sleep length	10 h 1 min	46 min	526	10 h 12 min	50 min	566	2.041	0.42	10 h 15 min	48 min	1092
Social jetlag	1 h 51 min	52 min	526	1 h 41 min	56 min	566	3.094	0.002	1 h 46 min	55 min	1092
Nap	15.42	36.59	521	13.42	33.21	570	0.943	0.346	14.42	34.94	1091

Table 23: Frequency distribution for napping by gender.

	Girl		Boy		Total	
How do you do nap?	N	%	N	%	N	%
Every day/almost every day	4	0.8	8	1.4	12	1.1
More times in the week	6	1.1	8	1.4	14	1.3
One time in the week	27	5.1	18	3.1	45	4.1
More times in the month	8	1.5	8	1.4	16	1.4
One time in the month/rare	96	18.1	92	15.9	188	17
Never	389	73.4	443	76.8	832	75.2
Total	530	100.0	577	100.0	1107	100.0

Table 24: Percent distribution of gender by napping.

	Girl	Boy
Nap	47.8%	52.2%
Total	521	570

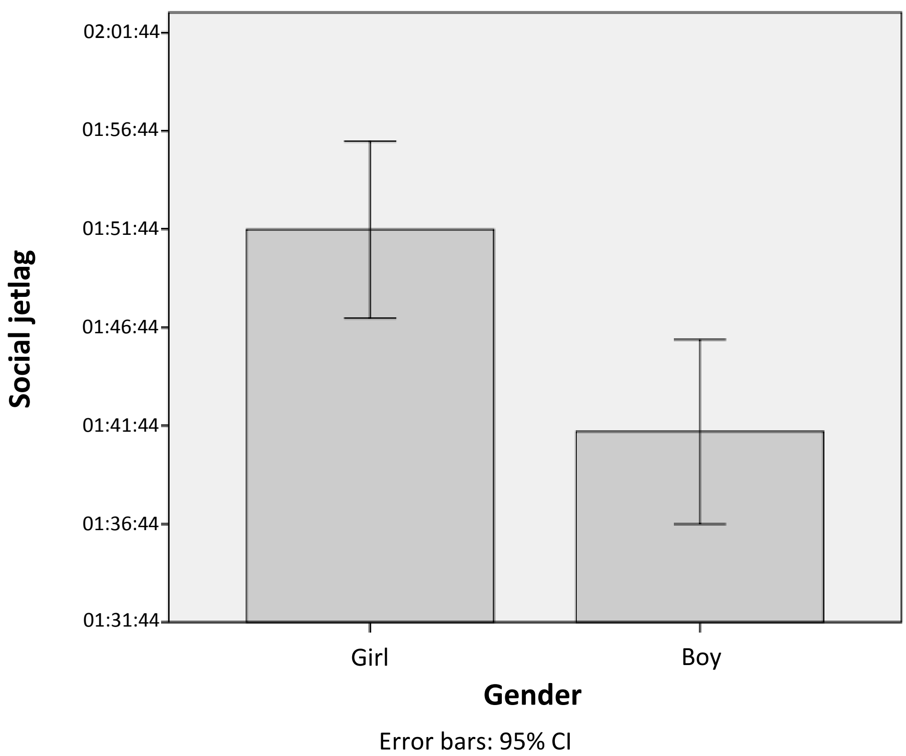


Fig. 24: Bar graph of social jetlag and gender.

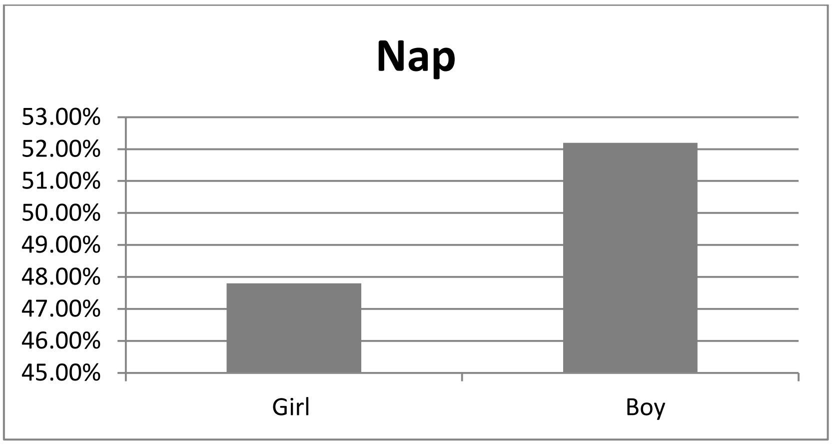


Fig. 25: Bar graph of napping and gender.

3.2.1.5. Intelligence by age and gender

After controlling for gender, age correlated negatively with intelligence [r = -0.98, p = 0.001], therefore younger pupils were more intelligent than older ones [M = 55, SD = 0.096 vs. M = 0.50, SD = 0.104] (Table 25 and Fig. 26).

Boys and girls did not differ in intelligence [p = 0.295, T = 1.048] (Table 26).

Table 25: Subtests of intelligence (mean and standard deviation) and age groups.

	CFT Series		CFT Classification		CFT Matrices		CFT Conditions		CFT Total	
Age	M	SD	M	SD	M	SD	M	SD	M	SD
8 to 10 years	0.63	0.142	0.52	0.131	0.63	0.162	0.38	0.173	0.55	0.096
10 to 10.24 years	0.62	0.163	0.52	0.134	0.63	0.155	0.40	0.173	0.55	0.109
10.25 to 10.49 years	0.62	0.155	0.51	0.151	0.62	0.170	0.39	0.168	0.55	0.109
10.50 to 10.74 years	0.62	0.141	0.51	0.138	0.64	0.148	0.40	0.173	0.55	0.096
10.75 to 12 years	0.56	0.169	0.49	0.137	0.54	0.160	0.36	0.159	0.50	0.104
Total	0.62	0.153	0.51	0.138	0.62	0.162	0.39	0.50	0.55	0.104

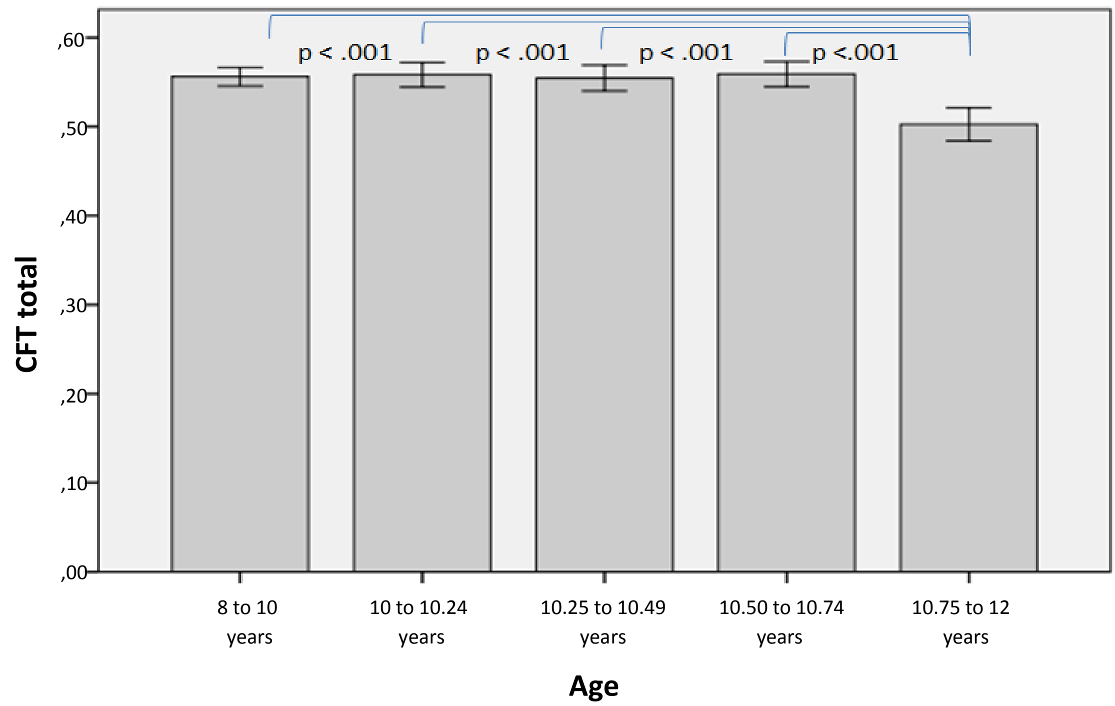


Fig. 26: Bar graph of CFT total (intelligence) and age group.

Table 26: Descriptive statistics for the intelligence by gender differences (t-test).

	Girls			Boys			t- test		Total		
Intelligence	Mean	SD	N	Mean	SD	N	T	*p*	Mean	SD	N
CFT Series	0.62	0.14	536	0.61	0.58	584	1.069	0.285	0.62	0.15	1120
CFT Classification	0.52	0.13	536	0.51	0.13	584	1.707	0.088	0.51	0.13	1120
CFT Matrices	0.63	0.15	536	0.62	0.17	584	1.057	0.291	0.62	0.16	1120
CFT Conditions	0.38	0.17	536	0.40	0.17	584	-1.318	0.188	0.39	0.17	1120
CFT Total	0.55	0.10	536	0.55	0.11	584	1.048	0.295	0.55	0.10	1120

3.2.1.6. Achievement by age and gender

Achievement in the four main subjects of Mathematic, German, English and Science & Culture differed between five groups of age from 8 to 12 years: 3.46, 3.45, 3.44, 3.40, 2.48 (M) respectively (Table 27). The age group of 8 to 10 years reported the best and the group of 10.75 to 12 years reported the worse grades. It shows that grades decreased with increasing age (Fig. 27). Age had significant influence on grades. Table 28 shows significant differences between grades and age. This was confirmed by correlation (r = -0.237, p < 0.001).

There were significant differences between sexes in academic performance but the direction was subject-specific: Girls did better in languages than boys (in English: M = 5.24, SD = 0.56 vs. M = 5.12, SD = 0.66 and in German: M = 4.87, SD = 0.64 vs. M = 4.72, SD = 0.78 and Science & Culture (M = 5.10, SD = 0.54 vs. M = 4.94, SD = 0.61) but boys had better scores in Math than girls (M = 4.90, SD = 0.74 vs. M = 4.75, SD = 0.79). Overall, there were no gender differences in grades [t = 1.937, p = 0.053] (see Table 29 and Fig. 28).

Table 27: Mean and standard deviation of age groups and grades.

	Math		German		English		Science & culture		Average gradings	
Age	M	SD	M	SD	M	SD	M	SD	M	SD
8 to 10 years	3.11	1.25	3.03	1.13	3.62	1.10	3.32	1.09	3.46	1.03
10 to 10.24 years	3.03	1.30	2.89	1.21	3.74	1.04	3.36	1.06	3.45	1.05
10.25 to 10.49 years	3.08	1.31	2.92	1.25	3.61	1.15	3.36	1.12	3.44	1.00
10.50 to 10.74 years	3.06	1.25	2.87	1.19	3.57	1.13	3.21	1.09	3.40	0.98
10.75 to 12 years	2.10	1.19	2.18	1.17	2.79	1.24	2.57	1.12	2.48	0.96
Total	2.97	1.30	2.85	1.21	3.54	1.15	3.24	1.12	3.33	1.06

Table 28: Partial correlation of age and grades.

Gradings	Math	German	Science & culture	English	Grading (total)
r	-0.213	-0.192	-0.163	-0.156	-0.237
p	<0.001	<0.001	<0.001	<0.001	<0.001

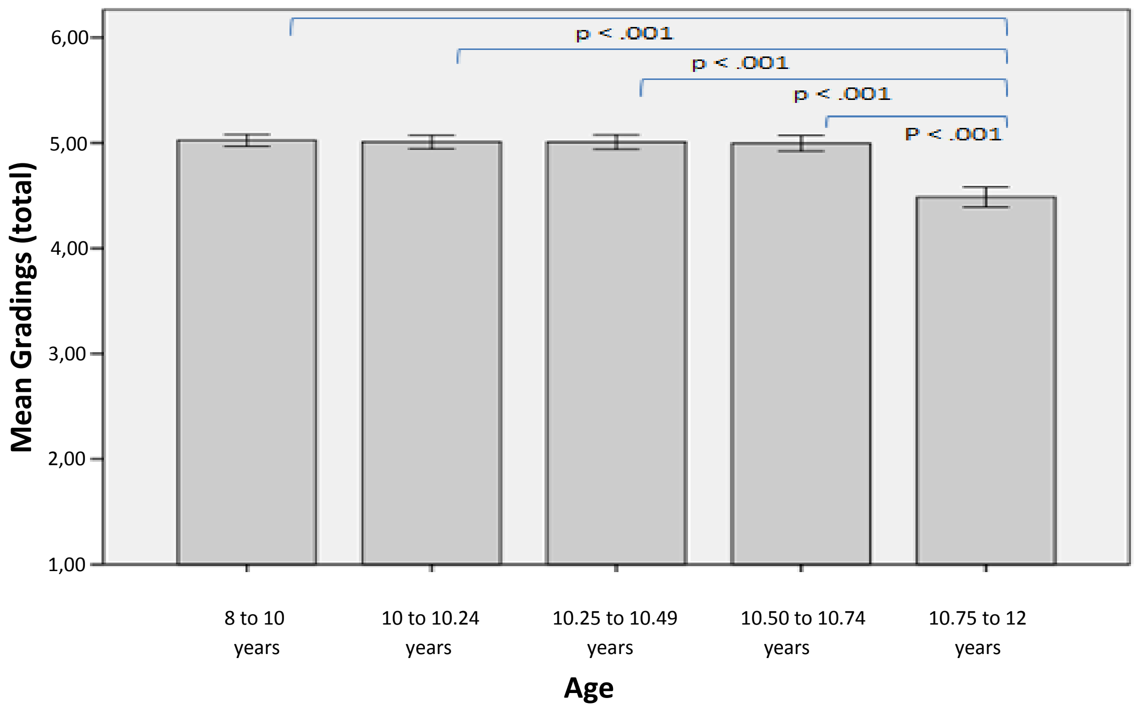


Fig. 27: Bar graph of grading and age groups.

Table 29: Achievement and gender differences.

	Girls			Boys			t- test		Total		
Achievement	Mean	SD	N	Mean	SD	N	T	*p*	Mean	SD	N
Mathematics	4.75	0.79	510	4.90	0.74	541	-3.242	0.001	4.83	0.77	1051
German	4.87	0.64	504	4.72	0.78	534	3.332	0.001	4.79	0.72	1038
English	5.24	0.56	505	5.12	0.66	537	3.063	0.002	5.18	0.61	1042
Science & culture	5.10	0.54	488	4.94	0.61	522	4.310	<0.001	5.02	0.58	1010
Average grade	4.98	0.50	499	4.92	0.54	531	1.937	0.053	4.95	0.52	1030

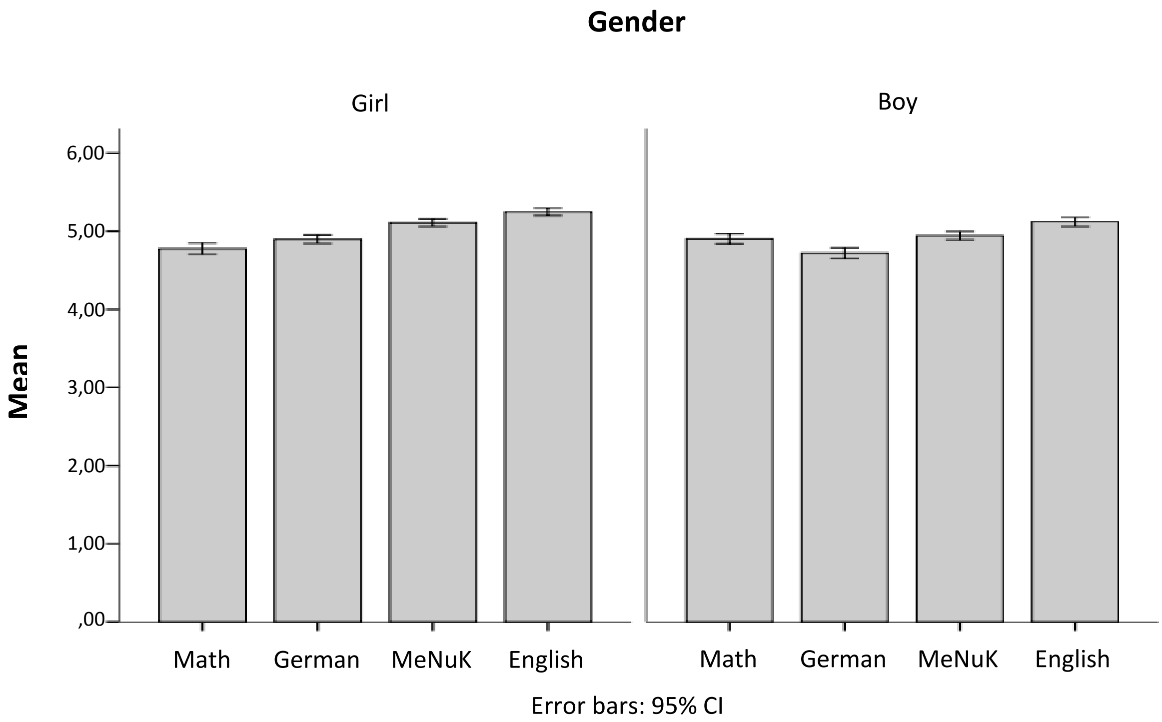


Fig. 28: Bar graph of gradings and gender.

3.2.1.7. Motivation by age and gender

Tables 30 and 31 show the relationship between age and four motivation scales (learning objectives: M = 4.19, SD = 0.57; approach performance objectives M = 3.41, SD = 0.79; avoidance performance objectives M = 2.79, SD = 0.92 and work avoidance M = 2.66, SD = 0.92), thus older students reported higher approach performance objectives ($r = 0.084$; $p = 0.005$), higher avoidance performance objectives ($r = 0.085$; $p = 0.005$) and higher work avoidance ($r = 0.123$; $p < 0.001$) but there were no age differences in learning objectives ($r = -0.003$; $p = 0.913$).

Girls scored higher on learning objectives than boys (M = 4.24; SD = 0.55 vs. M = 4.17; SD = 0.59) but boys scored higher on avoidance performance objectives (M = 2.86; SD = 0.95 vs. M = 2.73; SD = 0.95); and there were no gender differences in work avoidance and approach performance avoidance (Table 32 and Fig. 29).

Table 30: Mean and standard deviation of motivation and age groups.

	Learning objectives		Approach performance objectives		Avoidance performance objectives		Work avoidance	
Age	M	SD	M	SD	M	SD	M	SD
8 to 10 years	4.17	0.58	3.36	0.74	2.75	0.86	2.51	0.84
10 to 10.24 years	4.21	0.56	3.33	0.83	2.72	0.95	2.63	0.97
10.25 to 10.49 years	4.22	0.58	3.41	0.78	2.73	0.92	2.72	0.92
10.50 to 10.74 years	4.24	0.52	3.52	0.78	2.85	0.93	2.72	0.95
10.75 to 12 years	4.08	0.60	3.53	0.82	3.07	0.94	2.90	0.91
Total	4.19	0.57	3.41	0.79	2.79	0.92	2.66	0.92

Table 31: Partial correlation of motivation with age groups.

	Age	
Motivation	*r*	*p*
Learning objectives	-0.003	0.913
Approach performance objectives	0.084	0.005
Avoidance performance objectives	0.085	0.005
Work avoidance	0.123	<0.001

Table 32: Motivation (mean and standard deviation) by gender differences (t-test).

	Girl		Boy				Total	
Motivation	Mean (SD)	N	Mean (SD)	N	T	*p*	Mean (SD)	N
Learning objectives	4.24 (0.55)	536	4.17 (0.59)	580	2.065	0.039	4.20 (0.57)	1116
Approach performance objectives	3.37 (0.79)	535	3.45 (0.79)	580	-1.744	0.081	3.42 (0.79)	1115
Avoidance performance objectives	2.73 (0.95)	535	2.86 (0.95)	580	-2.438	0.015	2.80 (0.92)	1115
Work avoidance	2.62 (0.89)	535	2.70 (0.95)	580	-1.425	0.154	2.66 (0.92)	1115

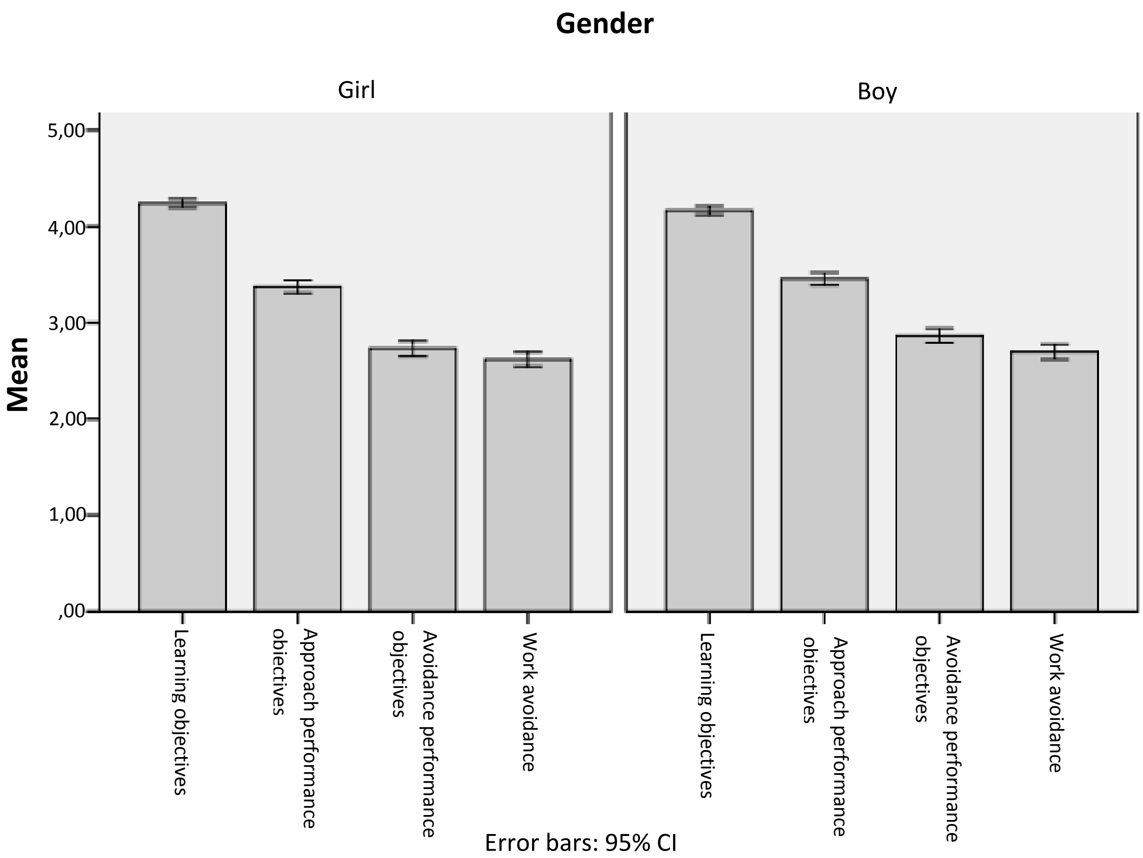


Fig. 29: Bar graph of gender and motivation.

3.2.1.8. Conscientiousness by age and gender

There were not any difference between age groups and conscientiousness [M = 3.73, SD = 0.509; r = -0.019, p = 0.524] (Table 33). Girls scored higher on conscientiousness [M = 3.79 and SD = 0.51] than boys [M = 3.68 and SD = 0.050] (Table 34).

Table 33: Descriptive statistics for conscientiousness by age groups.

Conscientiousness			
Age	M	SD	N
8 to 10 years	3.72	0.502	338
10 to 10.24 years	3.74	0.514	249
10.25 to 10.49 years	3.75	0.480	219
10.50 to 10.74 years	3.81	0.542	183
10.75 to 12 years	3.59	0.501	124
Total	3.73	0.509	1113

Table 34: Conscientiousness (mean and standard deviation of study variables) and gender differences (t-test).

Conscientiousness	M	SD	N	T	*p*
Girl	3.79	0.51	534		
Boy	3.68	0.50	582	3.766	<0.001
Total	3.73	0.51	1116		

3.2.2. Bivariate analyses of chronotype, midpoint of sleep, other sleep variables, intelligence, achievement, motivation and conscientiousness

3.2.2.1. Chronotype

3.2.2.2. Midpoint of sleep

Evening types had more midpoint of sleep compared to intermediate/morning types [school days 01:42 vs. 01:39 vs. 01:32; free days: 04:12 vs. 03:30 vs. 03:04] (see Tables 35 and 36 and Fig. 30).

Table 35: Means (M) and standard deviations (SD) of chronotype group and mid-sleep.

Chronotype (CSM)	Evening type		Neither type		Morning type		Total	
	Mean (SD)	N	Mean (SD)	N	Mean (SD)	N	Mean (SD)	N
Mid-sleep (MSFsc)	03:43 (01.04)	92	03:04 (00:53)	554	02:40 (00:54)	445	02:58 (00:57)	1091
Mid-sleep on school days	01:42 (00:26)	93	01:39 (00:26)	564	01:32 (00:23)	453	01:36 (00:25)	1110
Mid-sleep on free days	04:12 (01:04)	92	03:30 (00:55)	555	03:04 (00:54)	447	03:23 (00:59)	1094

Note. All times are showed as time since midnight.

Table 36: Partial correlation of chronotype with mid-sleep.

	Chronotype (CSM)	
	r	*p*
Mid-Sleep (MSFsc)	-0.331	<0.001
Mid-Sleep on school days	-0.178	<0.001
Mid-Sleep on free days	-0.367	<0.001

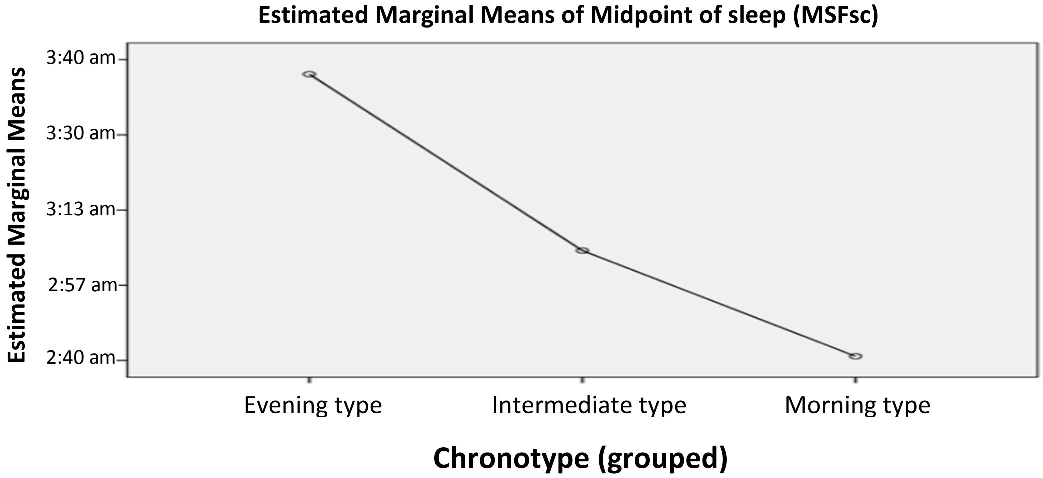


Fig. 30: General linear model (GLM) of chronotype and midpoint of sleep (MSFsc).

3.2.2.3. Other sleep variables (sleep-wake, sleep duration, social jetlag and napping)

Evening types got up later compared to neither and morning types [school days: 06:49 vs. 06:44 vs. 06:37; free days: 09:38 vs. 08:46 vs. 08:12], they went to bed later [school days 20:36 vs. 20:33 vs. 20:27; free days: 22:47 vs. 22:14 vs. 21:55] (Table 37), and also evening types showed higher sleep duration [r = -0.081, p = 0.009] (Tables 37 and 38 and Fig. 31). They also were shared higher social jetlag [r = -0.309, p < 0.001] (Table 38 and Fig. 32). Evening types took longer naps [5.70 vs. 5.56 vs. 5.57] while morning types had higher percentage of napping in compare with evening types (Table 39).

Table 37: Means (M) and standard deviations (SD) of chronotype groups and sleep habits.

Chronotype (CSM)	Evening type		Neither type		Morning type		Total	
	Mean (SD)	N	Mean (SD)	N	Mean (SD)	N	Mean (SD)	N
Rise time on school days	06:49 (00:28)	93	06:44 (00:24)	567	06:37 (00:26)	456	06:42 (00:25)	1116
Rise time on free days	09:38 (01:25)	92	08:46 (01:26)	560	08:12 (01:17)	449	08:37 (01:21)	1101
Bed time on school days	20:36 (00:41)	93	20:33 (00:43)	565	20:27 (00:40)	453	20:31 (00:42)	1111
Bed time on free days	22:47 (01:14)	92	22:14 (01:08)	556	21:55 (01:04)	450	22:09 (01:08)	1098
Sleep length on school days	10:12 (0:48)	93	10:10 (0:46)	564	10:10 (0:48)	453	10:10 (0:48)	1110
Sleep length on free days	10:51 (1:36)	92	10:31 (1:32)	555	10:17 (1:32)	447	10:27 (1:32)	1094
Average sleep duration	10:23 (0:48)	92	10:16 (0:46)	554	10:11 (0:50)	445	10:15 (0:48)	1091
Social jetlag	2:29 (1:05)	92	1:51 (0:51)	554	1:31 (0:50)	445	1:46 (0:55)	1091
Nap	5.70 (656)	93	5.56 (981)	558	5.57 (942)	456	5.57 (942)	1107

Note. All times are showed as time since midnight.

Table 38: Partial correlation of chronotype with sleep variables.

	Chronotype (CSM)	
	r	*p*
Rise time on school days	-0.194	<0.001
Rise time on free days	-0.334	<0.001
Bed time on school days	-0.092	0.003
Bed time on free days	-0.236	<0.001
sleep duration on school days	-0.025	0.413
sleep duration on free days	-0.116	<0.001
Average sleep duration	-0.081	0.009
Social jetlag	-0.309	<0.001
nap	-0.014	0.645

Table 39: Frequency distribution for napping by chronotype groups.

	E-type		N- type		M- type		Total	
How do you do nap in the afternoon?	N	%	N	%	N	%	N	%
Daily	0	0.0	8	1.4	4	0.9	12	1.1
several times in the week	0	0.0	5	0.9	9	2.0	14	1.3
once a week	3	3.2	28	5.0	14	3.1	45	4.1
several times in the month	1	1.1	5	0.9	10	2.2	16	1.4
once a month or never	17	18.3	92	16.5	79	17.3	188	17.0
never	72	77.4	420	75.3	340	74.6	832	75.2
Total	93	100.0	558	100.0	456	100.0	1107	100.0

Abbreviations: E-type: Evening-type, N-type: Neither-type, M-type: Morning-type.

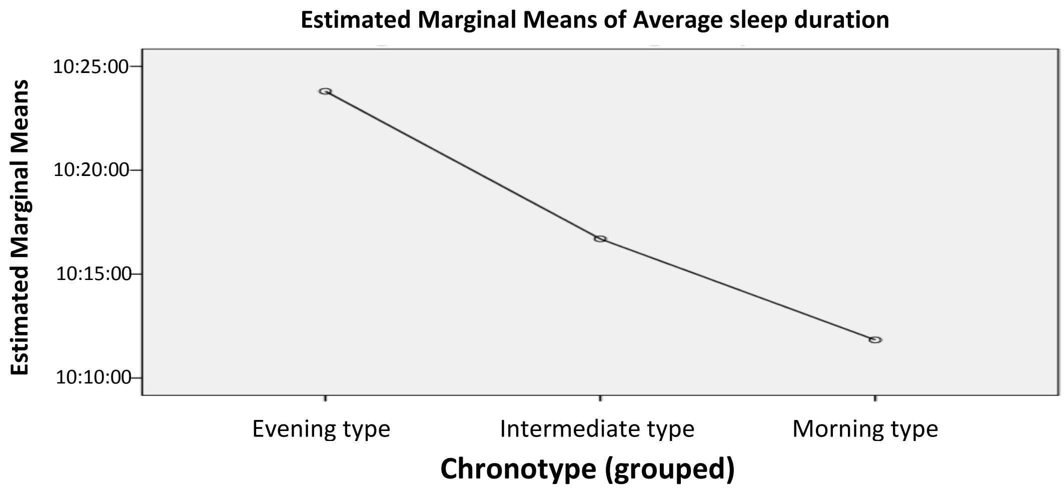


Fig. 31: General linear model (GLM) of chronotype groups and average sleep duration.

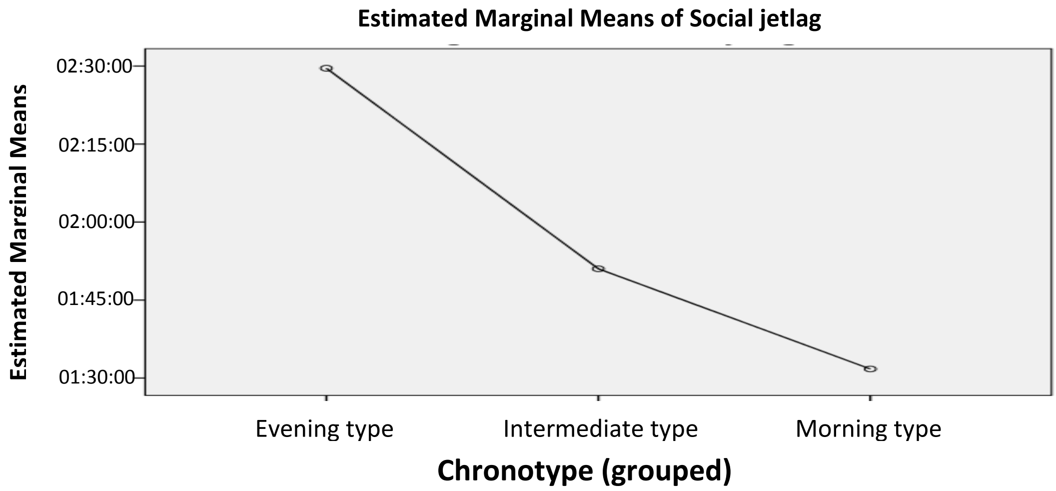


Fig. 32: General linear model (GLM) of chronotype groups and social jetlag.

3.2.2.4. Intelligence

Morningness orientation was positively related with higher intelligence. This relation remained significant when controlling for age and sex (*r* = 0.061, *p* = 0.042) but the mean score in CFT Total (intelligence) and CSM were not different [M = 0.55, SD = 0.104] (see Table 40).

Table 40: Distribution of chronotype groups and intelligence.

	E-type		N-type		M-type		Total	
Intelligence	M	SD	M	SD	M	SD	M	SD
CFT Series	.59	.168	.62	.156	.63	.146	.62	.153
CFT Classification	.51	.142	.52	.136	.51	.139	.51	.138
CFT Matrices	.59	.162	.62	.159	.63	.163	.62	.161
CFT Conditions	.38	.167	.38	.173	.40	.169	.39	.171
CFT Total	.53	.104	.55	.103	.55	.104	.55	.104

Abbreviations: E-type: Evening-type, N-type: Neither-type, M-type: Morning-type.

3.2.2.5. Achievement

There were positive relationship between CSM scores and grades [$r = 0.153$; $p < 0.001$] (Tables 41, 42 and Fig. 33). There was a significant positive correlation between average grading and morningness. Morningness reported the highest subjective level of achievement than the other groups of CSM, especial in math. This confirms that eveningness had worse grades (Fig. 33).

Table 41: Distribution of chronotype groups and grades.

Chronotype (CSM)	E-type			N-type			M-type			Total		
Grades	M	SD	N	M	SD	N	M	SD	N	M	SD	N
Math	2.57	1.20	85	2.91	1.27	535	3.10	1.34	432	2.96	1.21	1052
English	3.18	1.27	83	3.51	1.15	533	3.65	1.11	427	3.54	1.15	1043
German	2.36	1.18	86	2.87	1.16	525	2.94	1.25	428	2.85	1.21	1039
Science & culture	3.00	1.08	83	3.18	1.09	510	3.36	1.14	418	3.24	1.11	1011
Average gradings	2.94	1.07	85	3.31	1.01	522	3.44	1.09	424	3.33	1.06	1031

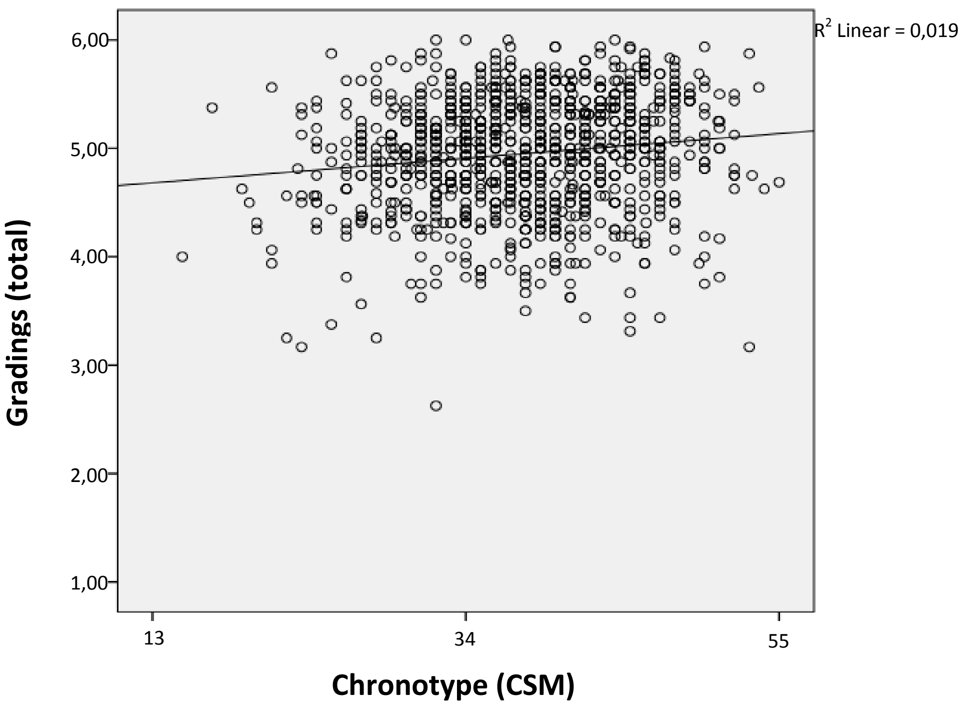


Fig. 33: General linear model (GLM) of chronotype groups and gradings.

Table 42: Partial correlation between chronotype and achievement.

	Chronotype (CSM)	
	r	*p*
Math	0.108	0.001
German	0.117	<0.001
Science & culture	0.136	<0.001
English	0.110	0.001
Gradings (total)	0.153	<0.001

3.2.2.6. Motivation

Morningness was positively related with higher scores in learning objectives, [p = 0.127] and approach performance objectives [p = 0.982] but eveningness was related to higher avoidance performance objectives [p = 0.030] and higher work avoidance [p = 0.001] (see Tables 43, 44, 45 and Fig. 34).

Table 43: Distribution of chronotype groups and motivation.

	E-type			N-type			M-type			Total		
Motivation	M	SD	N	M	SD	N	M	SD	N	M	SD	N
Learning objectives	4.04	0.6	493	4.17	0.59	556	4.25	0.53	458	4.19	0.57	1117
Approach performance objectives	3.32	0.7	893	3.40	0.78	565	3.45	0.80	458	3.41	0.79	1116
Avoidance performance objectives	2.97	0.8	893	2.86	0.91	565	2.70	0.93	458	2.80	0.92	1116
Work avoidance	2.94	0.9	593	2.70	0.90	565	2.55	0.92	458	2.66	0.92	1116

Abbreviations: E-type: Evening-type, N-type: Neither-type, M-type: Morning-type.

Table 44: Correlation of chronotype groups and motivation.

	E-type	N-type	M-type
Motivation	Sig.	Sig.	Sig.
Learning objectives	0.005	0.127	0.127
Approach performance objectives	0.517	0.982	0.982
Avoidance performance objectives	0.030	0.019	0.019
Work avoidance	0.001	0.027	0.027

Abbreviations: E-type: Evening-type, N-type: Neither-type, M-type: Morning-type.

Table 45: Partial correlation of chronotype (CSM) with motivation.

Motivation	Learning objectives		Approach performance objectives		Avoidance performance objectives		Work avoidance	
	r	*P*	*r*	*p*	*r*	*p*	*r*	*p*
Chronotype (CSM)	0.149	<0.001	0.039	0.203	0.118	<0.001	-0.127	<0.001

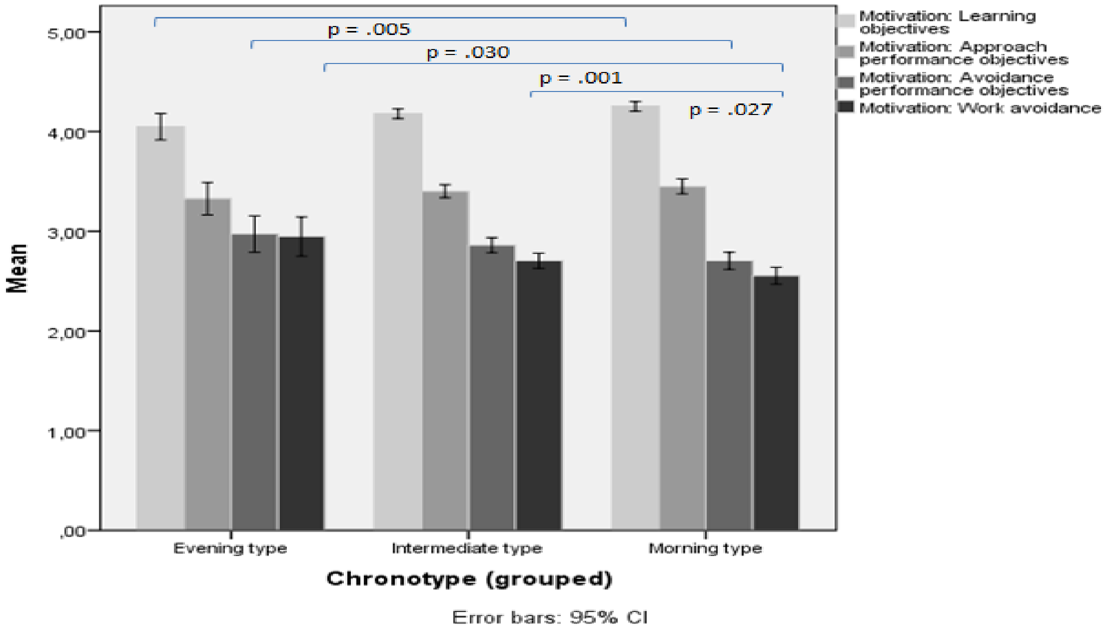


Fig. 34: Bar graph of chronotype and motivation.

3.2.2.7. Conscientiousness

The mean score in morning type were higher than intermediate type and evening type [M = 0.390, SD = 0.49 vs. M = 3.65, SD = 0.46 vs. M = 3.39, SD = 0.54] (see Table 46). Morning type was positively related with higher scores in conscientiousness. This relationship remained significant when controlling for age and sex [$r = 0.354$, $p < 0.001$] (Fig. 35).

Table 46: Distribution of chronotype groups and conscientiousness.

Conscientiousness	Mean	SD	N
Morning type	3.90	0.49	458
Intermediate type	3.65	0.46	567
Evening type	3.39	0.54	92
Total	3.73	0.50	1117

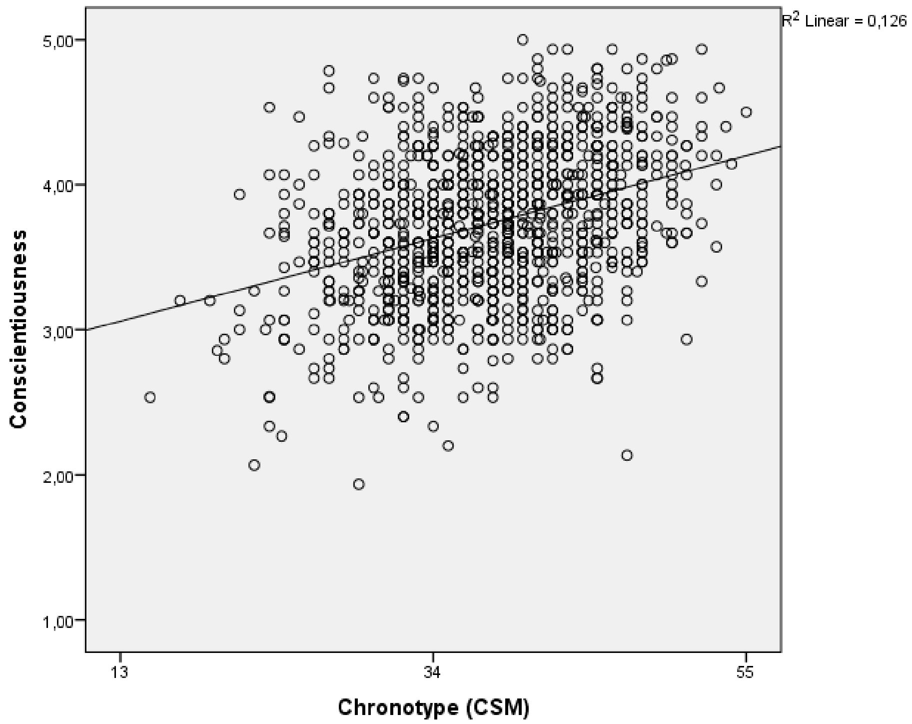


Fig. 35: Scatter plot of chronotype and conscientiousness.

3.2.3. Bivariate analyses of midpoint of sleep, other sleep variables, intelligence, achievement, motivation and conscientiousness

3.2.3.1. Midpoint of sleep

3.2.3.2. Other sleep variables (sleep-wake, sleep duration, social jetlag and napping)

The results showed that there were significant correlations between all sleep variables and mid-sleep (MSFsc), except average sleep length (Table 47).

Table 47: Partial correlation of mid-sleep and sleep variables.

	Mid-sleep on school days		Mid-sleep on free days		Mid-sleep (MSFsc)	
	r	*p*	*r*	*p*	*r*	*p*
Rise time on school days	0.562	<0.001	0.132	<0.001	0.167	<0.001
Rise time on free days	0.188	<0.001	0.825	<0.001	0.778	<0.001
Bedtime on school days	0.861	<0.001	0.354	<0.001	0.318	<0.001
Bedtime on free days	0.398	<0.001	0.751	<0.001	0.687	<0.001
Sleep length on school days	-0.452	<0.001	-0.239	<0.001	-0.189	<0.001
Sleep length on free days	-0.134	<0.001	0.159	<0.001	0.166	<0.001
Average sleep length	-0.390	<0.001	-0.082	0.007	-0.043	0.160
Social jetlag	-0.075	0.015	0.903	<0.001	0.835	<0.001
Nap	-0.013	0.678	0.079	0.010	0.072	0.020

3.2.3.3. Intelligence

There were significant negative correlations between intelligence with mid-sleep (MSFsc) [r = -0.130, p < 0.001]. Therefore students with later midpoint of sleep scored lower in intelligence (Table 48 and Fig. 36).

Table 48: Partial correlation of intelligence with mid-sleep.

	Intelligence	
	r	*p*
Mid-sleep on school days	-0.270	0.373
Mid-sleep on free days	-0.146	<0.001
Mid-sleep (MSFsc)	-0.130	<0.001

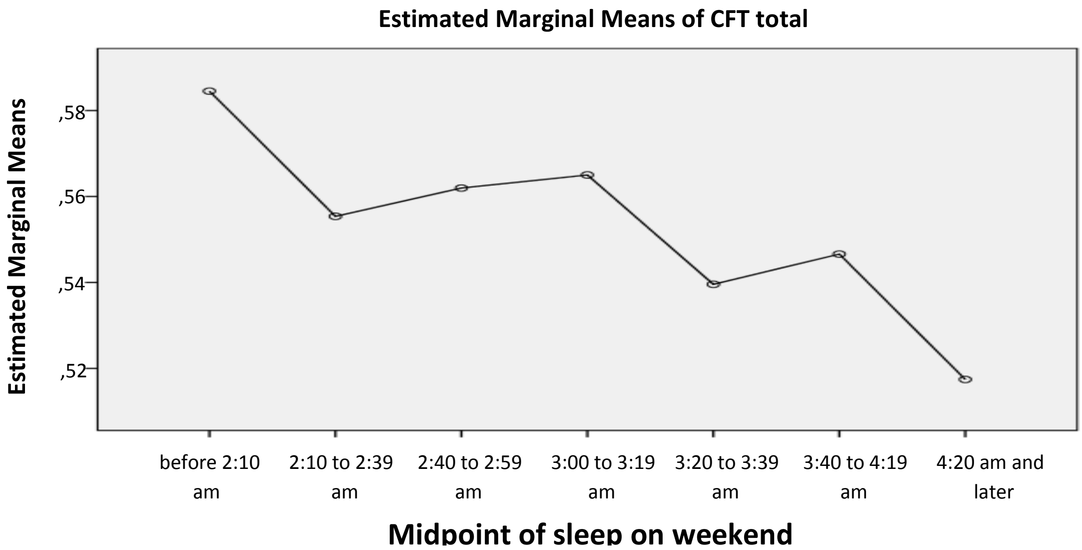


Fig. 36: General linear model (GLM) of midpoint of sleep on weekend and intelligence.

3.2.3.4. Achievement

We used a partial correlation controlling for age and gender. The results showed that there were significant negative correlations between four major subjects and mid-sleeps (Table 49); thus higher mid-sleep associated with worse grades.

Table 49: Partial correlation between mid-sleep and achievement.

Achievement	Math		German		English		Science & culture		Average grades	
	r	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*
Mid-sleep on school days	-0.084	0.009	-0.080	0.013	-0.089	0.006	-0.139	<0.001	-0.107	0.001
Mid-sleep on free days	-0.178	<0.001	-0.165	<0.001	-0.130	<0.001	-0.185	<0.001	-0.196	<0.001
Mid-sleep (MSFsc)	-0.169	<0.001	-0.136	<0.001	-0.114	<0.001	-0.150	<0.001	-0.172	<0.001

3.2.3.5. Motivation

There were negatively significant relationship between learning objectives and mid-sleep (MSFsc) but there was positive relationship with approach performance objectives, avoidance performance objective and work avoidance; indicating that learning objectives were associated with shorter mid-sleep (see Table 50).

Table 50: Partial correlation of mid-sleep with motivation.

Motivation	Learning objectives		Approach performance objectives		Avoidance performance objectives		Work avoidance	
	r	*P*	*r*	*p*	*r*	*p*	*r*	*p*
Mid-sleep on school days	-0.056	0.065	0.036	0.238	0.048	0.115	0.033	0.278
Mid-sleep on free days	-0.093	0.002	0.107	<0.001	0.131	<0.001	0.119	<0.001
Mid-sleep (MSFsc)	-0.075	0.014	0.090	0.003	0.114	<0.001	0.102	0.001

3.2.3.6. Conscientiousness

Table 51 shows that conscientiousness was negatively related with mid-sleep on school and free days (Respectively: r = -0.065, p = 0.034; r = -0.083, p = 0.006) [see also Figs. 37 and 38].

Table 51: Partial correlation of conscientiousness with mid-sleep.

	Conscientiousness	
	r	*p*
Mid-sleep on school days	-0.065	0.034
Mid-sleep on free days	-0.083	0.006
Mid-sleep (MSFsc)	-0.057	0.059

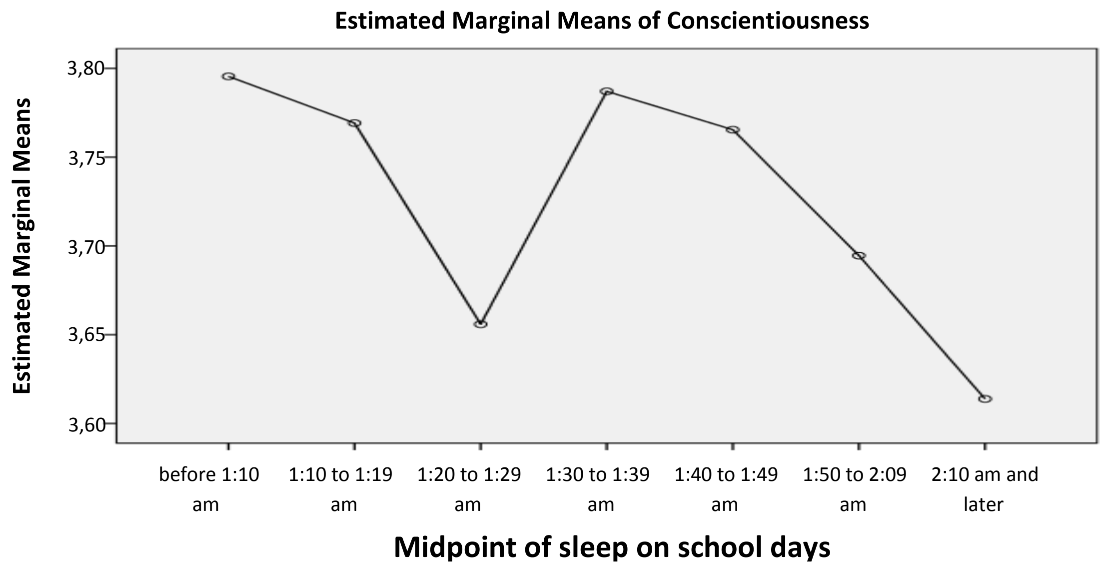


Fig. 37: General linear model (GLM) of midpoint of sleep on school days and conscientiousness.

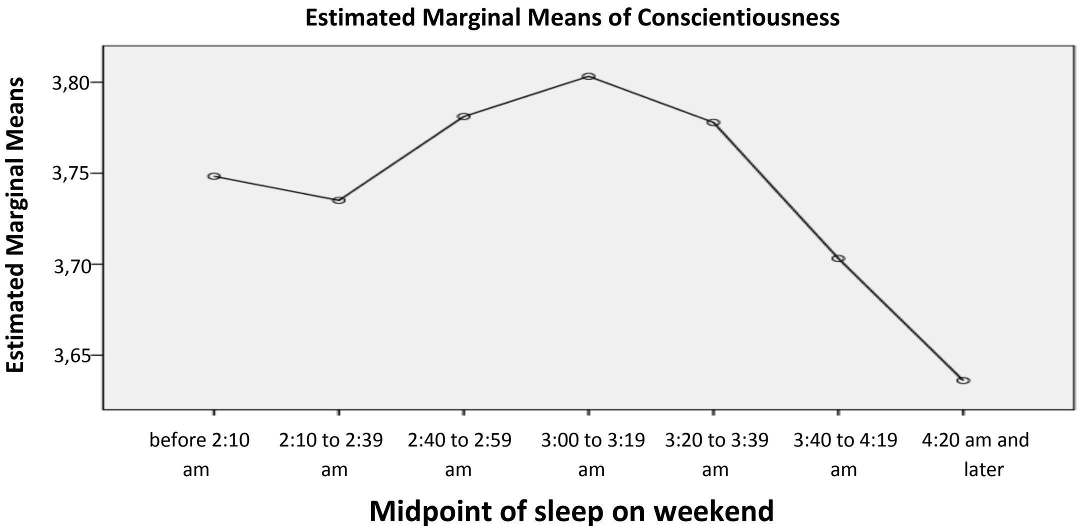


Fig. 38: General linear model (GLM) of midpoint of sleep on weekend and conscientiousness.

3.2.4. Bivariate analyses of other sleep variables, intelligence, achievement, motivation and conscientiousness

3.2.4.1. Other sleep variables (sleep-wake, sleep duration, social jetlag and napping)

The results showed that there were significant correlations between average sleep length and social jetlag [*r* = 0.097, *p* = 0.002] and there were negatively significant relationship only between sleep duration on school days and nap [*r* = -0.075, *p* = 0.014] (Table 52).

Table 52: Partial correlation of sleep duration with nap and social jetlag.

	sleep duration on school days		sleep duration on free days		Average sleep duration	
	r	*p*	*r*	*p*	*r*	*p*
Nap	-0.075	0.014	0.020	0.506	-0.042	0.173
Social jetlag	-0.043	0.162	0.235	<0.001	0.097	0.002

3.2.4.2. Intelligence

The analyses of correlations between intelligence and sleep showed a significant negative correlations between intelligence with social jetlag (r = -0.147, p < 0.001), rise time and bed time in free days. Therefore students with social jetlag scored lower in intelligence (see Table 53 and Fig. 39).

Table 53: Partial correlation of intelligence with sleep variables.

	Intelligence	
	r	*p*
Rise time on school days	-0.052	0.092
Rise time on free days	-0.061	0.046
Bedtime on school days	-0.048	0.114
Bedtime on free days	-0.071	0.020
Sleep length on school days	-0.040	0.189
Sleep length on free days	-0.034	0.259
Average sleep length	-0.047	0.124
Social-jetlag	-0.147	<0.001
Nap	-0.048	0.114

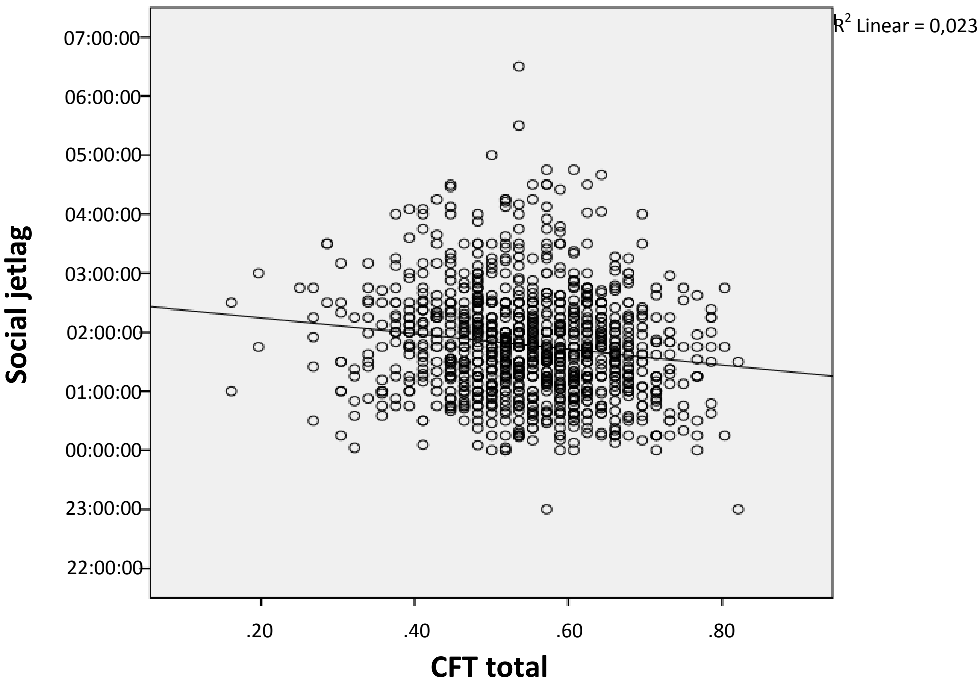


Fig. 39: Scatter plot of intelligence and social jetlag.

3.2.4.3. Achievement

We used a partial correlation controlling for age and gender. The results showed that there was a higher correlation between grades and sleep behaviour. Negative correlations were found between four major subjects with get up times, bed time free days and social jetlag (Table 54 and Fig. 40). Thus, earlier sleep behaviour and lower social jetlag may be predictive of higher grades. Correlation between grade of science and culture and napping were negative but it was not significant between math, German and English with napping. No significant correlations found between grades and sleep length (see Table 54).

Table 54: Partial correlation between sleep variables and achievement.

	Math		German		Science & culture		English		Gradings (total)	
	r	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*
Rise time on school days	-0.081	0.013	-0.75	0.022	-0.102	0.002	-0.063	0.054	-0.104	0.001
Rise time on free days	-0.160	<0.001	-0.100	0.002	-0.118	<0.001	-0.113	0.001	-0.163	<0.001
Bedtime on school days	-0.064	0.050	-0.051	0.119	-0.103	0.002	-0.078	0.016	-0.095	0.004
Bedtime on free days	-0.114	<0.001	-0.159	<0.001	-0.176	<0.001	-0.092	0.005	-0.176	<0.001
Sleep length on school days	0.013	0.695	0.005	0.889	0.036	0.277	0.035	0.284	0.027	0.407
Sleep length on free days	-0.058	0.076	0.028	0.393	0.024	0.457	-0.033	0.316	-0.015	0.642
Average sleep duration	-0.023	0.489	0.018	0.572	0.038	0.242	0.007	0.836	0.011	0.742
Social jetlag	-0.145	<0.001	-0.135	<0.001	-0.132	<0.001	-0.095	0.003	-0.167	<0.001
Nap	-0.061	0.060	-0.038	0.246	-0.076	0.020	-0.038	0.240	-0.069	0.034

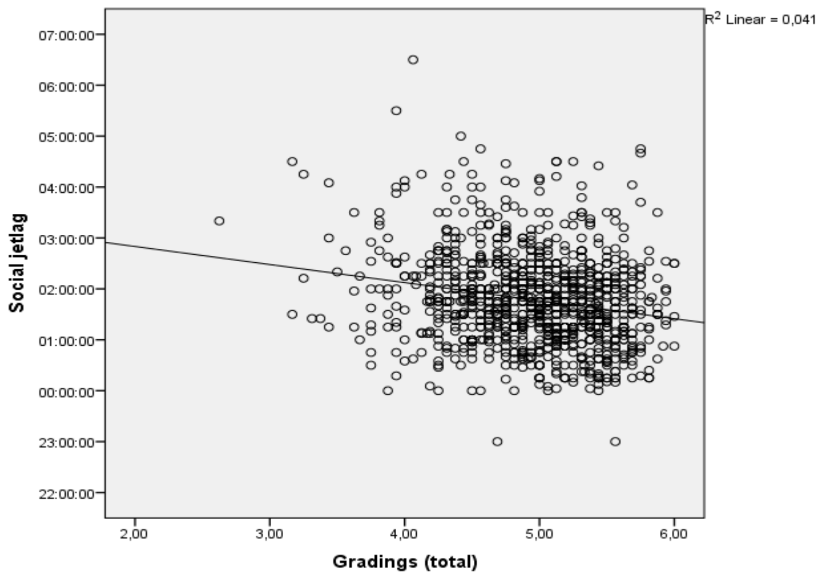


Fig. 40: Scatter plot of gradings (total) and social jetlag.

3.2.4.4. Motivation

There were negatively significant relationship between learning objectives and get and bed time in free days and social jetlag but there was positive relationship with approach performance objectives, avoidance performance objective and work avoidance; indicating that learning objectives were associated with shorter social jetlag (see Table 55).

Table 55: Partial correlation of motivation with sleep habits.

Motivation	Learning objectives		Approach performance objectives		Avoidance performance objectives		Work avoidance	
	r	*P*	*r*	*p*	*r*	*p*	*r*	*p*
Rise time on school days	-0.043	0.159	<0.001	0.993	-0.012	0.685	0.001	0.975
Rise time on free days	-0.061	0.046	0.076	0.012	0.096	0.002	0.094	0.002
Bed time on school days	-0.040	0.178	0.044	0.150	0.066	0.030	0.040	0.189
Bed time on free days	-0.088	0.004	0.095	0.002	0.112	<0.001	0.095	0.002
Sleep length on school days	0.012	0.692	-0.038	0.208	-0.064	0.034	0.149	<0.001
Sleep length on free days	0.012	0.704	-0.003	0.910	0.001	0.965	0.012	0.689
Average sleep length	0.017	0.588	-0.029	0.343	-0.045	0.144	-0.017	0.581
Social jetlag	-0.071	0.019	0.098	0.001	0.118	<0.001	0.114	<0.001
Nap	0.012	0.685	-0.045	0.145	-0.040	0.195	-0.052	0.087

3.2.4.5. Conscientiousness

There were negatively significant relationship between conscientiousness and get and bed times in free days [r = -0.062, p = 0.045 vs. r = -0.071, p = 0.021] (Table 56).

Table 56: Partial correlation of conscientiousness with sleep variables.

	Conscientiousness	
	r	*p*
Rise time on school days	-0.051	0.098
Rise time on free days	-0.062	0.045
Bedtime on school days	-0.056	0.071
Bedtime on free days	-0.071	0.021
Sleep length on school days	0.021	0.498
Sleep length on free days	-0.001	0.971
Average sleep duration	0.014	0.649
Social jetlag	-0.056	0.067
Nap	0.038	0.215

3.2.5. Bivariate analyses of intelligence, achievement, motivation and conscientiousness

3.2.5.1. Intelligence

3.2.5.2. Achievement

Higher intelligence associated with better grades (Table 57). Strong positive correlations were between cognitive variables and academic performance [r = 0.369, p < 0.001] (Table 58 and Fig. 41).

Table 57: Distribution of grades and intelligence.

Grades	Up to 4		4.25 to 4.50		4.75 to 5		5.25 to 5.50		5.75 to 6		Total	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Intelligence (CFT Total)	0.48	0.08	0.50	0.11	0.53	0.09	0.57	0.09	0.62	0.093	0.55	0.103

Table 58: Partial correlation between intelligence and achievement.

Achievement	Math		German		Science & culture		English		Gradings (total)	
	r	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*
CFT series	0.315	<0.001	0.158	<0.001	0.194	<0.001	0.231	<0.001	0.306	<0.001
CFT classification	0.196	<0.001	0.092	0.004	0.101	0.002	0.134	<0.001	0.183	<0.001
CFT matrices	0.333	<0.001	0.199	<0.001	0.192	<0.001	0.159	<0.001	0.302	<0.001
CFT conditions	0.136	<0.001	0.104	0.001	0.125	<0.001	0.134	<0.001	0.171	<0.001
CFT total	0.380	<0.001	0.213	<0.001	0.235	<0.001	0.250	<0.001	0.369	<0.001

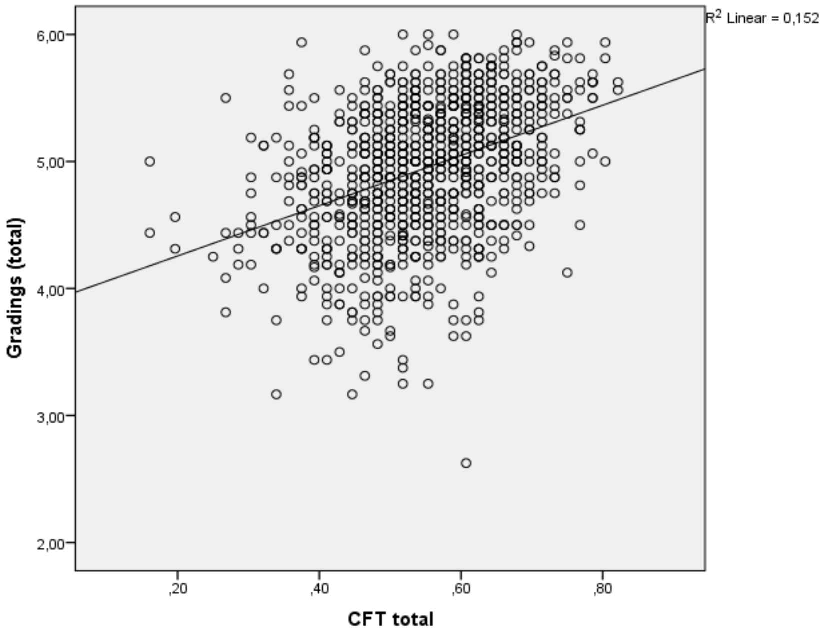


Fig. 41: Scatter plot of gradings (total) and intelligence (CFT total).

3.2.5.3. Motivation

There were positive relationship between learning objective and intelligence and negative relationship between avoidance performance objective and work avoidance with intelligence (see Table 59 and Figs. 42, 43 and 44).

Table 59: Partial correlation between intelligence and motivation.

	CFT Series		CFT Classification		CFT Matrices		CFT Conditions		CFT Total	
Motivation	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*
Learning objectives	0.090	0.003	0.045	0.138	0.097	0.001	0.040	0.179	0.105	<0.001
Approach performance objectives	0.024	0.068	-0.003	0.919	-0.087	0.004	0.019	0.552	-0.058	0.052
Avoidance performance objectives	-0.120	<0.001	-0.008	0.802	-0.145	<0.001	-0.037	0.220	-0.122	<0.001
Work avoidance	-0.149	<0.001	-0.035	0.850	-0.131	<0.001	-0.036	0.236	-0.137	<0.001

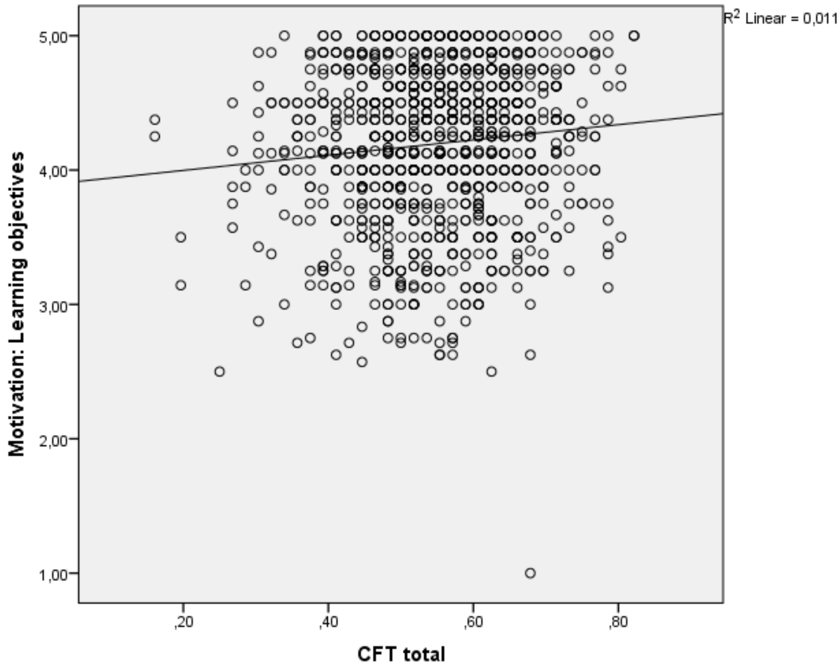


Fig. 42: Scatter plot of intelligence (CFT total) and learning objectives.

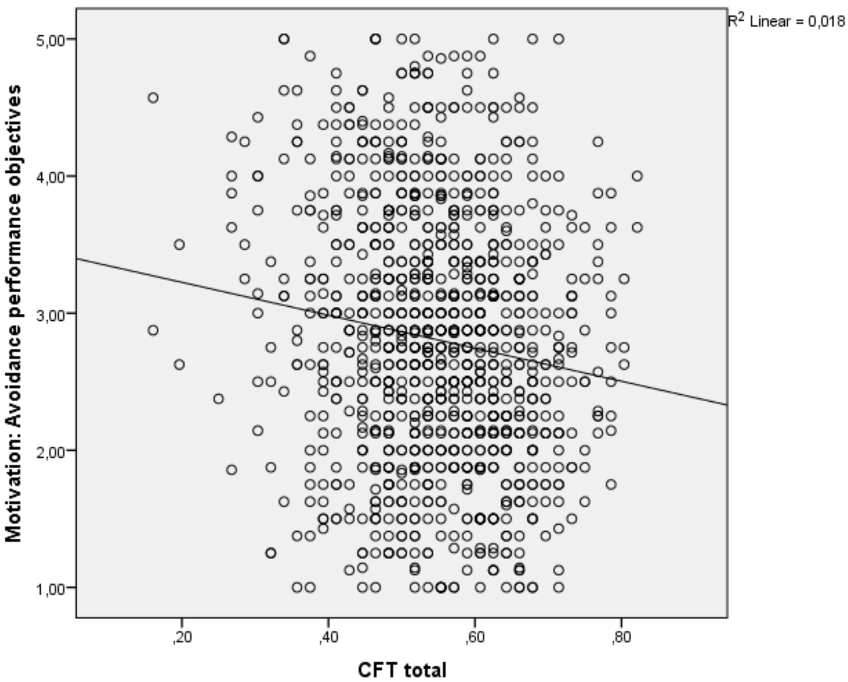


Fig. 43: Scatter plot of intelligence (CFT total) and avoidance performance objectives.

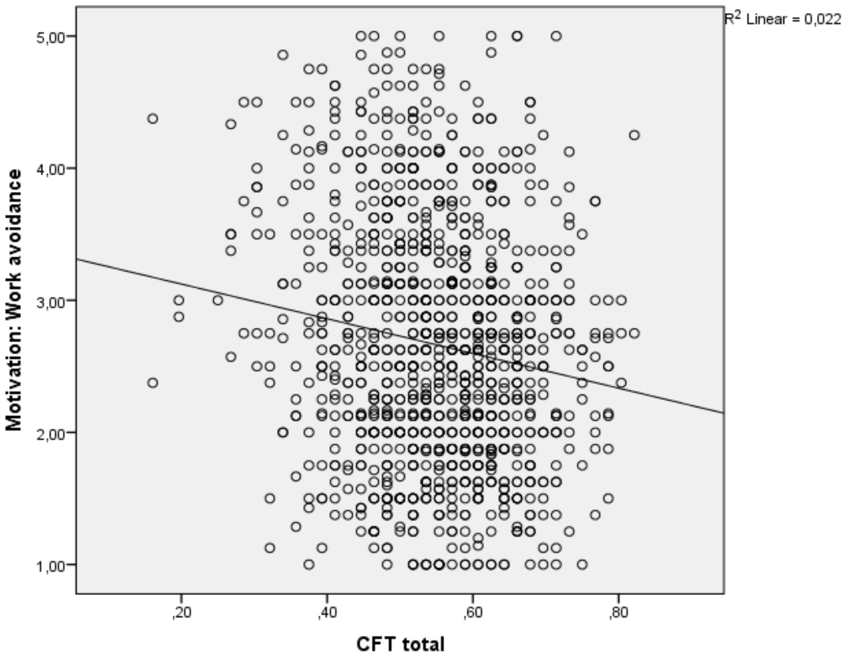


Fig. 44: Scatter plot of intelligence (CFT total) and work avoidance.

3.2.5.4. Conscientiousness

Higher intelligence scores were positively related to higher conscientiousness. With controlling for the effects of age and gender, there was a positive association between intelligence and conscientiousness [r = 0.129, p < 0.001] (Table 60 and Fig. 45).

Table 60: Partial correlation between intelligence and conscientiousness.

	Conscientiousness	
Intelligence	*r*	*p*
CFT series	0.087	0.004
CFT classification	0.079	0.008
CFT matrices	0.094	0.002
CFT conditions	0.083	0.006
CFT total	0.129	<0.001

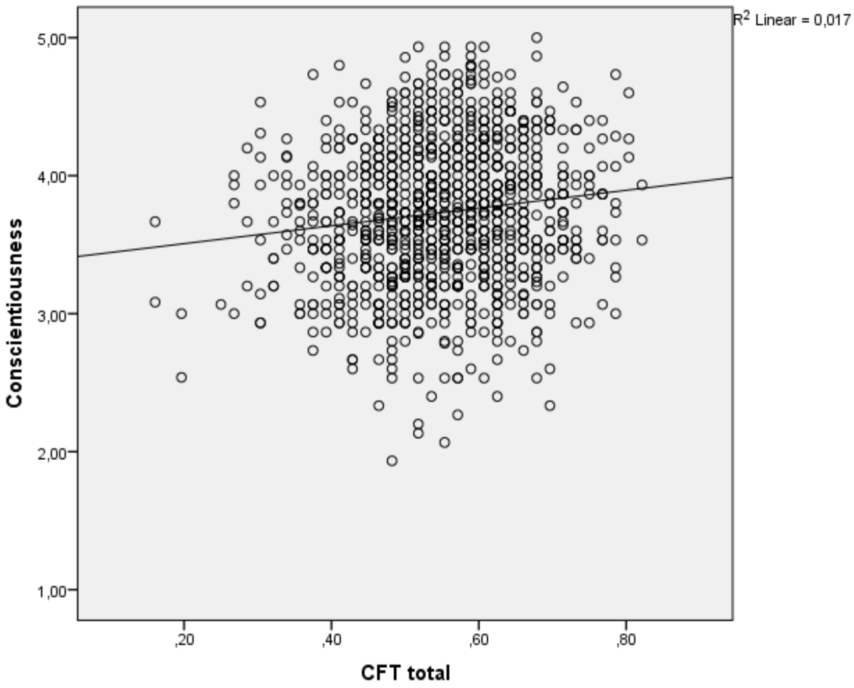


Fig. 45: Scatter plot of intelligence (CFT total) and conscientiousness.

3.2.6. Bivariate analyses of achievement, motivation and conscientiousness

3.2.6.1. Achievement

3.2.6.2. Motivation

The mean scores in learning objectives were higher than approach performance objectives, avoidance performance objectives and work avoidance [M = 4.19, SD = 0.57; M = 3.04, SD = 0.78; M = 2.80, SD = 0.92; M = 2.66, SD = 0.93, respectively] (Table 61).

Good grades positively related with learning objectives and negatively related with avoidance performance objectives and work avoidance but there was not any relationship in approach performance objectives with English and science & culture (see Table 62 and Fig. 46).

Table 61: Distribution of grades and motivation.

	Up to 4		4.25 to 4.50		4.75 to 5		5.25 to 5.50		5.75 to 6		Total	
Motivation	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Learning objectives	3.93	0.63	4.05	0.60	4.14	0.57	4.26	0.54	4.42	0.50	4.19	0.57
Approach performance objectives	3.46	0.79	3.56	0.74	3.42	0.75	3.40	0.78	3.28	0.88	3.04	0.78
Avoidance performance objectives	3.24	0.96	3.15	0.90	2.92	0.92	2.60	0.88	2.47	0.78	2.80	0.92
Work avoidance	3.05	0.96	3.03	0.94	2.74	0.91	2.54	0.89	2.18	0.78	2.66	0.93

Table 62: Partial correlation between motivation and grades.

	Math		German		Science & culture		English		Gradings (total)	
Motivation	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*
Learning objectives	0.131	<0.001	0.199	<0.001	0.175	<0.001	0.18	<0.001	0.222	<0.001
Approach performance objectives	-0.100	0.002	-0.082	0.010	-0.047	0.145	-0.026	0.411	-0.087	0.006
Avoidance performance objectives	-0.246	<0.001	-0.197	<0.001	-0.205	<0.001	-0.14	<0.001	-0.261	<0.001
Work avoidance	-0.224	<0.001	-0.217	<0.001	-0.186	<0.001	-0.169	<0.001	-0.263	<0.001

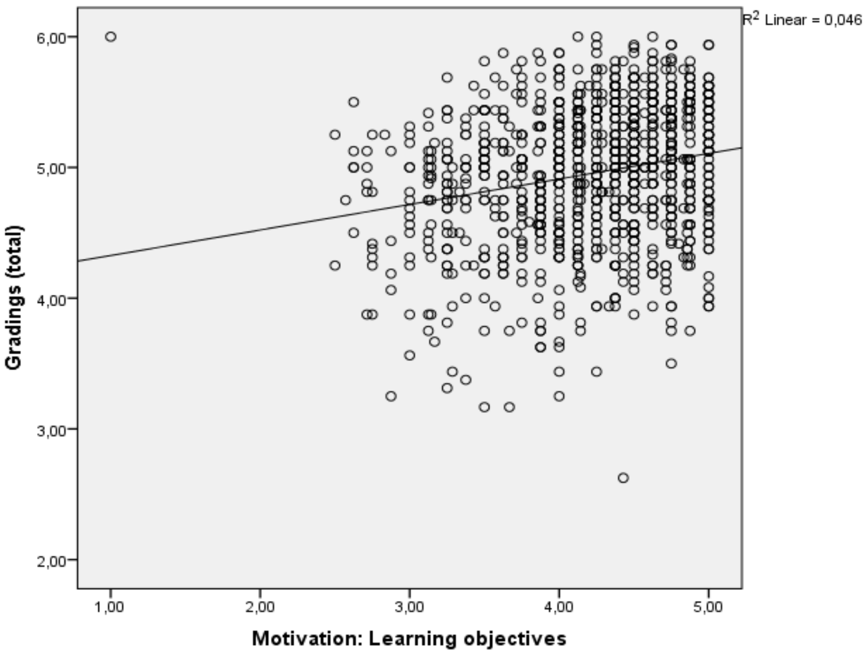


Fig. 46: Scatter plot of gradings and learning objectives.

3.2.6.3. Conscientiousness

Higher conscientiousness associated with better grades (Table 63). A series of bivariate and partial correlations used on the data in order to test the relationship between conscientiousness and academic achievement. Correlation coefficients have shown in Table 64; it indicates that conscientiousness was positively related to better grades (Fig. 47).

Table 63: Distribution of grades with conscientiousness.

Grades	Up to 4		4.25 to 4.50		4.75 to 5		5.25 to 5.50		5.75 to 6		Total	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Conscientiousness	3.46	0.56	3.53	0.44	0.36	0.04	3.86	0.47	4.13	0.45	3.73	0.51

Table 64: Partial and bivariate correlation of conscientiousness and grades.

Grades	Math	German	English	Science & culture	Average gradings
	sig.	sig.	sig.	sig.	sig.
Conscientiousness	<0.001	<0.001	<0.001	<0.001	<0.001

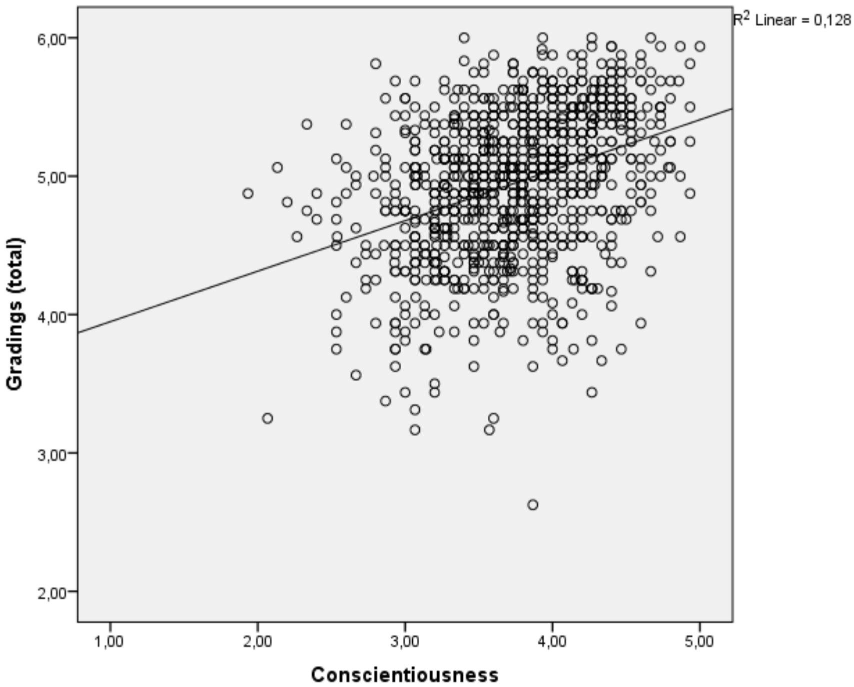


Fig. 47: Scatter plot of gradings and conscientiousness.

A multivariate general linear model used for achievement as the dependent variable with conscientiousness, intelligence, mid-sleep (MSFsc), chronotype, motivation and age as independent variables (Table 65).

Conscientiousness, intelligence, mid-sleep (MSFsc), age, learning objective, avoidance performance objective and gender had a significant effect on grades (Table 65), but not chronotype, approach performance objectives and work avoidance.

Table 65 shows that older pupils were associated with worse grades than younger pupils, F = 8.257, p = < 0.001, Partial η^2 = 0.034.

Gender had higher effect on math, F = 25.815, p = < 0.001, Partial η^2 = 0.026 (Table 65).

The independent variables altogether account for 26.7 % of variance in mathematics, 18.9 % in German, 20.9 % in Science and culture and 16.2 % in English (Table 65).

Table 65: GLM for the four grades by conscientiousness, intelligence, chronotype, mid-sleep (MSFsc), motivation, age and gender.

	Wilks' Λ	F	p	Partial η^2
Conscientiousness	.911	23,187	.000	.089
CFTtotal	.883	31,341	.000	.117
CSM	.996	,883	.473	.004
Mid-sleep (MSFsc)	.978	5,257	.000	.022
Age_years	.966	8,257	.000	.034
Learning objectives	.988	2,949	.019	.012
Approach performance objectives	.997	,602	.661	.003
Avoidance performance objectives	.980	4,920	.001	.020
Work avoidance	.996	,982	.416	.004
Gender	.937	16,039	.000	.063

Tests of Between-Subjects Effects

Source	Dependent variable	F	p	Partial η^2
Conscientiousness	Mathematics	38.224	<0.001	0.039
	German	41.739	<0.001	0.042
	Science & culture	65.009	<0.001	0.064
	English	36.224	<0.001	0.037
CFTtotal	Mathematics	112.838	<0.001	0.106
	German	19.743	<0.001	0.020
	Science & culture	25.424	<0.001	0.026
	English	36.61	<0.001	0.037
CSM	Mathematics	3.055	0.081	0.003
	German	1.116	0.291	0.001
	Science & culture	1.147	0.284	0.001
	English	0.948	0.331	0.001
Mid-sleep (MSFsc)	Mathematics	15.006	<0.001	0.016
	German	7.998	0.005	0.008
	Science & culture	11.315	0.001	0.012
	English	5.252	0.022	0.005
Age_years	Mathematics	21.257	<0.001	0.022
	German	19.133	<0.001	0.020
	Science & culture	12.838	<0.001	0.013
	English	12.033	0.001	0.012

Source	Dependent variable	F	*p*	Partial η^2
Learning objectives	Mathematics	0.278	0.598	000
	German	9.172	0.003	0.01
	Science & culture	2.812	0.094	0.003
	English	4.818	0.028	0.005
Approach performance objectives	Mathematics	0.099	0.754	000
	German	1.224	0.269	0.001
	Science & culture	0.138	0.710	000
	English	0.012	0.912	000
Avoidance performance objectives	Mathematics	14.048	<0.001	0.015
	German	3.391	0.066	0.004
	Science & culture	11.6	0.001	0.012
	English	1.438	0.231	0.002
Work avoidance	Mathematics	1.09	0.297	0.001
	German	2.61	0.107	0.003
	Science & culture	0.072	0.788	000
	English	1.98	0.160	0.002
Gender	Mathematics	25.815	<0.001	0.026
	German	5.414	0.020	0.006
	Science & culture	9.519	0.002	0.01
	English	3.477	0.063	0.004

Mathematics	Adjusted R^2 = .267
German	Adjusted R^2 = .189
Science & culture	Adjusted R^2 = .209
English	Adjusted R^2 = .162

3.2.7. Bivariate analyses of motivation and conscientiousness

3.2.7.1. Motivation

There were positive relationship between learning objective and approach performance objectives with conscientiousness but there were negative relationship between avoidance performance objective and work avoidance with conscientiousness (Table 66 and Fig. 48).

Table 66: Partial correlation between motivation and conscientiousness.

	Conscientiousness	
Motivation	*r*	*p*
Learning objectives	0.329	<0.001
Approach performance objectives	0.139	<0.001
Avoidance performance objectives	-0.101	0.001
Work avoidance	-0.170	<0.001

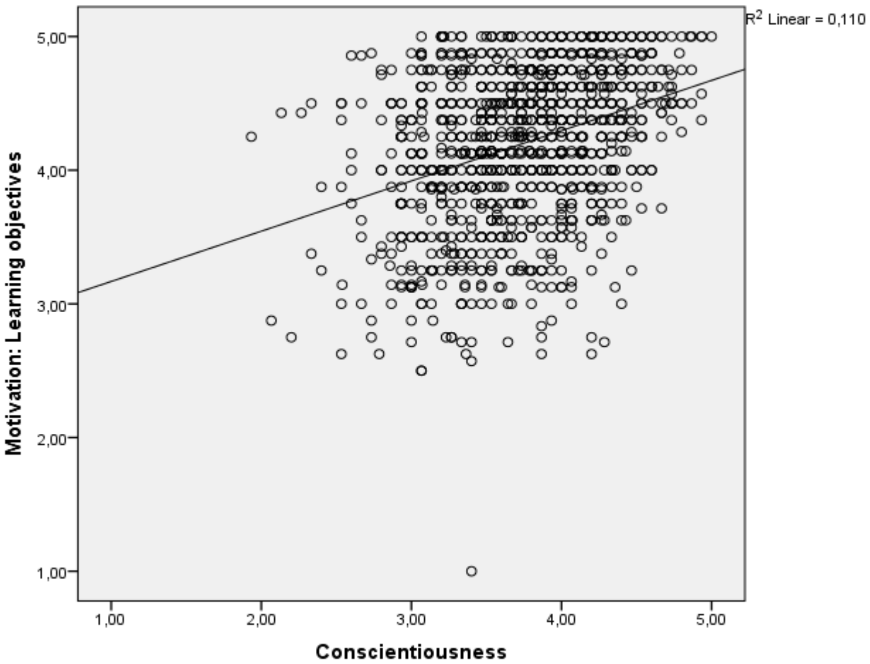


Fig. 48: Scatter plot of learning objectives and conscientiousness.

In the linear model, motivation was used as a dependent variable with four aspects and conscientiousness, intelligence, mid-sleep (MSFsc), chronotype, age and gender as independent variables. Gender and chronotype had no significant effect on motivation (Table 67).

The independent variables altogether account for 11.5% of variance in learning objective, 03.9% of variance in approach performance objectives, 04.4% in avoidance performance objectives and 06.7% in work avoidance (Table 67).

Table 67: GLM for the four motivational variables by conscientiousness, intelligence, chronotype, mid-sleep (MSFsc), age and gender.

	Wilks' Λ	F	*p*	Partial η^2
Conscientiousness	0.879	36,695	<0.001	0.121
Intelligence (CFTtotal)	0.980	5,526	<0.001	0.020
Chronotype (CSM)	0.995	1,339	0.253	0.005
Mid-sleep (MSFsc)	0.987	3,547	0.007	0.013
Age (years)	0.989	2,947	0.019	0.011
Gender	0.992	2,231	0.064	0.008

Tests of Between-Subjects Effects

Source	Dependent variable	F	*p*	Partial η^2
Conscientiousness	Learning objectives	103.264	<0.001	0.088
	Approach performance objectives	20.884	<0.001	0.019
	Avoidance performance objectives	5.409	0.020	0.005
	Work avoidance	19.052	<0.001	0.017
Intelligence (CFTtotal)	Learning objectives	5.046	0.025	0.005
	Approach performance objectives	5.617	0.018	0.005
	Avoidance performance objectives	12.409	<0.001	0.011
	Work avoidance	15.038	<0.001	0.014
Chronotype (CSM)	Learning objectives	0.277	0.599	0.000
	Approach performance objectives	0.421	0.517	0.000
	Avoidance performance objectives	1.109	0.293	0.001
	Work avoidance	2.152	0.143	0.002
Mid-sleep (MSFsc)	Learning objectives	1.628	0.202	0.002
	Approach performance objectives	9.453	0.002	0.009
	Avoidance performance objectives	6.826	0.009	0.006
	Work avoidance	3.828	0.051	0.004
Age_years	Learning objectives	0.001	0.971	0.000
	Approach performance objectives	4.152	0.042	0.004
	Avoidance performance objectives	4.56	0.033	0.004
	Work avoidance	11.383	0.001	0.011
Gender	Learning objectives	0.619	0.431	0.001
	Approach performance objectives	5.417	0.020	0.005
	Avoidance performance objectives	4.581	0.033	0.004
	Work avoidance	0.649	0.421	0.001

Learning objectives	Adjusted R^2 = ,115
Approach performance objectives	Adjusted R^2= ,039
Avoidance performance objectives	Adjusted R^2= ,044
Work avoidance	Adjusted R^2= ,067

3.2.8. Bivariate analyses of conscientiousness

Conscientiousness had a significant effect on all dependent variables, except age. Therefore, girls, morningness, higher intelligence and earlier mid-sleep were associated with higher conscientiousness. The independent variables altogether account for 14.9 % of variance in conscientiousness (Table 68).

Table 68: GLM for the conscientiousness by intelligence, chronotype, mid-sleep (MSFsc), age and gender.

Dependent variable	Tests of Between-Subjects Effects		
Source	F	*P*	Partial η^2
CFTtotal	16.217	.000	.015
MSFsc	7.288	.007	.007
CSM	155.783	.000	.127
Age_years	1.258	.262	.001
Gender	7.742	.005	.007

Adjusted R^2= .149

3.3. Regression analysis

3.3.1. Regression for age by gender

3.3.1.2. Chronotype

Chronotype was not related with age and gender (*ß* = -0.010, *p* = 0.734).

3.3.1.3. Mid-sleep

Regression analysis showed that there were significant influences of age and gender with mid-sleep. Older children and girls associated with more mid-sleep (Table 69).

Table 69: Standardized beta regression coefficients of age and gender with mid-sleep.

	Mid-sleep on school days		Mid-sleep on free days		Mid-sleep (MSFsc)	
	ß	*P*	*ß*	*P*	*ß*	*P*
Age	0.116	<0.001	0.178	<0.001	0.142	<0.001
Gender	0.049	0.100	-0.079	0.005	-0.093	0.001

3.3.1.4. Other sleep variables (sleep-wake, sleep duration, social jetlag and napping)

There were no significant differences in bedtimes by gender and rise time on school days with age (see Table 70) but there were significant differences in sleep length by age [*ß* = -0.141, *p* = < 0.001]; also there were significant differences between gender and sleep length on free days [*ß* = -0.137, *p* = < 0.001] (see Table 71). Regression analysis indicated that there were significant influences of age and gender with social jetlag. Older children and girls associated with higher social jetlag (Table 72).

Table 70: Standardized beta regression coefficients of age and gender with sleep-wake variables.

	Rise time on school days		Rise time on free days		Bedtime on school days		Bedtime on free days	
	ß	*P*	*ß*	*P*	*ß*	*P*	*ß*	*P*
Age	-0.011	0.717	0.085	0.003	0.140	<0.001	0.204	<0.001
Gender	0.069	0.019	-0.134	<0.001	0.012	0.678	0.024	0.040

Table 71: Standardized beta regression coefficients of age and gender with sleep length.

	Sleep length on school days		Sleep length on free days		Average sleep length	
	ß	*P*	*ß*	*P*	*ß*	*P*
Age	-0.132	<0.001	-0.074	0.013	-0.141	<0.001
Gender	0.026	0.380	-0.137	<0.001	-0.053	0.081

Table 72: Standardized beta regression coefficients of age and gender with social jetlag and nap.

	Social jetlag		Nap	
	ß	*P*	*ß*	*P*
Age	0.131	<0.001	0.014	0.639
Gender	-0.108	<0.001	-0.028	0.354

3.3.1.5. Intelligence

Intelligence did not differ between girls and boys but showed significant differences with age ($ß$ = -0.117, p < 0.001, R^2= 0.016). Younger people were more intelligence (Table 73).

Table 73: Standardized beta regression coefficients of age and gender with intelligence.

	Intelligence	
	ß	*p*
Age	-0.117	<0.001
Gender	-0.023	0.448
R^2	0.016	

3.3.1.6. Achievement

Regression linear reported a high significant correlation between grade averages with age groups ($ß$ = -0.261, P = < 0.001). Gender had significant influence on four main subjects but there were no significant difference between gender and grading total (Table 74).

Table 74: Standardized beta regression coefficients of age and gender with gradings.

	Math		German		English		Science & culture		Gradings (total)	
	ß	*p*	*ß*	*p*	*ß*	*p*	*ß*	*p*	*ß*	*p*
Age	-0.219	<0.001	-0.208	<0.001	-0.167	<0.001	-0.176	<0.001	-0.261	<0.001
Gender	0.112	<0.001	-0.089	0.004	-0.083	<0.001	-0.119	<0.001	-0.044	0.149
R^2	0.056		0.052		0.035		0.047		0.07	

3.3.1.7. Motivation

There was a significant multiple linear regressions of approach performance objectives, avoidance performance objectives, work avoidance and age, whereas only there was significant on avoidance performance objectives and gender (Table 75).

Table 75: Standardized beta regression coefficients of age and gender with motivation.

Motivation	Learning objectives		Approach performance objectives		Avoidance performance objectives		Work avoidance	
	ß	*p*	*ß*	*p*	*ß*	*p*	*ß*	*p*
Age	-0.020	0.512	0.090	0.003	0.101	0.001	0.138	<0.001
Gender	-0.051	0.086	0.051	0.089	0.066	0.028	0.031	0.299
R^2	0.023		0.010		0.023		0.034	

3.3.1.8. Conscientiousness

There was significant multiple linear regressions of conscientiousness and gender [*ß* = -0.098, $p < 0.001$], whereas there was no significant difference on conscientiousness and age (Table 76).

Table 76: Standardized beta regression coefficients of age and gender with conscientiousness.

	Conscientiousness	
	ß	*p*
Age	-0.032	0.250
Gender	-0.098	<0.001
R^2	0.134	

3.3.2. Regression for chronotype

3.3.2.1. Mid-sleep

Regression linear showed that there were significant influences of CSM scores with mid-sleep (Table 77); evening types showed later times of mid-sleep.

Table 77: Standardized beta regression coefficients of chronotype with mid-sleep.

	Mid-sleep on school days		Mid-sleep on free days		Mid-sleep (MSFsc)	
	ß	*P*	*ß*	*P*	*ß*	*P*
Chronotype (CSM)	-0.180	<0.001	-0.359	<0.001	-0.326	<0.001

3.3.2.2. Other sleep variables (sleep-wake, sleep duration, social jetlag and napping)

There was a significant multiple linear regressions of rise time and bed time on school and free days with chronotype (Table 78). Regression linear indicated that there were significant influences of chronotype and average sleep length [$ß$ = -0.072, p = 0.016] (Table 79). Later chronotype associated with higher sleep length and social jetlag (Tables 79 and 80).

Table 78: Standardized beta regression coefficients of chronotype with sleep-wake variables.

	Rise time on school days		Rise time on free days		Bedtime on school days		Bedtime on free days	
	ß	*P*	*ß*	*P*	*ß*	*P*	*ß*	*P*
Chronotype (CSM)	-0.177	<0.001	-0.333	<0.001	-0.106	<0.001	-0.234	<0.001

Table 79: Standardized beta regression coefficients of chronotype with sleep length.

	Sleep length on school days		Sleep length on free days		Average sleep length	
	ß	*P*	*ß*	*P*	*ß*	*P*
Chronotype (CSM)	-0.002	0.947	-0.117	<0.001	-0.072	0.016

Table 80: Standardized beta regression coefficients of chronotype with social jetlag and nap.

	Social jetlag		Nap	
	ß	*P*	*ß*	*P*
Chronotype (CSM)	-0.306	<0.001	-0.014	0.646

3.3.2.3. Intelligence

There were significant differences with intelligence and chronotype [*ß* = 0.061, *p* = 0.042] (Table 81).

Table 81: Standardized beta regression coefficients of chronotype with intelligence.

	Intelligence		
	ß	*p*	R^2
Chronotype (CSM)	0.061	0.042	0.016

3.3.2.4. Achievement

Regression linear reported a reached significant correlation between grade averages with CSM scores [*ß* = 0.129, *P* < 0.001] (Table 82).

Table 82: Standardized beta regression coefficients of chronotype with gradings.

	Math		German		English		Science & culture		Average gradings	
	ß	*p*	*ß*	*p*	*ß*	*p*	*ß*	*p*	*ß*	*p*
Chronotype (CSM)	0.105	0.001	0.109	<0.001	0.105	0.001	0.118	<0.001	0.129	<0.001
R^2	0.010		0.011		0.010		0.013		0.016	

3.3.2.5. Motivation

There was a significant multiple linear regressions of learning objectives, avoidance performance objectives, work avoidance and chronotype (Table 83).

Table 83: Standardized beta regression coefficients of chronotype and motivation.

	Learning objectives		Approach performance objectives		Avoidance performance objectives		Work avoidance	
	ß	*p*	*ß*	*p*	*ß*	*p*	*ß*	*p*
Chronotype (CSM)	0.149	<0.001	0.040	0.183	-0.096	0.001	-0.124	<0.001
R^2	0.023		0.010		0.023		0.034	

3.3.2.6. Conscientiousness

There was significant multiple linear regressions of conscientiousness and chronotype [$ß$ = 0.351, $p < 0.001$] (Table 84).

Table 84: Standardized beta regression coefficients of chronotype and conscientiousness.

	Conscientiousness		
	ß	*p*	R^2
Chronotype (CSM)	0.351	<0.001	0.134

3.3.3. Regression for mid-sleep

3.3.3.1. Intelligence

Regression linear showed a relationship between intelligence and mid-sleep on free days and mid-sleep (MSFsc). Thus, Pupils with higher mid-sleep showed lower scores in intelligence (Table 85).

Table 85: Standardized beta regression coefficients of mid-sleep and intelligence.

	Mid-sleep on school days		Mid-sleep on free days		Mid-sleep (MSFsc)	
	ß	*P*	*ß*	*P*	*ß*	*P*
Intelligence	-0.035	0.248	-0.159	<0.001	-0.140	<0.001
R^2	0.000		0.024		0.019	

3.3.3.2. Achievement

There were no significant multiple linear regressions of mid-sleep (MSFsc) and gradings (Table 86).

Table 86: Standardized beta regression coefficients of mid-sleep and gradings (total).

	Gradings (total)	
	ß	*P*
Mid-sleep on school days	-0.057	0.080
Mid-sleep on free days	-0.292	<0.001
Mid-sleep (MSFsc)	0.075	0.363

3.3.4. Regression for other sleep variables (sleep-wake, sleep duration, social jetlag and napping)

3.3.4.1. Intelligence

The regression linear on inelligence had a significant influence on rise time, bed time on free days and social jetlag. Therefore, higher intelligence associated with lower social jetlag (see Tables 87, 88 and 89).

Table 87: Standardized beta regression coefficients of intelligence and sleep-wake.

	Rise time on school days		Rise time on free days		Bedtime on school days		Bedtime on free days	
	ß	*P*	*ß*	*P*	*ß*	*P*	*ß*	*P*
Intelligence	-0.073	0.015	-0.129	<0.001	0.003	0.927	-0.115	<0.001

Table 88: Standardized beta regression coefficients of intelligence and sleep length.

	Sleep length on school days		Sleep length on free days		Average sleep length	
	ß	*P*	*ß*	*P*	*ß*	*P*
Intelligence	-0.039	0.196	-0.033	0.275	-0.036	0.239

Table 89: Standardized beta regression coefficients of intelligence with social jetlag and nap.

	Social jetlag		Nap	
	ß	*P*	*ß*	*P*
Intelligence	-0.152	<0.001	-0.02	0.503

3.3.4.2. Achievement

Regression linear indicated that there were relation between grading (total) and rise time on school days and free days as well as bedtime on free days and social jetlag [*ß* = -0.072, p = 0.020 vs. *ß* = -0.128, p < 0.001 vs. *ß* = -0.168, p < 0.001 vs. *ß* = -0.174 vs. p < 0.001] (Table 90).

Table 90: Standardized beta regression coefficients of gradings with sleep-wake and social jetlag.

	Gradings (total)	
	ß	*p*
Rise time on school days	-0.072	0.020
Rise time on free days	-0.128	<0.001
Bedtime on school days	-0.006	0.868
Bedtime on free days	-0.168	<0.001
Social jetlag	-0.174	<0.001
R^2	0.061	

3.3.4.3. Motivation

The regression linear on learning objective had a significant influence on bedtime on free days and social jetlag [*ß* = 0.119, p = < 0.001 vs. *ß* = -0.083, p = 0.011] (Table 91).

Table 91: Standardized beta regression coefficients of motivation with bedtime on free days and social jetlag.

	Bedtime on free days		Social jetlag	
	ß	*p*	*ß*	*p*
Learning objectives	-0.119	<0.001	-0.083	0.011
Approach performance objectives	0.086	0.031	0.072	0.074
R^2	0.028		0.021	

3.3.4.4. Conscientiousness

There was a significant multiple linear regressions of bedtime on school days and free days with conscientiousness (Table 92).

Table 92: Standardized beta regression coefficients of conscientiousness with bedtimes and social jetlag.

	Bedtime on school days		Bedtime on free days		Social jetlag	
	ß	*p*	*ß*	*p*	*ß*	*p*
Conscientiousness	-0.064	0.033	-0.085	0.005	-0.054	0.073
R^2	0.003		0.006		0.002	

3.3.5. Regression for intelligence

3.3.5.1. Achievement

More intelligent individuals reported better grades (Table 93).

Table 93: Standardized beta regression coefficients of conscientiousness with bedtimes and social jetlag.

	Gradings (total)	
	ß	*p*
CFT Series	0.206	<0.001
CFT Classification	0.062	0.043
CFT Matrices	0.218	<0.001
CFT Conditions	0.075	0.011

3.3.5.2. Motivation

Regression linear reported a reached relationship between intelligence and motivation (Table 94).

Table 94: Standardized beta regression coefficients of intelligence with motivation.

	Learning objectives		Approach performance objectives		Avoidance performance objectives		Work avoidance	
	ß	*p*	*ß*	*p*	*ß*	*p*	*ß*	*p*
Intelligence	0.103	0.001	-0.073	0.015	-0.136	<0.001	-0.148	<0.001
R^2	0.010		0.004		0.018		0.021	

3.3.5.3. Conscientiousness

Intelligence was positively related with conscientiousness [$ß$ = 0.131, $p < 0.001$, R^2 = 0.016] (Table 95).

Table 95: Standardized beta regression coefficients of intelligence with conscientiousness.

	Conscientiousness		
	ß	*p*	R^2
Intelligence	0.131	<0.001	0.016

3.3.6. Regression for achievement

3.3.6.1. Motivation

The regression linear on learning objective had a significant influence on grading ($ß$ = 0.348, $p < 0.001$, R^2 = 0.124); but avoidance performance objectives and work avoidance had negatively related to gradings (Table 96).

Table 96: Regression linear of grades and motivation.

	Gradings (total)	
	ß	*p*
Learning objectives	0.348	<0.001
Approach performance objectives	0.063	0.241
Avoidance performance objectives	-0.250	<0.001
Work avoidance	-0.138	0.002
R^2	0.124	

3.3.6.2. Conscientiousness

Regression linear on conscientiousness had a significant influence on grading [*ß* = 0.350, $p < 0.001$, $R^2 = 0.121$] (Table 97).

Table 97: Regression linear of grades and conscientiousness.

	Average gradings		
	ß	*P*	R^2
Conscientiousness	0.350	<0.001	0.121

The regression linear on gradings as the dependent variable with conscientiousness, intelligence, mid-sleep (MSFsc), chronotype, motivation and age as independent variables.

Conscientiousness, intelligence, mid-sleep (MSFsc), age, learning objective and avoidance performance objective had effect on grades (Table 98); but chronotype, approach performance objectives, work avoidance and gender were not a significant predictor.

Table 98: Regression linear of gradings (total) and independent variables.

	Gradings (total)	
	ß	*p*
Conscientiousness	0.268	<0.001
CFT total	0.270	<0.001
Chronotype (CSM)	-0.051	0.084
Mid-sleep (MSFsc)	-0.127	<0.001
Age (years and month)	-0.176	<0.001
Learning objectives	0.080	0.006
Approach performance objectives	0.010	0.771
Avoidance performance objectives	-0.150	<0.001
Work avoidance	-0.064	0.069
Gender	-0.001	0.963
R^2	0.338	

3.3.7. Regression for motivation

Regression linear indicated a high relation between conscientiousness and motivation (Table 99).

Table 99: Regression linear of conscientiousness and motivation.

Conscientiousness		
	ß	*p*
Learning objectives	0.256	<0.001
Approach performance objectives	0.210	<0.001
Avoidance performance objectives	-0.160	<0.001
Work avoidance	-0.125	0.001
R^2	0.149	

3.4. Structural equation model

Goodness of fit statistics of the SEM revealed that the overall model (M1) and the unconstrained gender group analysis (M2) fitted best (Table 100). The specification search of the SEM removed two facets of motivation, resulting in a single factor of motivation labeled ''negative motivation'' (avoidance performance objectives and work avoidance). Higher intelligence was the strongest predictor of good grades. Moreover, conscientiousness, motivation, younger age and an earlier midpoint of sleep were positively related to good grades. Although earlier CSM score was associated with good grades in bivariate analysis, CSM scores did not directly contribute to differences in grades in the SEM. However, chronotype contributed to grades mediated by midpoint of sleep and conscientiousness. Whereas intelligence contributed on a direct path to grades, intelligence also contributed indirectly by motivation, conscientiousness and midpoint of sleep (Fig. 49).

Table 100: Goodness of fit statistics of the structural equation model.

Overall model	x^2	x^2/df	RMSEA	CFI
M1	125.388	1.929	0.029	0.979
Multiple group (boys/girls) comparison				
M2: Unconstrained	204.471	1.573	0.023	0.974
M3: Invariance of measurement weights	227.350	1.636	0.024	0.970
M4: Invariance of measurement intercepts	299.839	1.986	0.030	0.949
M5: Invariance of structural weights	336.117	2.037	0.030	0.941
M6: Invariance of structural intercepts	340.664	2.04	0.030	0.940
M7: Invariance of structural residuals	355.776	2.068	0.031	0.937
M8: Invariance of measurement residuals	411.484	2.236	0.033	0.922

x^2 = Chi-square; df = degrees of freedom; RMSEA = root mean square error of approximation; CFI = comparative fit index. Parameters are constrained to be equal for both groups (boys/girls). M1 and M2 do not differ significantly. Other models (M3–M8) fitted significantly worse than M1 and M2.

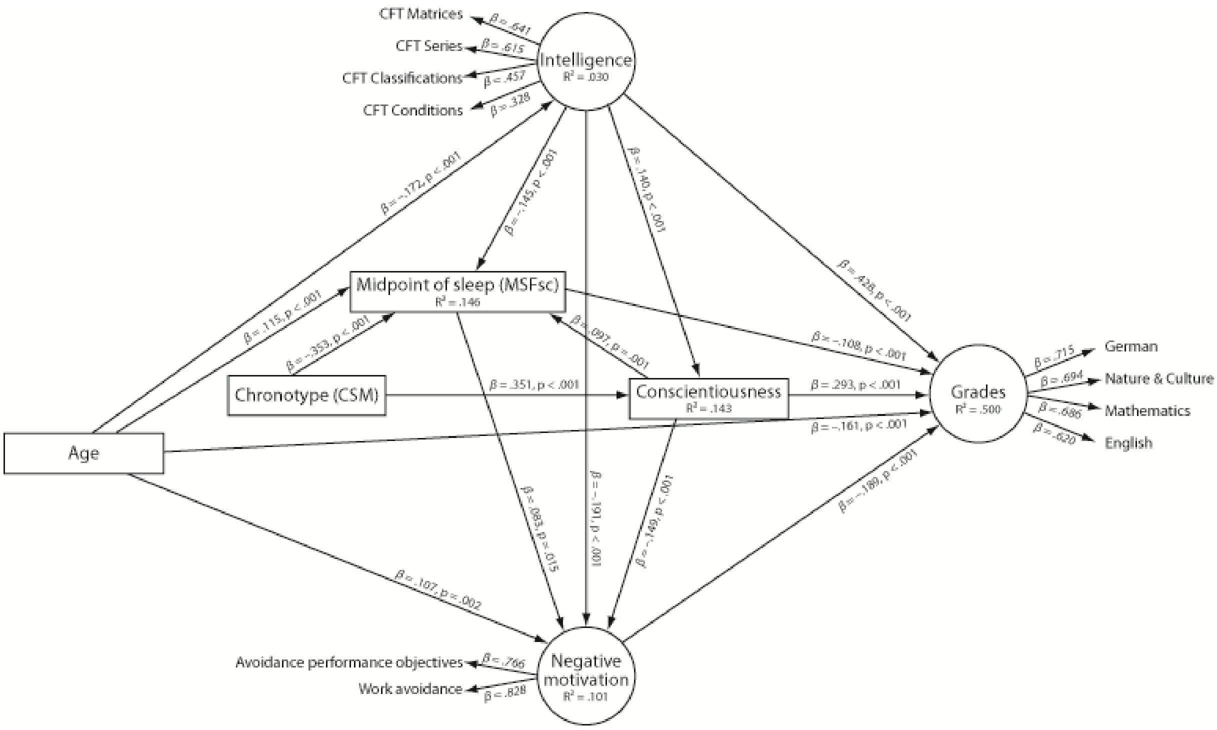


Fig. 49: Influence chronotype and intelligence on grades with conscientiousness, midpoint of sleep and motivation as mediators and gender as moderator variable, structural equation model.

Note: Significant regression coefficients (*ß*) from the overall model were included: overall model (M1), in brackets: moderator variable (girls/boys; unconstrained model M2). Age in months; chronotype (CSM, Composite Scale of Morningness) from 13 = extreme evening type to 55 = extreme morning type; midpoint of sleep (MSFsc) in clock times; intelligence: Cultural Fair Test (CFT) with higher values indicating higher intelligence, conscientiousness (FFPI-C) with higher values indicating higher conscientiousness; negative motivation (2 facets from SELLMO) with lower values indicating higher motivation; grades from 1 = fail to 6 = outstanding.

4. Discussion

4.1. Correlates of chronotype

The principal aim of the present study was to examine the relationships between chronotype, intelligence, conscientiousness, motivation and academic achievement. The main findings of this study show that intelligence is a higher predictor of academic achievement than any other variables.

In line with previous work (Diaz-Morales & Sorroche, 2008), we found that earlier chronotype was associated with earlier midpoint of sleep and less social jetlag, showing that individual circadian preferences are manifest, and, thus late chronotype can be detrimental to early school schedules already in pre-adolescent children. The mean CSM score was 37.84, and thus much more shifted towards morningness compared, e.g. to adolescents (e.g. with a CSM score of about 30–32 at the age of 15–17 years, which is considered the peak of lateness/eveningness; Randler, 2011). Similarly, midpoint of sleep was very early at 1:36 compared to an average of 4:28 in about 14-year-old adolescents (Vollmer et al., 2012). This indicates that primary school pupils in grade 4 are more morning oriented compared to adolescents. Morningness was associated with better school achievement. However in overall, the influence of chronotype on academic achievement is lower compared to studies based on secondary school pupils and university students in Germany. For example, Vollmer et al. (2013) reported a correlation coefficient between achievement and morningness-eveningness of 0.227 and Randler & Frech (2009) of 0.182 in secondary school pupils, while Randler & Frech (2006) reported a coefficient of 0.230 in university students. In their meta-analysis, Tonetti et al. (2015b) reported a mean correlation of .14; this might have several reasons: one might lie in the nature of our study where we have controlled for many other important predictors of school achievement thus decreasing the effect size of the bivariate relationship. Another reason might lie in the developmental aspects: young people have their strong transition to eveningness around the age of 12–14 years, thus their delayed sleep pattern is less obvious in primary school.

Although there are many more morning types in this sample than evening types, there is variance CSM scores as shown by the standard deviation (SD) is 6.65 in this study and therefore comparable to the value of adolescents and adults showing that the group that was assessed here is not uniform.

The sleep-wake schedule of primary pupils does not differ so much between weekdays and weekends, so their internal biological rhythm better fits the school schedules (see Fig. 50). However, this was one of the reasons why we carried out the study: we wanted to test whether the association between chronotype and achievement is already prevalent in this neglected age group with a smaller difference in misalignment. Nevertheless, there are evening-type pupils already in primary school although their proportion is lower compared to adolescent samples.

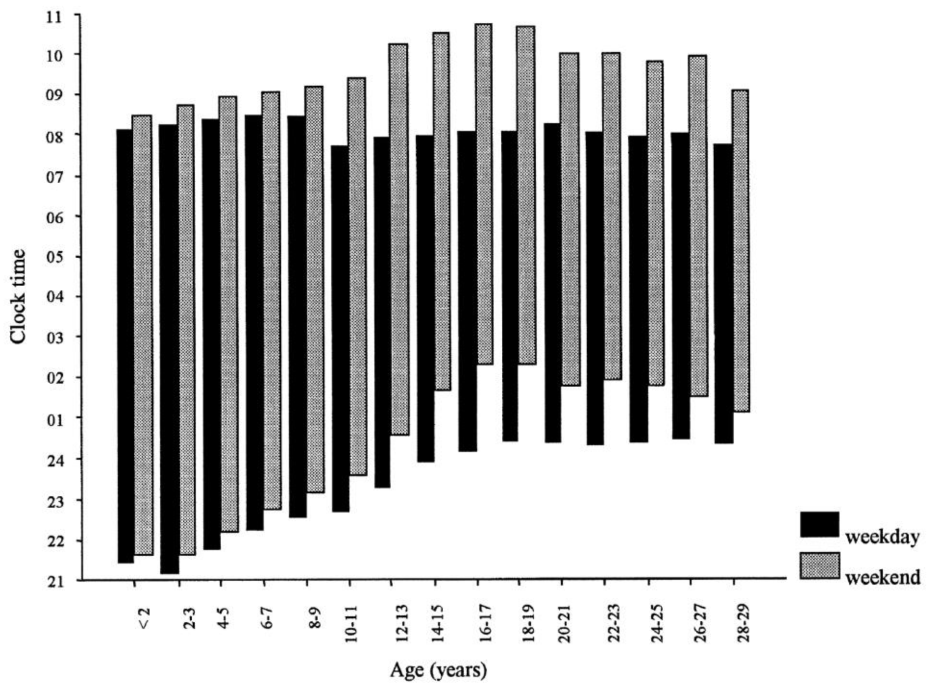


Fig. 50: Mean bedtimes and wake-up times on weekdays and weekends compared with age (Thorleifsdottir et al., 2002).

Another possibility might lie in the school start times; because early school start times negatively impact on school achievement (Kim et al., 2002). Epstein et al. (1998) found that early school start times negatively impact sleep length and, in turn, daytime behaviour (Gau et al., 2007). Students with less sleep length get more tiredness over the day and tiredness correlated negatively with achievement motivation and conscientiousness (Preckel et al., 2013). In the other hand, late-starting class times remove the effect of social jetlag (Haraszti et al., 2014; Smit, 2014) and were associated with better grades and indicate that early morning courses usually worse for students grades (Dills & Hernández-Julián, 2008).

Carrell et al. (2011) and Cortes et al. (2012) showed that students determined to start classes prior to 8:00 a.m. performed worse not only in their first class, but in all of their courses. A study by Edwards (2012) indicates that school start times shifted 1 h later increase reading and math test scores. Carrell et al. (2011) showed that melatonin levels peak at approximately 7:00 a.m. for teenagers and at 4:00 a.m. for adults; thus, waking a teenager at 7:00 a.m. is equivalent to waking an adult at 4:00 a.m. Therefore, it is really difficult for adolescents to adjust fully to an early school day. They need to asleep when their bodies want to be awake, and they are forced to be awake when their bodies want to be asleep.

One recent study compared morning and afternoon school schedules in adolescents between the 11 and 18 years old in Croatia, and showed that the afternoon groups slept longer than the morning groups. All three chronotype groups went to bed and woke up later than in the morning schedule groups (Koscec et al., 2014).

Edwards (2012) found no effects of school start times on elementary students. However, elementary schools start later than middle schools, while one study by Dahl (2005) revealed that 35 minutes more sleep affected memory, attention, and reaction time in childern between 9 and 12 years old, and also researchers recommended around 11 to 13 hours of sleep for preschool children (3–5 years old) and around 10 to 11 hours of sleep for children that are 5–10 years old (National Sleep Foundation, 2015).

As a result, school start times in primary school might be a bit later (albeit only up to half an hour), but taken together with the fact that pupils at this age are more morning-oriented and may go to school a bit later, these factors may be responsible for the lower correlation between morningness-eveningness and achievement in primary pupils.

In contrast to previous studies (Killgore & Killgore, 2007; Roberts & Kyllonen, 1999), morning orientation was positively related with higher intelligence in bivariate analyses. However, a meta-analysis by Preckel et al. (2011) shows a weak but significant negative correlation among morning-types and cognitive ability of $r = -.04$ and a positive and significant correlation among evening-types and cognitive ability of $r = .08$. This could be based on the samples because we assessed school children in primary school (thus a different age) and further a more representative sample; since Roberts & Kyllonen (1999) were based on army people; and Killgore & Killgore (2007) relied on a small sample size.

The fourth grade is nearly representative of the pupil population because more than 95% of children are taught in these regular schools (special needs set aside). Thus the representativeness is given, and all schools of the district were asked to participate. However, the results are not contradictory because Preckel et al. (2011) reported four studies with a positive correlation between cognitive ability and morningness, and their main effect size is low so that the result should be treated with caution. Unfortunately, exactly these four studies with a positive relationship between morningness and intelligence are unpublished (for details, see Preckel et al., 2011), so we here conclude that the relationship between cognitive ability or intelligence on the one hand and chronotype on the other is far from being resolved. The few studies focused on different populations (pupils, students and army people) and used different measures of cognitive ability as well as different measures of chronotype. I used CSM and MSF. Also Randler & Truc (2014) and Randler et al. (2015) used CSM, while Diaz-Morales & Escribano, 2013a (2013b) and Diaz-Morales & Gutiérrez Sorroche (2008) used the Morningness-Eveningness Scale for Children (MESC). Preckel et al. (2013) used a short German version of the Lark-Owl Chronotype Indicator (LOCI; Roberts, 1998). MCTQ, MSF, MSFsc and MSFsasc were used by Roenneberg et al. (2007). CSM and MSFsc by Vollmer et al. (2012). Werner et al. (2009) used the Children's ChronoType Questionnaire (CCTQ) and MSF for measures of chronotype.

Morning orientation was related to proactive behavior such as a higher conscientiousness, which were found by the other researchers (Diaz-Morales, 2007; Gray & Watson, 2002; Preckel et al., 2011; Preckel et al., 2013; Randler, 2008c; Tsaousis, 2010; Vollmer & Randler, 2012; Young et al., 2007), and higher learning objectives, which is important for school performance; while late midpoint of sleep was related to less conscientiousness, higher avoidance performance objectives and higher work avoidance. The present result suggest that the ''morning personality'' indeed is already prevalent in young children at the primary level, and, that these factors are responsible for academic achievement in primary school. Further studies might assess trajectories of personality and chronotype in combination with progress of the schooling in a prospective study. Furthermore, in the study done by Preckel et al. (2013) evening types associated with less conscientiousness and less performance motivated than morning types.

4.2. Achievement

4.2.1. Achievement and sleep length

The data showed that timing of sleep and wakefulness related more closely with academic achievement than sleep duration and other relevant factors (Eliasson et al., 2010). Although several studies showed that later bedtimes and shorter sleep length associated with poor performance at school (Chung & Cheung, 2008; Dewald et al., 2010; Gau & Soong, 1995; Kelly et al., 2001; Medeiros et al., 2003; Perkinson-Gloor et al., 2013; Randler, 2008a; Randler & Frech, 2009; Teixeira et al., 2007; Trockel et al., 2000; Wolfson & Carskadon, 1998, 2003).

Researchers have consistently found correlation between sleep factors—earlier bedtimes, more total sleep with better academic performance and higher grades (Miller et al., 2008; Ming et al., 2011; Wolfson & Carskadon, 2003; Wolfson, 2007). "Not getting enough sleep may result in problems with attention, memory, decision-making, organization, and creativity, all of which are clearly important for success in school (Mindell, 2010).

In the present study, higher napping was related to worse performance, pupils with more napping had shorter sleep length in school days, higher social jetlag and higher midpoint of sleep, which can explain their lower performance. In contrast, Eliasson et al. (2010) showed that students with higher napping correlated with high performance. However, there were no significant differences in average sleep duration with or without naps, similarly with studies of Eliasson et al. (2010).

4.2.2. Achievement and conscientiousness

The present results are consistent with several recent studies on the relationship between conscientiousness and academic performance, pupils with higher conscientiousness had better grades (Bauer & Liang, 2003; Busato et al., 2000; Conard, 2006; Chamorro-Premuzic & Furnham, 2008; Furnham et al., 2002; Furnham & Chamorro-Premuzic, 2004; Lounsbury et al., 2003; Noftle & Robins, 2007; O'Connor & Paunonen, 2007;

Phillips et al., 2003; Poropat, 2009; Preckel et al., 2006; Trautwein et al., 2009; Wagerman & Funder, 2007).

A study by Laidra et al. (2007) in Estonian schoolchildren from elementary to secondary school (7 to 19 years of age) indicated a positive correlation between academic performance and conscientiousness. Also, Barbaranelli et al. (2003) found a similar relationship between conscientiousness and grades in elementary school and junior high school children.

Some reports even claim that conscientiousness or self-discipline is a better predictor than intelligence (Duckworth & Seligman, Martin E. P., 2006).

4.2.3. Achievement and motivation

This study has shown that pupils with higher learning objectives reported better grades; however pupils with higher approach performance objectives, avoidance performance objectives and work avoidance associated with worse grades. Similarly, research of Wigfield & Cambria (2010) showed that work-avoidant goals correlated with less adaptive academic outcomes. Some researches indicated that intrinsic motivation related with better learning and achievement (Cordova & Lepper, 1996; Deci & Ryan, 1985; Gottfried, 1985).

Awan et al. (2011) and Broussard (2002) indicated that higher levels of mastery motivation are found to be related to higher achievement in third graders and first graders; and also Boggiano et al. (1992) showed that fifth grade children with an intrinsic motivational orientation had better grades in reading and mathematics and higher overall performance.

There was a positive relationship between motivation and academic performance (Ahmed & Bruinsma, 2006; Broussard, 2004; Collins et al., 2004; Kushman. et al., 2000; Muola, 2010; Sikhwari, 2014; Singh et al., 2002; Skaalvik & Skaalvik, 2004, 2006; Tella, 2007; van den Berg & Coetzee, 2014). However, Emmanuel et al. (2014) and Niebuhr (1995) showed that there was no significant difference between achievement motivation and academic achievement. A study by Stipek & Ryan (1997) also showed a weak relationship between motivation and young children’s performance. Similar findings were obtained by Areepattamannil & Freeman (2008) and Othman & Leng (2011).

4.2.4. Achievement and intelligence

Considering all the investigated variables, higher intelligence contributed the most to good grades. This goes in line with most studies and is a well-known fact (Chamorro-Premuzic & Furnham, 2008; Phillipson & Phillipson, 2012; Rohde & Thompson, 2007; Spinath et al., 2006, 2008; Strenze, 2007; Taub et al., 2008; Worland et al., 1984), as well as relationship between mathematical achievement and general cognitive ability in investigations of (Lubinski et al., 2001; Shea et al., 2001). A research by Rohde & Thompson (2007) showed that general cognitive ability alone was incapable to account for more than 50% of the variance correlated with academic performance. The results for both mathematics and reading showed that intelligence tests were useful for predicting academic performance (Deary et al., 2007; Jensen, 1980; Walberg, 1984). A study of 4th grade evaluation data base from a suburb of Portland, Oregon found a strong relation between reading and cognitive ability was 0.68 and for math was 0.69 (Smith, 2011). An analysis by Laidra et al. (2007) indicates that intelligence is the strongest predictor of school achievement in grades 2 to 12.

The present study reveals that intelligence was a stronger predictor of school achievement than conscientiousness and motivation. Gottfredson (2002) and Gustafsson & Undheim (1996) as well as Jensen (1980) and Laidra et al. (2007) have noted that the correlation between intelligence and achievement performance would weaken from elementary to secondary school. Although other studies indicated that personality and motivational constructs play important roles in school achievement even over and above intelligence (Furnham & Chamorro-Premuzic, 2004; Poropat, 2009; Spinath et al., 2006; Spinath et al., 2010; Steinmayr & Spinath, 2008; Zyphur et al., 2007). Kappe & van der Flier (2012) showed that conscientiousness and motivation were stronger predictors of academic achievement than intelligence.

Researchers found conscientiousness to be the best predictor of school achievement (Maltby et al., 2013; Musgrave-Marquart et al., 1997). Accordingly, Poropat (2009) showed that the relationship between conscientiousness and academic achievement was largely independent of intelligence.

In addition, we found an unexpected time of testing effect on CFT scores (cognitive ability). This result does not affect the study because of its small size (below 1% of variance explained) and should be therefore unimportant for survey studies but might become important for individual diagnostics. Although the result does not influence the current survey study, it might have implications on diagnostic individual testing. This should be considered in future work on diagnosis.

4.3. Intelligence with conscientiousness and motivation

Our study showed that more intelligent pupils had a positive relationship with higher conscientiousness. In contrast, the research of Ziegler & Raul (2000) has failed to find any consistent evidence for the relationship between intelligence and conscientiousness; this is in line with the other vast studies on the personality and intelligence interface (Ackerman & Heggestad, 1997; Reeve et al., 2006). Researches by Moutafi et al. (2003) and Moutafi et al. (2004) showed that conscientiousness is negatively correlated with intelligence. Furnham et al. (2002) indicated more conscientious people were more likely to think that intelligence can be increased through the life span; whereas low conscientious individuals were more likely to believe that intelligence is fixed.

One reason could be the different age groups of the previous study because here, primary school children have been assessed. Another aspect might be the sample size, because the sample size in this study was rather high. In addition, measures for intelligence and for conscientiousness may also be different in this study compared to the others.

4.4. Conscientiousness and sleep length

Results showed that low conscientiousness pupils go to bed and wake up later on free days than higher conscientiousness children, which are consistent with the findings of (Randler, 2008c). This different suggests that higher conscientious children may pay more attention towards their bed and wake times; but there was no significant difference between conscientiousness and sleep length. However, Randler (2008c) showed that longer sleep duration correlated to higher conscientiousness, similar to Duggan et al. (2014) which found low conscientiousness associated with poor sleep. A study by Gray & Watson (2002) indicated that conscientiousness predicted earlier rising and retiring times. More conscientious people associated with more stable sleeping patterns by retiring and rising time at regular times throughout the week (Randler, 2008c).

4.5. Age

4.5.1. Age with chronotype and sleep

We found a correlation between age and chronotype only in the midpoint of sleep but not with the CSM scores, similar to Werner et al. (2009) which found no relationship, while a lot of studies showed correlation between age and CSM, with older children become later chronotype (Carskadon et al., 1998; Diaz-Morales & Gutiérrez Sorroche, 2008; Diaz-Morales & Randler, 2008; Kim et al., 2002; Randler, 2008d; Russo et al., 2007). We indicated that older children were more insufficient in sleep and had later rise and bedtimes (Drake et al., 2003; Randler et al., 2009), more mid-sleep (Randler & Truc, 2014; Werner et al., 2009) and more social jetlag. As a consequence older pupils which reported worse grades were related to sleepiness (Diaz-Morales & Escribano, 2013b; Drake et al., 2003). However, in this study, the age range was very restricted because the focus was especially on the group of fourth graders, thus if we also had asked 2nd, 3rd or 5th graders, the correlation between age and CSM scores surely would have been detected.

4.5.2. Age and intelligence

The negative association between age and intelligence can be explained by the German school system where gifted children are sent to school earlier, sometimes around the age of 5 years, whereas less skilled pupils start schooling around the age of 7 years old; or they skip a grade and thus are younger in our population (the 4th grade of primary school).

In line with these findings, Mayer & Knutson (1999) reported that children who start schooling at a younger age score better on cognitive tests than older ones conditional on schooling length, however, some studies showed that working memory does increase during adolescence. For instance, Zald & Iacono (1998) measured the development of spatial working memory from 14–20 years of age. Another study by Swanson (1999) also indicated monotonic increases in both verbal and spatial working memory throughout the ages of 6–35.

I believe that usually intelligence should be positively correlated with age, because children become slightly more intelligent as they grew older. However, in this respective case, pupils that enter school earlier are younger and less intelligent pupils may be schooled later, thus this could explain the negative correlation between age and intelligence.

4.5.3. Age and achievement

Age correlated negatively with achievement, when students grow older they get a worse school performance which is consistent with the findings of Randler & Frech (2009). This finding is consistent with the results of Coleman et al. (1966), Jabor et al. (2011) and White (1982) studies, which showed that as students become older, the correlation between age and school achievement declines. As noted by Strøm (2004), if a teacher reads the same text to two otherwise equal pupils, one exactly nine-year-olds and the other nearly eight-year-olds, the effect on performance for the two pupils may differ. Some cognitive theories suggest that young children are more receptive for learning compared older ones. Langer et al. (1984) showed significantly higher performance scores of the oldest compared to the youngest pupils at an age of 9, but this difference disappeared by the age of 17. On the other hand, Crosser (1991), La Paro & Pianta (2000), Milling Kinard & Reinherz (1986), Uphoff & Gilmore (1985) and Waldman & Avolio (1986) found a positive relationship between age and performance. They discussed that the older and/or more mature students in the class fare better than younger classmates. In contrast, Demeis & Stearns (1992), Dietz & Wilson (1985) and McEvoy & Cascio (1989) found no significant relationship between age and achievement.

4.5.4. Age and motivation

Findings indicated that older pupils associated with higher approach performance objectives, higher avoidance performance objectives and higher work avoidance but there were no age differences in learning objectives.

Recent studies by Wang & Pomerantz (2009) and Wigfield & Cambria (2010) showed that mastery orientation or learning objectives decreased between 6 and 15 years of age. Dekker et al. (2013) also reported that young adolescents related with higher mastery orientation than older adolescents. Likewise, 14–19 year old adolescents showed more work avoidant goals than 10–14 year old adolescents [18% versus 8%] (Freudenthaler et al., 2008; Steinmayr et al., 2011; Steinmayr & Spinath, 2008). It is also consistent with the findings of Gottfried et al. (2001) that showed decrease on intrinsic motivation from 9-year-old through 17-year-old students in reading, math, science, and school in general.

4.6. Gender aspects

4.6.1. Gender with chronotype and sleep length

The data showed some differences between genders. Boys got up earlier than girls on free days but later on school days. Bed time in both free days and school days for boys was a little later than girls; while no difference was observed in average sleep length. Girls slept more on free days but boys slept more on school days. Girls were sharing more social jetlag and reported more napping than boys. The observed delayed wake time and longer sleep time in free days for girls is consistent with many findings (Collado Mateo et al., 2012; Laberge et al., 2001; Natale et al., 2009; Russo et al., 2007; Tonetti et al., 2008). In contrast, an analysis by Yang (2005) on sleep/wake patterns among Korean teenagers (grades 5 to 12) and also Canellas et al. (1994) on teenagers in Mallorca indicated that girls sleep longer on school nights than boys. Greater social jetlag and napping in girls compared to boys have also been reported in some researches (Bearpark & Michie, 1987; Collado Mateo et al., 2012; Lack, 1986; Lee et al., 1999; Ohayon et al., 1997; Vignau et al., 1997). Weissbluth

(1995) reported that there were no gender differences in napping patterns between 6 months and 7 years old.

Girls reported that they woke up earlier than boys on school mornings but later on weekend mornings. As previous researchers have speculated (Gau & Soong, 1995; Lee et al., 1999; Wolfson & Carskadon, 1998; Yang, 2005). We also assume that these differences result from differences in the time needed to prepare for school. For sure girls, alone or with the assistant of their parents, need more time to brush their long hair, wrap or braid them, use different hair clips or bands and set the colors with their clothes. Even they need more time for wearing their leggings and skirts instead of boy's pants. Our findings that girls have a greater oversleep suggest that girls may suffer more sleep deprivation on school days.

We found different sleeping patterns between genders, with girls having their midpoint of sleep later than boys. These findings are in line with previous studies that obtained similar results (Önder & Beşoluk, 2013; Randler et al., 2012b; Randler & Truc, 2014; Werner et al., 2009).

We didn't find differences between gender and morningness-eveningness. Evidence for gender differences is contradictory. Some studies found gender differences and others not, however, this seems dependent on different factors, such as sample size and variance in age (Randler, 2007). Recent study of Randler & Truc (2014) on preschool children (3–6 years old) showed similar consequence. This result is in line with those studies indicating no sex difference in CSM score in preadolescents (Gau & Soong, 2003; Kim et al., 2002; Russo et al., 2007; Werner et al., 2009; Wolfson, 1996). They suggested that in prepubertal children there is generally no gender difference in sleep patterns.

Numerous studies, which were done on adolescents and adults, showed gender difference in circadian preference Adan & Natale (2002), Delgado Prieto et al. (2012) and Randler (2007) in adolescents. Gaina et al. (2006) reported an evening preference in Japanese girls, and Diaz-Morales & Gutiérrez Sorroche (2008) indicated a greater tendency (non-significant) toward later chronotypes in girls between 600 adolescents. However, Duarte et al. (2014a) and Randler (2007, 2011) showed that girls and women were on average more morning-oriented than Boys and men.

These differences suggest that sexual hormones have an influence on the circadian system. This differences between the sexes are greatest from puberty until menopause, when differences decrease again (Roenneberg et al., 2004). This hypothesis is supported by results from Randler et al. (2012b) where evening oriented male University students showed a higher testosterone level in saliva. Therefore, differences in preadolescence children, which are not highly affected by sexual hormones, remain small. In contrast, some studies reported significant gender differences starting before puberty (Carskadon, 1990; Laberge et al., 2001; Petta et al., 1984; Wolfson & Carskadon, 1998).

4.6.2. Gender with achievement and intelligence

In the present study, girls did better grades in languages (German and English) and Science & Culture than boys but not in mathematics, consistent with previous findings (Golsteyn & Schils, 2014; Gustafsson & Undheim, 1996; Spinath et al., 2010). Deary et al. (2007) found that girls performed better than boys on all subjects except Physics.

These gender differences in subjects can be explained by difference of interests. Steele (2003) on a research on gender differences on children aged 6–10 years old showed that girls are less interested in math than boys.

In general, in my study no significant differences were found on the effect of boys and girls in total grades; but many studies mentioned that boys and girls are different in academic achievement. Mehrafza (2004) and Noori (2002) showed the average of academic achievement in girls was more than in boys; also Epstein et al. (1998) and Wong et al. (2002) presented that girls perform better in school than boys in all major subjects and all levels of the school system.

We did not find any significant difference between gender and intelligence, but Freudenthaler et al. (2008) and Steinmayr & Spinath (2008) showed that boys scored higher on intelligence than girls. Some of the other researches Mellon et al. (1980), Seashore (1962) and Spinath et al. (2008) indicated that intelligence was a stronger predictor of school performance for boys than girls.

4.6.3. Gender and conscientiousness

The present study found gender differences in conscientiousness with girls scored higher on conscientiousness than boys. Studies of Freudenthaler et al. (2008), Klimstra et al.

(2009), Pursell et al. (2008), Rubinstein (2005) and Zupančič et al. (2003) showed the same result.

Feingold (1994) and Costa et al. (2001) found that women scored somewhat higher than men on some facets of conscientiousness, such as order, dutifulness, and self-discipline but no significant gender difference has typically been found in conscientiousness at the Big Five trait level.

Lamb et al. (2002) found no sex differences on conscientiousness from ages 2 to 15, but Soto et al. (2011) found a small gender difference in conscientiousness at each year of age from 10 to 65 with females being more conscientious than males and also Zupančič et al. (2003) found a few gender differences in children between one and seven years old with girls scoring higher on conscientiousness than boys.

Freudenthaler et al. (2008) and Spinath et al. (2008) reported that conscientiousness was an influential factor only in girls' but not in boys' school performance; and Spinath et al. (2010) reported that conscientiousness was important in math achievement for both sexes.

4.6.4. Gender and motivation

Our data showed a gender difference in learning objectives with girls scored higher than boys but boys had higher scores on avoidance performance objectives than girls, while no gender difference was observed for work avoidance and approach performance objectives.

The results of some other studies showed that learning goals were more associated with girls than boys (Brdar et al., 2006; Dekker et al., 2013, Meece & Holt, 1993; Meece et al., 2006; Pajares & Valiante, 2001; Steinmayr et al., 2011), while, boys had more tendencies toward performance goals (Byme, 2011; Freudenthaler et al., 2008; Middleton & Midgley, 1997; Patrick et al., 1999; Ryan et al., 1997).

Other researchers reported that males were more performance avoidant goal oriented than females (Brdar et al., 2006; Meece et al., 2006). It is also interesting to note that studies by Dekker et al. (2013), Freudenthaler et al. (2008), Rijavec & Brdar (2002) and Thorkildsen & Nicholls (1998) indicated that work avoidance goals were more associated with males than females. On the other hand, some studies indicated that women were more performance goal oriented than males (Chan et al., 2004; Chan et al., 2002). As noted by

Emmanuel et al. (2014), 91 percent of boys were more motivated than 11.9 percent of girls in Ghana, while several studies indicated that girls were more motivated than boys (Sikhwari, 2014; Awan et al., 2011). This contrasting findings may be due to environmental differences (Emmanuel et al., 2014).

Furthermore, in the study done by Pajares & Valiante (2001), no significant differences were found between gender and performance avoidance goals. Similarly, Chan et al. (2002) and Hinkley et al. (2001) indicated no significant differences between gender and mastery goals.

In the same way, other studies have shown no difference on performance goal orientation between males and females (Meece & Holt, 1993; Niemivirta, 1996). In addition, one research has shown that there were no significant differences between gender and four types of goals (Rashidi & Javanmardi, 2012).

4.7. Limitations

We did not assess all variables that were related to school achievement, e.g. the need for cognition was not assessed although it might have an influence on grades because there was no instrument applicable for primary school. The instrument by Preckel et al. (2013) for 5th and 6th graders was published after the study was carried out and should be taken into account in future work.

We didn't ask pupils at which time they go to bed and wake up themselves or their parents send them to bed and wake them up in the morning, or if they set the alarm. In the questionnaires the time which they fall asleep was also not asked (because it is not easy for the children in this age to consider it), only the time they go to bed was questioned; which can have an effect on sleep duration. I should mention that I did not assess sleep difficulties, sleep quantity and quality.

Similar to previous studies (Grzegorek et al., 2004; Komarraju et al., 2009; Ruban et al., 2003), I used self-reported grades to assess academic achievement and sleep times rather than objective data measured by actigraphy and grades reported by the parents or teachers for real evaluation (Eliasson et al., 2010). However self-reported grades have been found to be strongly related to objective grades (e.g., r = .89, Noftle & Robins, 2007).

Generalizability of my findings is restricted; it should be taken into account that the sample included 4th grade German pupils only. Replications with younger and older pupils are needed. Moreover, further studies are needed to investigate whether my findings can be replicated in Germany in all grades of primary school (Randler & Diaz-Morales, 2007).

The strength of the study is that it controls for many co-variates and predictors of academic achievement to unveil the effects of chronotype on academic achievement. Nevertheless, an effect of chronotype on achievement remained significant.

5. Conclusions and implications

Concerning the grades, intelligence, conscientiousness and motivation were important predictors. The results further show that these important predictors have to be taken into account when assessing the relationship between chronotype and academic achievement. Nevertheless, chronotype was an important predictor of school achievement even when controlling for many confounding variables. In addition, the relationship between academic achievement and chronotype was weaker in primary school students, probably because they are not yet in their transition to evening types, which occurs around the age of 12–14 years (Adan et al., 2012). The internal sleep-wake cycle of the primary school pupils, therefore, better fits the social and school schedules, suggesting a smaller misalignment between their own internal clock and the social clock, and therefore, a weaker correlation between achievement and chronotype. One implication of the study could be to reduce the misalignment of adolescents (and hence improve their person-environment-fit), which are predominantly evening types, and to start school later in adolescents to better fit the internal clocks of the evening types. An implication for primary school pupils would be to carefully check school start times and time for travelling to school (which is different among the many schools) to avoid early getting up times. Further, as the CFT was weakly related to testing time, we suggest to write examinations in primary school pupils later during the day, e.g. at 10:00 o'clock, and not in the first lesson.

Conscientiousness has systematically been found to predict academic performance from preschool (Abe, 2005) through high school (Noftle & Robins, 2007). Conscientiousness might actually influence performance through its effect on the sleep schedule; that is, conscientiousness is related to "morningness" (Randler, 2008c; Roberts & Kyllonen, 1999), and highly conscientious individuals have earlier rising and retiring times (Gray & Watson, 2002). Therefore morningness is associated with better performance at schools (Laidra et al., 2007; Randler & Frech, 2006).

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8. Appendices

Appendix 1. The Composite Scale of Morningness (CSM)

Stell dir vor, die Schule fällt aus. Du darfst aufstehen, wann du möchtest. Wann stehst du morgens auf?
5 [ ] vor 6:30 Uhr
4 [ ] zwischen 6:30 Uhr und 7:45 Uhr
3 [ ] zwischen 7:45 Uhr und 9:45 Uhr
2 [ ] zwischen 9:45 Uhr und 11 Uhr
1 [ ] nach 11 Uhr

Du darfst ins Bett gehen wann du möchtest. Wann gehst du abends ins Bett?
5 [ ] vor 21 Uhr
4 [ ] zwischen 21 Uhr und 22:15 Uhr
3 [ ] zwischen 22:15 Uhr und 0:30 Uhr
2 [ ] zwischen 0:30 Uhr und 1:45 Uhr
1 [ ] nach 1:45 Uhr

Wie leicht fällt es dir morgens aufzustehen?
1 [ ] überhaupt nicht leicht
2 [ ] nicht so leicht
3 [ ] ziemlich leicht
4 [ ] sehr leicht

Wie wach fühlst du dich morgens in der ersten halben Stunde nach dem Aufwachen?
1 [ ] überhaupt nicht wach
2 [ ] etwas wach
3 [ ] ziemlich wach
4 [ ] sehr wach

Wie müde fühlst du dich morgens in der ersten halben Stunde nach dem Aufwachen?
1 [ ] sehr müde
2 [ ] ziemlich müde
3 [ ] ziemlich fit
4 [ ] sehr fit

Der Sportunterricht beginnt um 7 Uhr. Wie wäre das für dich?
4 [ ] Ich wäre gut in Form.
3 [ ] Ich wäre ziemlich in Form.
2 [ ] Es wäre ziemlich schwierig für mich.
1 [ ] Es wäre sehr schwierig für mich.

Wann wirst du abends müde und möchtest deshalb schlafen gehen?
5 [ ] vor 21 Uhr
4 [ ] zwischen 21 Uhr und 22:15 Uhr
3 [ ] zwischen 22:15 Uhr und 0:30 Uhr
2 [ ] zwischen 0:30 Uhr und 1:45 Uhr
1 [ ] nach 1:45 Uhr

Für eine Klassenarbeit, die sehr anstrengend ist, möchtest du in Bestform sein. Du kannst dir deinen Tag völlig frei einteilen. Wann würdest du diese schreiben?
4 [ ] von 8 bis 10 Uhr
3 [ ] von 11 bis 13 Uhr
2 [ ] von 15 bis 17 Uhr
1 [ ] von 19 bis 21 Uhr

Manche Menschen sind Morgentypen, andere dagegen Abendtypen. Zu welchem Typ würdest du dich zählen?
4 [ ] eindeutig „Morgentyp"
3 [ ] eher „Morgentyp" als „Abendtyp"
2 [ ] eher „Abendtyp" als „Morgentyp"
1 [ ] eindeutig „Abendtyp"

Wann würdest du am liebsten morgens aufstehen, um zur Schule zu gehen?
4 [ ] vor 6:30 Uhr
3 [ ] zwischen 6:30 Uhr und 7:30 Uhr
2 [ ] zwischen 7:30 Uhr und 8:30 Uhr
1 [ ] nach 8:30 Uhr

Stell dir vor, du müsstest jeden Morgen um 6:00 Uhr aufstehen. Wie wäre das für dich?
1 [ ] sehr schwierig und unangenehm
2 [ ] ziemlich schwierig und unangenehm
3 [ ] etwas unangenehm, aber kein größeres Problem
4 [ ] einfach und nicht unangenehm

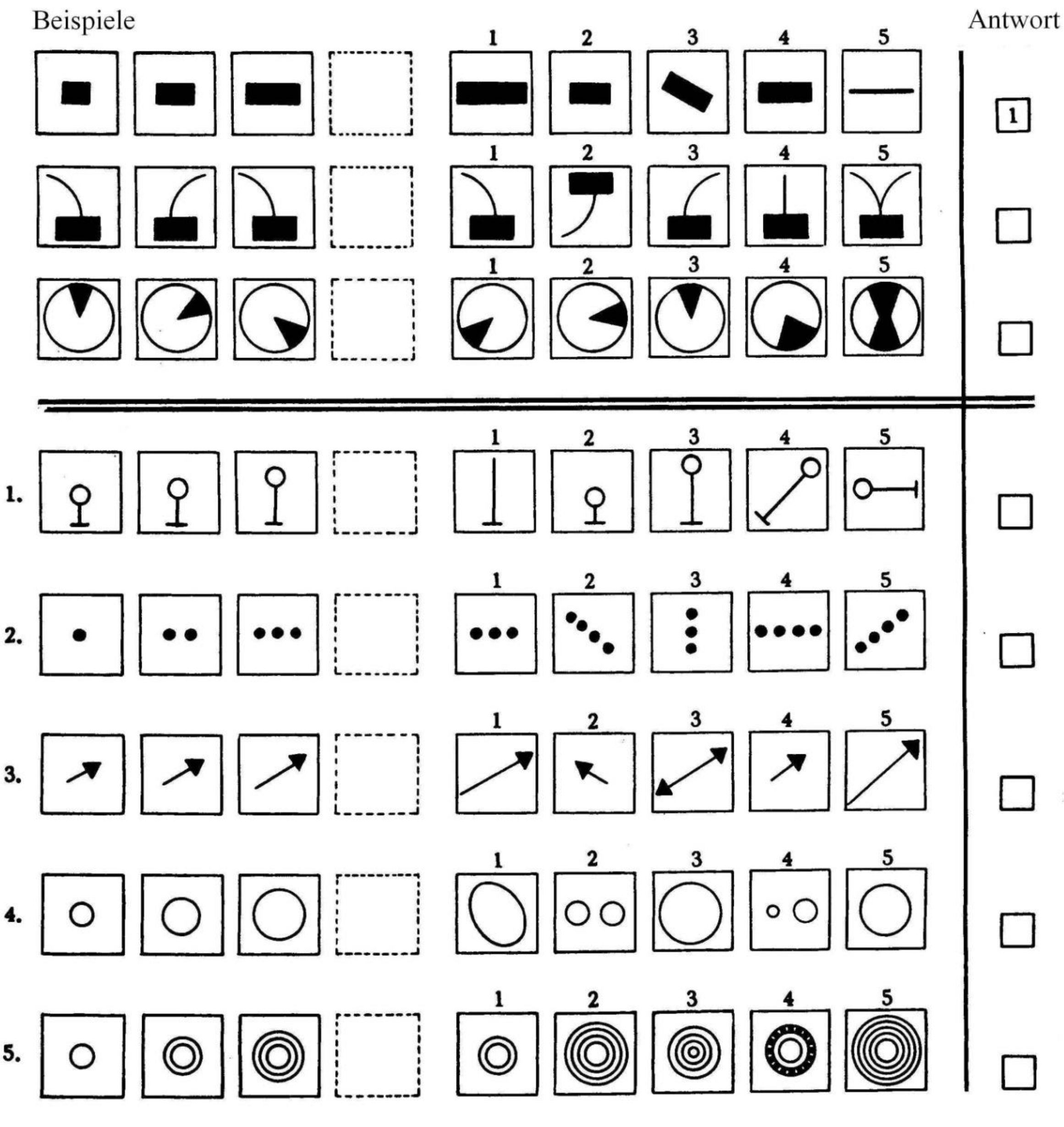
Wie lange dauert es bei dir morgens nach dem Aufstehen, bis du richtig wach bist und klar denken kannst?
4 [ ] 0 bis 10 Minuten
3 [ ] 11 bis 20 Minuten
2 [ ] 21 bis 40 Minuten
1 [ ] mehr als 40 Minuten

Bist du eher morgens oder abends aktiv?
4 [ ] ausgesprochen morgens aktiv (morgens wach, abends müde)
3 [ ] eher morgens aktiv
2 [ ] eher abends aktiv
1 [ ] ausgesprochen abends aktiv (morgens müde, abends wach)

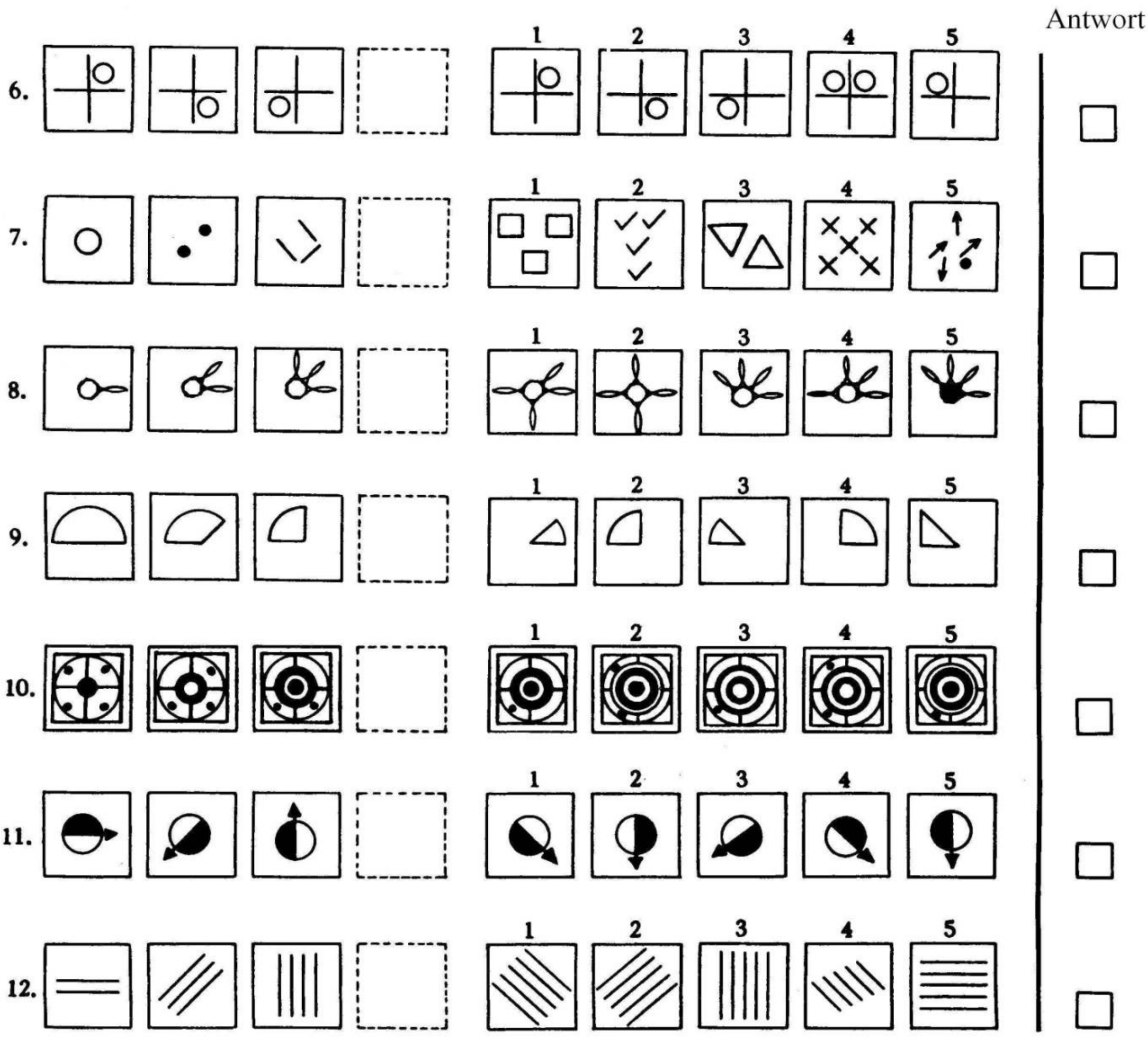
Appendix 2.

2.1. The first subtest of intelligence test (series)

TEST 1



Weiter mit der nächsten Seite.

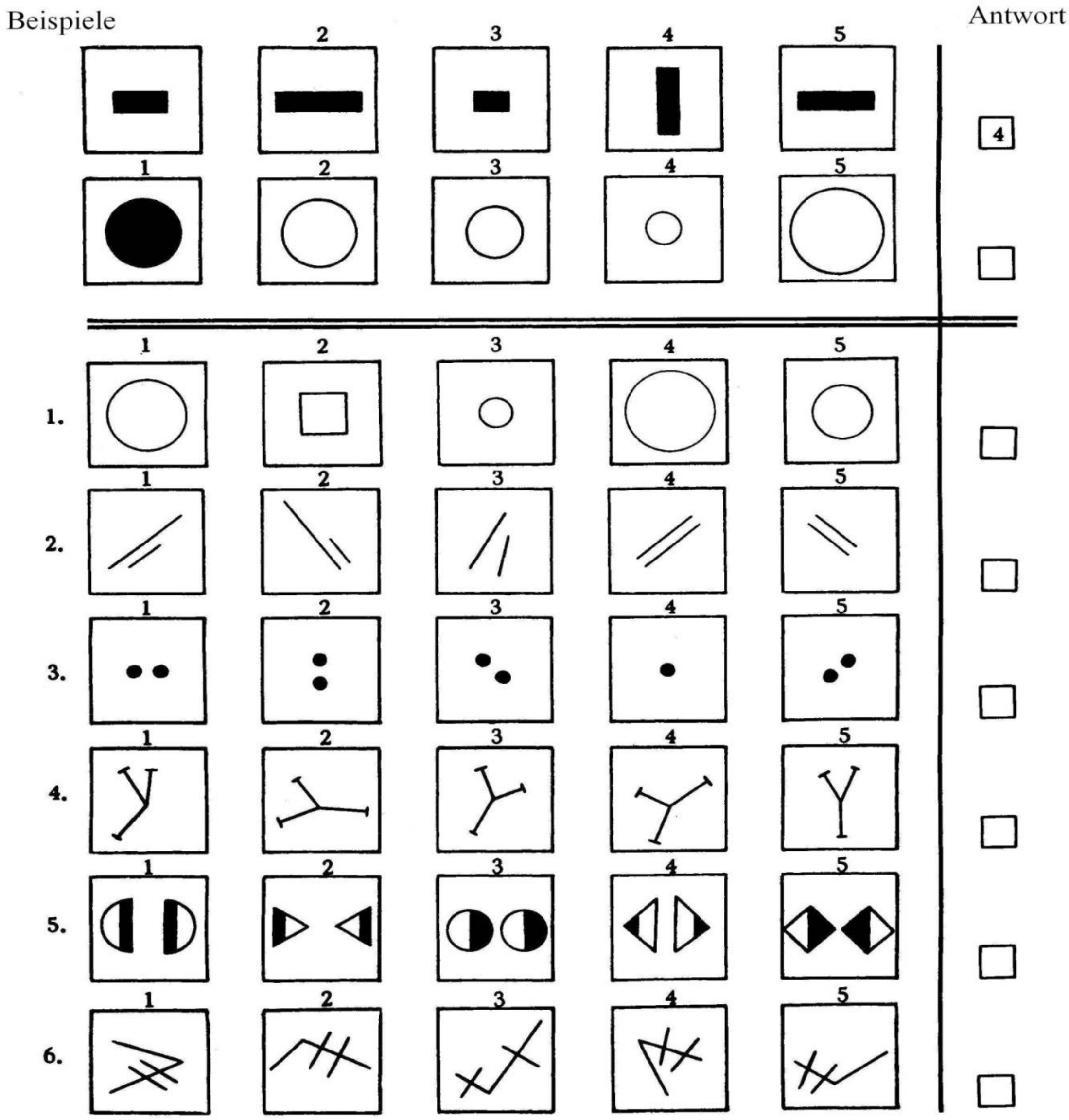


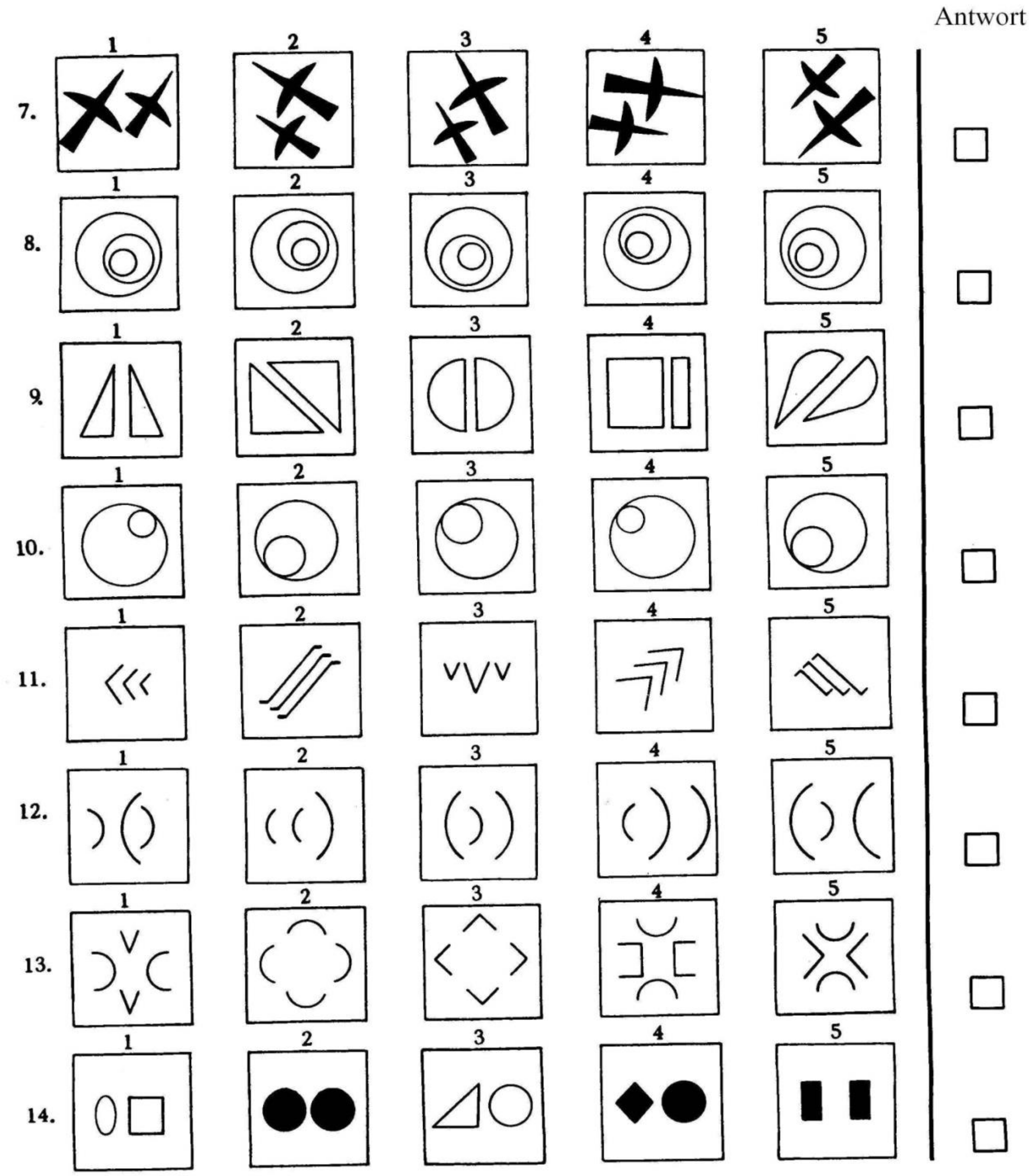
Ende von Test 1

STOPP! Nicht umblättern bis wir es dir sagen.

2.2. The second subtest of intelligence test (classifications)

TEST 2



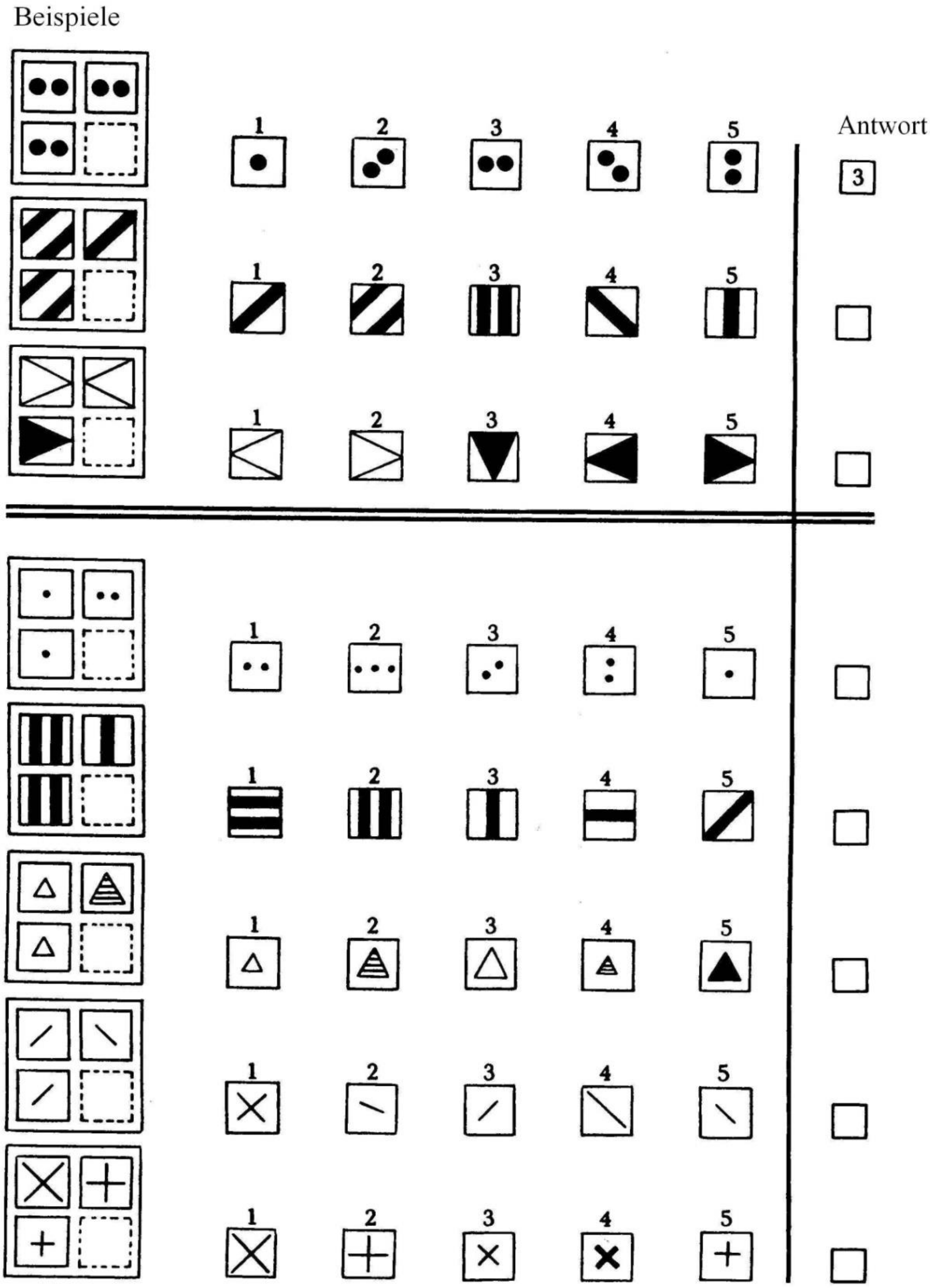


Ende von Test 2

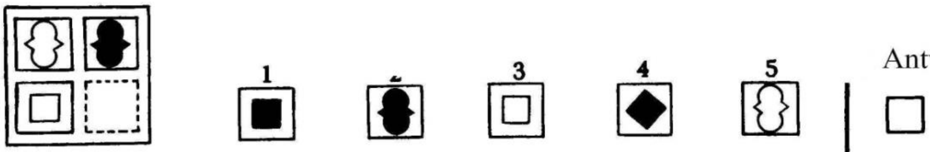
STOPP! Nicht umblättern bis wir es dir sagen.

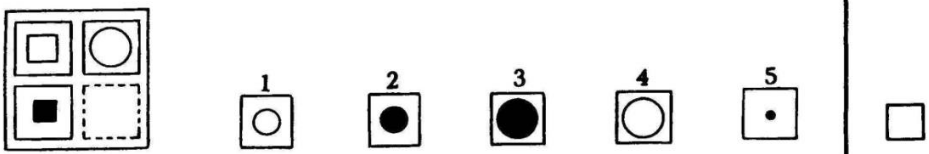
2.3. The third subtest of intelligence test (matrices)

TEST 3



Antwort

6.


7.


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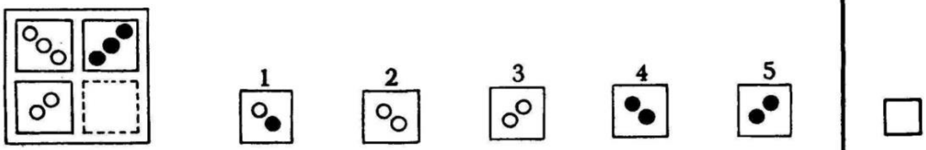
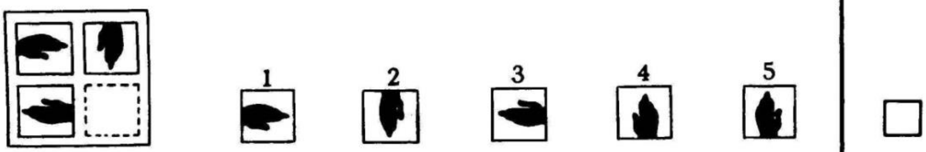


9.


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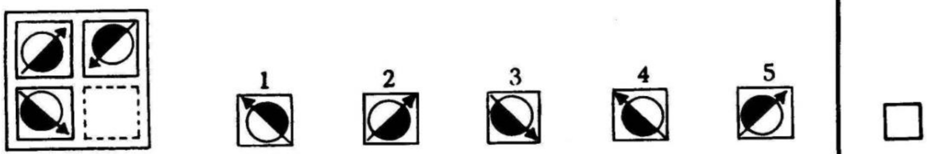
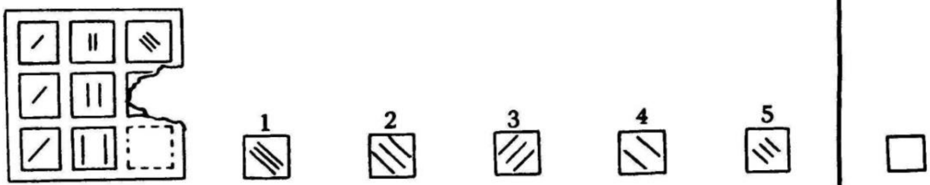
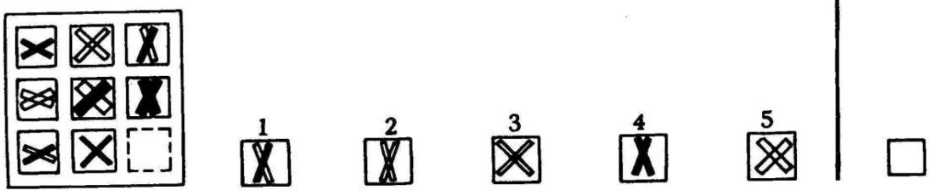


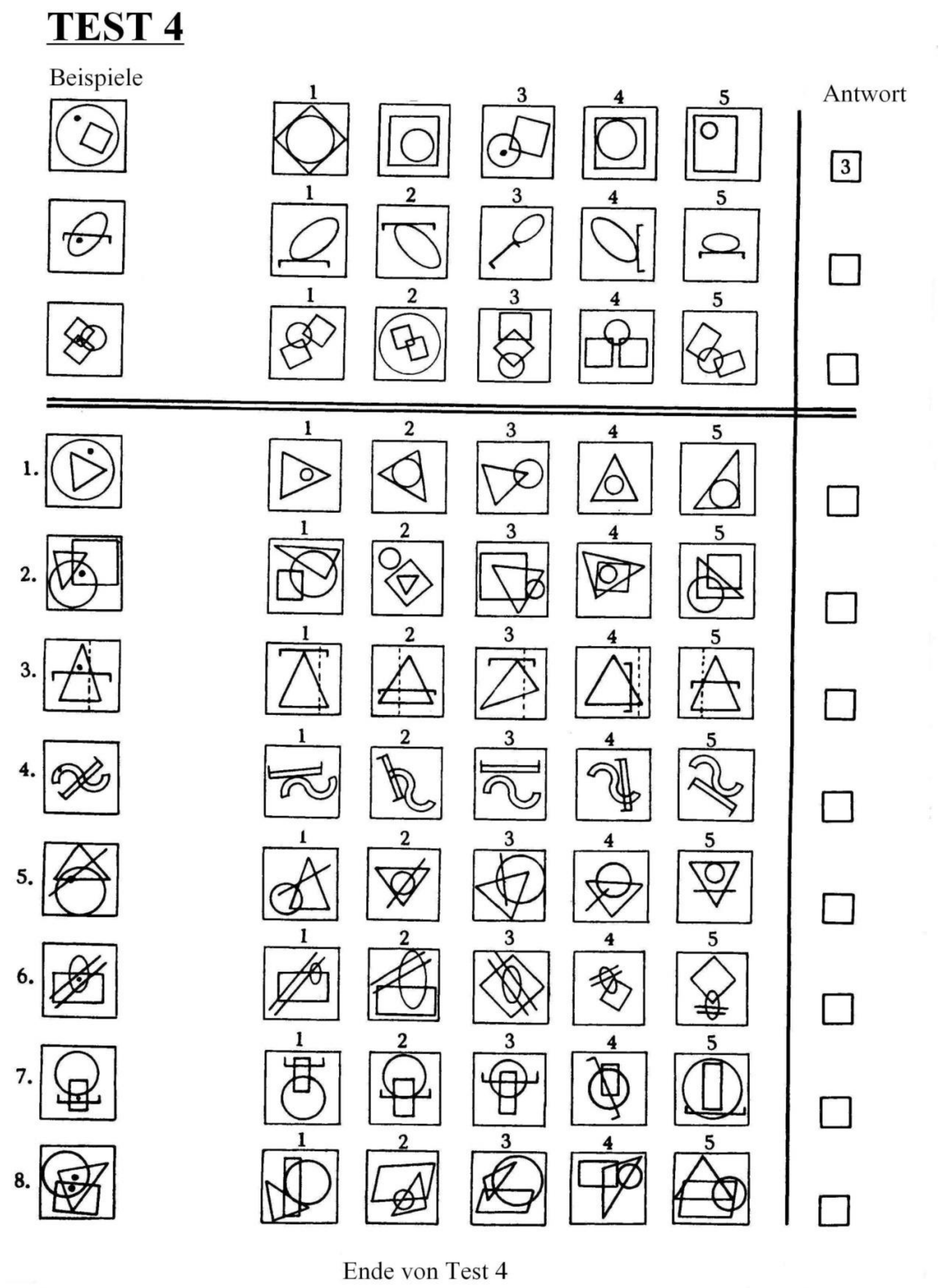
11.


12.


Ende von Test 3

STOPP! Nicht umblättern bis wir es dir sagen.

2.4. The fourth subtest of intelligence test (topological reasoning)



Appendix 3. Five-Factor Personality Inventory-Children (FFPI-C)

Jede Zeile hat zwei Sätze. Sie beschreiben, wie Menschen fühlen und über Dinge denken. Es sind fünf Kästchen zwischen den Sätzen. Lies die Sätze und kreuze an, wie sehr du ihnen zustimmst. Wenn du einem Satz zustimmst, kreuze das Kästchen an, das dem Satz am nächsten ist. Schau dir das Beispiel unten an. Falls du findest, dass Hunde eher lieb sind, kreuzt du das zweite Kästchen an.

Beispiel:

Ich glaube, Hunde sind lieb. [ ] [ ] [ ] [ ] [ ] Ich glaube, Hunde machen Angst.

Falls du dich nicht entscheiden kannst, welcher Satz eher auf dich zutrifft, kreuze das Kästchen in der Mitte an. Benutze das mittlere Kästchen so wenig wie möglich. Falls du einen Satz nicht verstehst, frage nach. Es gibt hier keine richtigen oder falschen Antworten.

Ich kann mich nicht gut an Dinge erinnern.	[ ]	[ ]	[ ]	[ ]	[ ]	Ich kann mich gut an Dinge erinnern.
Ich strenge mich im Unterricht sehr an.	[ ]	[ ]	[ ]	[ ]	[ ]	Ich strenge mich im Unterricht nicht sehr an.
Ich kann Dinge gut organisieren.	[ ]	[ ]	[ ]	[ ]	[ ]	Ich kann Dinge nicht gut organisieren.
Ich überprüfe meine Aufgaben genau, bevor ich sie abgebe.	[ ]	[ ]	[ ]	[ ]	[ ]	Ich überprüfe meine Aufgaben nicht, bevor ich sie abgebe.
Ich gebe immer mein Bestes.	[ ]	[ ]	[ ]	[ ]	[ ]	Ich mache nicht mehr als nötig.
Ich gebe meine Aufgaben zu spät ab.	[ ]	[ ]	[ ]	[ ]	[ ]	Ich erledige meine Aufgaben rechtzeitig.
Ich lege meine Kleidung ordentlich zusammen.	[ ]	[ ]	[ ]	[ ]	[ ]	Ich lege meine Kleidung nicht ordentlich zusammen.
Ich habe Probleme, meine Aufgaben rechtzeitig zu erledigen.	[ ]	[ ]	[ ]	[ ]	[ ]	Mir fällt es leicht, meine Aufgaben rechtzeitig zu erledigen.
Ich höre auf zu arbeiten, wenn ich allein bin.	[ ]	[ ]	[ ]	[ ]	[ ]	Ich arbeite weiter, wenn ich allein bin.
Ich arbeite so lange an etwas, bis es perfekt ist.	[ ]	[ ]	[ ]	[ ]	[ ]	Ich höre auf an etwas zu arbeiten, wenn es gut genug ist.
Ich will bei Gruppenarbeit meinen Teil beitragen.	[ ]	[ ]	[ ]	[ ]	[ ]	Bei Gruppenarbeiten sollen die anderen arbeiten.
Ich kann nicht gut im Voraus planen.	[ ]	[ ]	[ ]	[ ]	[ ]	Ich kann gut im Voraus planen
Ich kümmere mich darum, dass sich alle an die Regeln halten.	[ ]	[ ]	[ ]	[ ]	[ ]	Es ist mir egal, ob sich jeder an die Regeln hält.
Ich muss nicht das beste Zeugnis haben.	[ ]	[ ]	[ ]	[ ]	[ ]	Ich möchte nur das beste Zeugnis haben.
Ich achte sehr darauf, keine Fehler zu machen.	[ ]	[ ]	[ ]	[ ]	[ ]	Es ist mir relativ egal, ob ich Fehler mache.

Appendix 4. Skalen zur Erfassung der Lern-und Leistungsmotivation [Scales for the assessment of learning and performance motivation] (SELLMO)

In der Schule geht es darum,…

Bitte mache in jeder Zeile ein Kreuz.	stimmt genau 5	stimmt eher 4	weder/ noch 3	stimmt eher nicht 2	stimmt gar nicht 1
…neue Ideen zu bekommen.	[ ]	[ ]	[ ]	[ ]	[ ]
…zu zeigen, dass ich bei einer Sache gut bin.	[ ]	[ ]	[ ]	[ ]	[ ]
…dass andere Schülerinnen und Schüler nicht denken, ich sei dumm.	[ ]	[ ]	[ ]	[ ]	[ ]
…keine schwierigen Tests oder Arbeiten zu haben.	[ ]	[ ]	[ ]	[ ]	[ ]
…etwas Interessantes zu lernen.	[ ]	[ ]	[ ]	[ ]	[ ]
…mich nicht zu blamieren (zum Beispiel durch falsche Ergebnisse oder dumme Fragen).	[ ]	[ ]	[ ]	[ ]	[ ]
…zu Hause keine Arbeiten erledigen zu müssen.	[ ]	[ ]	[ ]	[ ]	[ ]
…später knifflige Probleme lösen zu können.	[ ]	[ ]	[ ]	[ ]	[ ]
…Arbeiten besser zu schaffen als andere.	[ ]	[ ]	[ ]	[ ]	[ ]
…dass niemand merkt, wenn ich etwas nicht verstehe.	[ ]	[ ]	[ ]	[ ]	[ ]
…keine schwierigen Fragen oder Aufgaben lösen zu müssen.	[ ]	[ ]	[ ]	[ ]	[ ]
…komplizierte Inhalte zu verstehen.	[ ]	[ ]	[ ]	[ ]	[ ]
…bessere Noten zu bekommen als andere.	[ ]	[ ]	[ ]	[ ]	[ ]
…nicht zu zeigen, falls ich weniger schlau bin als andere.	[ ]	[ ]	[ ]	[ ]	[ ]
…nicht so schwer zu arbeiten.	[ ]	[ ]	[ ]	[ ]	[ ]
…dass das Gelernte für mich Sinn ergibt.	[ ]	[ ]	[ ]	[ ]	[ ]
…dass andere denken, dass ich klug bin.	[ ]	[ ]	[ ]	[ ]	[ ]
…zu verheimlichen, wenn ich weniger weiß als andere.	[ ]	[ ]	[ ]	[ ]	[ ]
…dass die Arbeit leicht ist.	[ ]	[ ]	[ ]	[ ]	[ ]
…zum Nachdenken angeregt zu werden.	[ ]	[ ]	[ ]	[ ]	[ ]
…zu zeigen, dass ich die Unterrichtsinhalte beherrsche.	[ ]	[ ]	[ ]	[ ]	[ ]
…keine falschen Antworten auf Fragen der Lehrerinnen und Lehrer zu geben.	[ ]	[ ]	[ ]	[ ]	[ ]
…Aufgaben, die viel Arbeit machen, nicht selber erledigen zu müssen.	[ ]	[ ]	[ ]	[ ]	[ ]
…so viel wie möglich zu lernen.	[ ]	[ ]	[ ]	[ ]	[ ]

…das was ich kann und weiß auch zu zeigen.	[ ]	[ ]	[ ]	[ ]	[ ]
…nicht durch dumme Fragen aufzufallen.	[ ]	[ ]	[ ]	[ ]	[ ]
…mit wenig Arbeit durch die Schule zu kommen.	[ ]	[ ]	[ ]	[ ]	[ ]
…die Unterrichtsinhalte wirklich zu verstehen.	[ ]	[ ]	[ ]	[ ]	[ ]
…dass die anderen merken, wenn ich in Tests gut abschneide.	[ ]	[ ]	[ ]	[ ]	[ ]
…nicht zu zeigen, wenn mir eine Aufgabe schwerer fällt als den anderen.	[ ]	[ ]	[ ]	[ ]	[ ]
…den Arbeitsaufwand immer gering zu halten.	[ ]	[ ]	[ ]	[ ]	[ ]

Appendix 5. The permission letter which sent to the ministry of education

Hartwig Weik
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68165 Mannheim

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Talat Arbabi
Didaktik der Biologie (Chronobiologie)
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Im Neuenheimer Feld 561
69120 Heidelberg

Antrag auf Genehmigung einer wissenschaftlichen Untersuchung an Grundschulen im Rhein-Neckar-Kreis

Sehr geehrter Herr Weik,

wir bitten Sie, die Durchführung eines empirischen Forschungsprojektes an Grundschulen im Rhein-Neckar-Kreis zu genehmigen.
Das Disserationsvorhaben„ Academic Achievement and Chronotype in Elementary School Students" der Abteilung Didaktik der Biologie (Chronobiologie) der PH Heidelberg möchte herausfinden, aus welchen Gründen Schüler(innen) der Klassenstufe 4 früh oder spät schlafen und wie dieses Timing des Schlafverhaltens mit kognitiver Leistung und Persönlichkeitsvariablen wie Gewissenhaftigkeit und Motivation in Beziehung steht. Für diesen Zweck möchten wir Schüler (innen) an Grundschulen des Rhein-Neckar-Kreises befragen. Die Feldphase ist vom 15. April bis 19. Juli 2013 angesetzt. Alle Daten sollen schriftlich mit Fragebögen im Klassenzimmer erhoben werden (bitte sehen Sie Anlage 1).

Die Zustimmung der Schulleiter(innen) ist Vorbedingung. Selbstverständlich werden die Eltern von unserem Vorhaben rechtzeitig informiert (bitte sehen Sie Anlage 2) und ihre schriftliche Zustimmung abgewartet. Die Teilnahme ist anonym. Wir versichern, dass die erhobenen Daten ausschließlich für Forschungszwecke verwendet und die datenschutzrechtlichen Bestimmungen eingehalten werden.

Bitte sehen Sie in der Anlage eine ausführliche Beschreibung des Forschungsprojektes und den Fragebogen im Entwurf.

Wir freuen uns über eine positive Rückmeldung und verbleiben mit freundlichen Grüßen

Prof. Dr. Christoph Randler (Projektleiter)

Talat Arbabi (Doktorandin)

Anlagen

- Anlage 1: Befragungsinstrument für den Einsatz in der Grundschule im Entwurf
- Anlage 2: Elternbrief
- Anlage 3: Exposé zum Dissertationsvorhaben„ Academic Achievement and Chronotype in Elementary School Students"

Appendix 6. Acceptance letter of the ministry of education (Regierungspräsidium Karlsruhe)

Baden-Württemberg
REGIERUNGSPRÄSIDIUM KARLSRUHE
ABTEILUNG 7 - SCHULE UND BILDUNG

Regierungspräsidium Karlsruhe · 76247 Karlsruhe

Prof. Dr. Christoph Randler
Frau Talat Arbabi
Pädagogische Hochschule
Im Neuenheimer Feld 561
69120 Heidelberg

Karlsruhe	30.01.2013
Name	Ulrike Berger
Durchwahl	0721 926-4535
Aktenzeichen	71c2- 6499.25
	(Bitte bei Antwort angeben)

Durchführung einer wissenschaftlichen Untersuchung mit dem Thema "Beziehung von Schlafverhalten und kognitiver Leistung"
Ihr Antrag vom 13.12.2012

Sehr geehrter Herr Prof. Dr. Randler,
sehr geehrte Frau Arbabi,

das Regierungspräsidium Karlsruhe dankt für Ihr Schreiben vom 13.12.2012 samt den beigefügten Unterlagen und genehmigt die o.g. Befragung mit folgenden Maßgaben:

In Baden-Württemberg ist die Teilnahme der Schulen an wissenschaftlichen Erhebungen freiwillig; nach § 47 Abs. 4 Ziffer 4 Schulgesetz Baden-Württemberg entscheidet die Schulleiterin bzw. der Schulleiter nach Anhörung der Schulkonferenz über eine Beteiligung.
Selbst bei Zustimmung der Schulleitung erfolgt die Teilnahme der Schülerinnen und Schüler an der Befragung auf freiwilliger Basis.
Die betroffene Schulleitung ist rechtzeitig und umfassend über die beabsichtigte Umfrage zu unterrichten. Auf schulische Belange ist in vollem Umfang Rücksicht zu nehmen.
Im Elternbrief ist deutlich darauf hinzuweisen, dass die Teilnahme an der Befragung auf freiwilliger Basis erfolgt und eine Nichtteilnahme mit keinerlei Nachteilen verbunden ist.

Dienstgebäude Hebelstraße 2 76133 Karlsruhe • Telefon 0721 926-0 • Fax 0721 933-40270
abteilung7@rpk.bwl.de • www.rp.baden-wuerttemberg.de • www.service-bw.de
ÖPNV Haltestelle Marktplatz Parkmöglichkeit Parkhaus Kreuzstraße Behindertenparkplätze im Hof

Ebenso sind die betroffenen Schülerinnen und Schüler sowie deren Eltern über Sinn und Zweck der Studie sowie über die weitere Verarbeitung der Daten zu informieren. Es ist außerdem darüber zu informieren, wer die Daten erhebt, wo und wie lange diese gespeichert und von wem und wie sie ausgewertet werden.

Die bei der Befragung gewonnenen Daten dürfen nicht für andere als die angegebenen wissenschaftlichen Zwecke verwendet werden.

Die Untersuchung ist anonym durchzuführen; insbesondere darf bei der Auswertung kein Rückschluss auf die konkret befragten Einzelpersonen möglich sein.

Wir wünschen Ihnen einen erfolgreichen Verlauf der Untersuchungen.
Mit freundlichen Grüßen

Berger

Ulrike Berger

Appendix 7. Schools application letter

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«Kopf»
«Schulleitung»

«Name_der_Schule»
«Adresse»

Befragung von Viertklässlern zum Thema Chronotyp und Schlaf

«SchulleitungAnrede»,

wir möchten «Artikel»«Name_der_Schule» zur Teilnahme an einer wissenschaftlichen Studie im Rahmen des Dissertationsvorhabens„AcademicAchievementandChronotypeinElementary School Students“ einladen. Wir sind auf die Teilnahme Ihrer Schule angewiesen, um aussagekräftige Ergebnisse zu erhalten.
Ziel der Studie ist es, den Zusammenhang zwischen frühem oder spätem Schlafverhalten –dem sogenannten „Chronotyp“ – und der Schulleistung bei Grundschülerinnen und Grundschülern (Viertklässlern) im Rhein-Neckar-Kreis zu untersuchen. Wir möchten herausfinden, warum Kinder mit stärkerer Morgenorientierung besser in der Schule sind als Kinder, die einen späteren Tagesrhythmus leben. Uns interessiert, ob dieser Zusammenhang durch Charaktereigenschaften wie kognitive Fähigkeiten, Gewissenhaftigkeit und Motivation moderiert wird.
Alle Daten sollen im Klassenzimmer erhoben werden (Dauer ca. eine Schulstunde). Die Befragung soll drei Wochen nach der Zeitumstellung auf die Sommerzeit, also ab dem 15. April, stattfinden.
In der parallel zu diesem Schreiben versandten E-Mail finden Sie eine ausführliche Beschreibung des Projektes und das Befragungsinstrument im Entwurf.
Zurzeit wird die Genehmigung des Regierungspräsidiums Karlsruhe eingeholt. Die Teilnahme Ihrer Schule ist selbstverständlich freiwillig. Selbstverständlich werden die Eltern von unserem Vorhaben rechtzeitig informiert und ihre schriftliche Zustimmung abgewartet. Jede(r) Schüler(in) kann für sich entscheiden, ob sie/er teilnehmen möchte. Die Teilnahme ist für Schüler(innen) und Schulen anonym. Wir versichern, dass die erhobenen Daten ausschließlich für Forschungszwecke verwendet und die datenschutzrechtlichen Bestimmungen eingehalten werden.

Im Anschluss an die Studie erhalten die teilnehmenden Schulen ein Feed-back überIhrer Schüler(innen) mit Handlungsempfehlungen.

Wir würden uns sehr freuen, wenn Sie unsere wissenschaftliche Arbeit unterstützen.

Für Rückfragen steht Ihnen Talat Arbabi (E-Mail: arbabit@ph-heidelberg.de, Tel. dienstlich: 06221-477-256, Tel. mobil: 0176-79018610) gerne zur Verfügung.
Wir hoffen Ihr Interesse geweckt zu haben und bitten um Ihre Rückmeldung bis zum 30. Januar2013.

Mit freundlichen Grüßen
Prof. Dr. Christoph Randler M. Ed. Talat Arbabi

Parallel zu diesem Schreiben erhalten Sie eine E-Mail an «EMail» mit folgenden weiterführenden Informationen:

- Exposé zum Dissertationsvorhaben „Academic Achievement and Chronotype in Elementary School Students“ vom 7. January 2012

- Befragungsinstrument für den Einsatz in der Grundschule I im Entwurf

Appendix 8. Parental consent letter

Prof. Dr. Christoph Randler
Talat Arbabi
Pädagogische Hochschule Heidelbe
Didaktik der Biologie
Im Neuenheimer Feld 561-2
69120 Heidelberg
Tel.: 06221-477256
E-Mail: arbabit@ph-heidelberg.de

Test und Befragung zum Thema Schlaf,
Bitte um die Genehmigung zur Teilnahme Ihres Kindes

Liebe Eltern,

wie Sie vielleicht schon festgestellt haben, ändert sich das Schlafverhalten ihres Kindes mit der Zeit. Was wir noch nicht wissen, ist **wie stark Biologie, Persönlichkeit und das Schlafverhalten die kognitive Leistung beeinflussen**. Wir möchten deshalb die Schüler(innen) der Klassenstufe 4 darum bitten, einen Fragebogen auszufüllen. **Die Befragung findet in der Schule statt.** Test und Befragung sollen dazu beitragen, dass die Schüler (innen) ihre Schlafbedürfnisse besser verstehen, im Alltag berücksichtigen und im Unterricht aufmerksamer sind. Die Teilnahme eines jeden ist selbstverständlich **freiwillig**, dennoch wäre es wichtig, dass alle Schüler(innen)mitmachen. Test und Befragung sind **anonym**. Die erhobenen Daten werden den Datenschutzrichtlinien entsprechend behandelt und in tabellarischer Form (zum Beispiel nach Alter und Geschlecht) ausgewertet. Sie können sich gerne weiter über unsere Arbeit informieren, zum Beispiel unter *http://www.ph-heidelberg.de/biologie/personen/lehrende/randler.html.*

Wir sind auf Ihre Genehmigung angewiesen und würden uns sehr freuen, wenn Ihr Kind an dieser Befragung teilnehmen dürfte. In der Hoffnung, dass Sie unsere wissenschaftliche Studie unterstützen,
verbleiben wir mit den besten Wünschen

Christoph Randler
Talat Arbabi

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Test und Befragung zum Thema Schlaf: Genehmigung zur Teilnahme meines Kindes

Mein Kind, (**Vorname, Nachname des Kindes**:) ____,
darf an der Befragung zum Thema Schlaf teilnehmen.

Unterschrift eines Erziehungsberechtigten ________________________ Datum __________

Appendix 9. The name and position of the attendant schools, time of the test and number of attendant pupils in every school

N.	Name and position of the schools	Time of the test	N. of pupils
1	Schlosswiesenschule, Eschelbronn	10:20,11:25	22
2	Tiefburgschule, Heidelberg-Handschuhsheim	10:00	18
3	Schillerschule, Wiesloch	8:35,9:35	20
4	Schillerschule, Nußloch	10:40,11:00	72
5	Schatthausen, Wiesloch	12:15	16
6	Merianschule, Epfenbach	10:10	22
7	Cent-Grundschule, Reichartshausen	8:45	10
8	Karl-Drais-Schule, Hirschberg	9:45,10:30	47
9	Hans-Thoma-Grundschule, Heddesheim	11:45	22
10	Maria-Sibylla-Merian Grundschule, Wiesloch	8:45,10:15	27
11	Grundschule Wilhelmsfeld, Wilhelmsfeld	11:10	16
12	Großeicholzheim Grundschule, Seckach	9:40,10:40	14
13	Schule am Giebel, Sinsheim	10:45	31
14	Goethe-Grundschule, Hemsbach	10:00	21
15	Pestalozzi-GHS, Baiertal	8:50,10:20	36
16	Turmschule, Leimen	8:00,9:48	63
17	Leimbachtalschule, Dielheim	11:10,11:50	48
18	Dalberg-Grundschule, Ladenburg	10:30,11:30	48
19	Minneburgschule Grundschule, Neckargerach	8:45	16
20	Theodor-Heuss-Grundschule, Oberflockenbach	11:15	15
21	Theodor-Heuss-GWR, Oftersheim	8:25	10
22	Hebelgrundschule, Hemsbach	10:00	20
23	Grundschule Dühren, Sinsheim	9:35	8
24	Grundschule Rippenweier, Weinheim	12:05	7
25	Neuberg-Grundschule, Dossenheim	8:05, 9:25	46
26	Schefflenztalschule, Schleffenz	8:30	19
27	Grundschule Sulzbach, Billigheim	10:35	8
28	Wilhelm-Stern-Grundschule, Mosbach	08:40	16
29	Schwarzach Grundschule, Schwarzach	08:40	20
30	Grundschule Bargen, Helmstadt-Bargen	10:10	17
31	Humboldt-Grundschule, Plankstadt	8:45, 9:40	22
32	Brunnenschule, Waibstadt	9:40,11:40	30
33	Karl-Bühler-Schule, Meckesheim	8:25	13
34	Obrigheim Grundschule and Werkrealschule Obrigheim	9:15,10:30	41
35	Karl-Bühler-Schule, mönchzece	10:35	11
36	Häusel-Grundschule, Zuzenhausen	10:25	16
37	Eschelbach Grundschule, Sinsheim	9:55	15
38	Heiligkreuzsteinach Grundschule, Heiligkreuzsteinach	11:35	10
39	Sepp-Herberger-Grundschule, Hohensachsen	10:45	18
40	Waldsteige Grundschule, Mosbach	9:35	23
41	Lohrtalschule, Mosbach	10.40	29
42	Grundschule Rettigheim, Mühlhausen	9:15	22
43	M.Guttenbrunn Schule, Mosbach	10:40	19
44	Grundschule Dilsberg-Mückenloch, Dilsberg	9:45	13
45	Albert-Schweitzer-Schule, Weinheim	8:50	8
46	Grundschule Bargen, Bargen	10:00	12
Total			1125

Appendix 10. The work plan of the project

Plan	2012							2013												2014												2015				
	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5
1.Gathering information	*	*	*																																	
1.1.Literature studies	*	*	*																																	
1.2.Preparing and developing questionnaires	*	*	*																																	
1.3.Extraction of the participatingschools	*	*	*																																	
2.Data collection				*	*	*	*	*	*	*	*	*	*																							
2.1.Fill in the questionnaires				*	*	*	*	*	*	*	*	*	*																							
3. Final analysis														*	*	*	*	*	*	*	*	*	*													
3.2.Data input														*	*	*	*																			
3.3.Using analysis software																		*	*	*	*	*	*													
4.Scientific writing																								*	*	*	*	*	*	*	*	*	*	*	*	*
4.1.Preparation of publications																								*	*	*	*	*	*	*						
4.2.Completion of the dissertation																														*	*	*	*	*	*	*