Prediction of School Achievement by Conscientiousness, Test Anxiety, Gender, and Intelligence: The Unique Role of Chronotype

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Arash Rahafar
aus Teheran, dem Iran

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1. Berichterstatter:	Prof. Dr. Christoph Randler
2. Berichterstatter:	JProf. Dr. Christian Vollmer

To all the courageous women of my country specially:

Neda Agha-Soltan

Narges Mohammadi

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Bahareh Hedayat

Reyhaneh Tabatabai

&

"The Great" Gohar Eshghi

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Abstract

In order to extend our knowledge about school achievement and particular chronotype's role, three studies were carried out with a grand total of 695 students. Study 1 dealt with investigating psychometric properties of the reduced version of the Persian Morningness-Eveningness Questionnaire (rMEQ). Participants were 268 students recruited from two different universities. The correlations between the rMEQ and depression, happiness, and general health were -.45, .48, -.41, respectively. Moreover, the factor analysis of the rMEQ resulted in a single-factor solution and the Cronbach's α was .71. In sum, the Persian rMEQ seemed to be a reliable and valid instrument to differentiate circadian types.

In the second study, we included chronotype, gender, conscientiousness, and test anxiety in a structural equation model (SEM) with grade point average (GPA) as academic achievement outcome. Participants were 158 high school students and the SEM demonstrated that gender was the strongest predictor of academic achievement. Lower test anxiety predicted higher GPA in girls but not in boys. Additionally, chronotype as moderator revealed a significant association between gender and GPA for evening-types and intermediate-types, while intermediate-types showed a significant relationship between test anxiety and GPA. Our results suggested that gender is an essential predictor of academic achievement even stronger than low or absent test anxiety.

Study 3 examined the predictability of school achievement employing intelligence, chronotype, conscientiousness, gender, and the main subject of study in 269 students. Results showed a positive relationship between GPA and chronotype, GPA and intelligence, and between chronotype and conscientiousness. The predictors together explained 14% of variance in GPA. The variance in school achievement was explained the most by intelligence followed by gender, main subject of study, and chronotype. Chronotype was significantly correlated with school achievement even when controlled for the effects of intelligence and conscientiousness. These findings add to our knowledge about the nature of school achievement and also about the particular role of chronotype in learning.

Keywords: RMEQ, Chronotype, School achievement, Test anxiety, Intelligence, Conscientiousness

Zusammenfassung

Um unser Wissen über die schulischen Leistungen und insbesondere die Rolle des Chronotyps zu erweitern, wurden drei Studien durchgeführt. Studie 1 befasste sich mit psychometrischen Eigenschaften der reduzierten Version des persischen Morningness-Eveningness Questionnaire (rMEQ). Die Teilnehmer waren 268 Studenten und aus zwei verschiedenen Universitäten rekrutiert. Die Korrelationen zwischen dem rMEQ und Depression, Glück und allgemeiner Gesundheit waren jeweils -45, .48, -.41. Darüber hinaus führte die Faktoranalyse der rMEQ zu einer einfaktoriellen-Lösung und Cronbachs α war 0,71. Insgesamt schien die persische rMEQ ein zuverlässiges und valides Instrument sein um circadiane Typen zu unterscheiden.

In zweiten Studie schlossen wir Chronotyp, Geschlecht, Gewissenhaftigkeit und Prüfungsangst in einem Strukturgleichungsmodell (SEM) ein, mit dem Notendurchschnitt (GPA) als akademischer Leistung als abhängiger Variable. Die Teilnehmer waren 158 Schüler und das SEM zeigte, dass das Geschlecht der stärkste Prädiktor für akademische Leistung war. Geringere Prüfungsangst sagte besseren GPA bei Mädchen voraus, aber nicht bei Jungen. Zusätzlich zeigte der Chronotyp als Moderator einen signifikanten Zusammenhang zwischen Geschlecht und GPA für Abendtypen und Mischtypen, während Mischtypen eine signifikante Beziehung zwischen Prüfungsangst und GPA zeigten. Unsere Ergebnisse legen nahe, dass das Geschlecht ein wesentlicher Indikator für die akademische Leistung ist, noch stärker als niedrige oder fehlende Prüfungsangst.

Studie 3 untersuchte die Berechenbarkeit der schulischen Leistungen durch Intelligenz, Chronotyp, Gewissenhaftigkeit, Geschlecht und Hauptfach. Die Ergebnisse zeigten eine positive Beziehung zwischen GPA und Chronotyp, GPA und Intelligenz, und zwischen Chronotyp und Gewissenhaftigkeit. Die Prädiktoren erklärten zusammen 14% der Varianz in der GPA. Die Varianz im Schulerfolg wurde am meisten durch Intelligenz und nachfolgend Geschlecht, Hauptfach und Chronotyp gefolgt erläutert. Der Chronotyp war signifikant mit Schulleistung korreliert, auch wenn die Auswirkungen der Intelligenz und Gewissenhaftigkeit kontrolliert wurden. Diese Ergebnisse ergänzen unser Wissen über die Natur der Schulleistungen und auch über die besondere Rolle des Chronotyps beim Lernen.

Stichworte: RMEQ, Chronotyp, Schulleistung, Prüfungsangst, Intelligenz, Gewissenhaftigkeit

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1. Introduction to Chronotypes

Aschoff (1960), in one of the earliest studies, stated that there was a 24-hour rhythm of variation in body temperature, which is not only dependent on the environment but strongly endogenous. According to this phenomenon, the term “chronotype” has emerged. Chronotype is referred to a biological categorization, which differentiate individuals according to the time of their best feel (Kerkhof, 1985). In the study of human circadian typology there have been identified three differentiated types: on the one hand, “morningness” people tend to go to bed earlier, wake up early in the morning, and reach their physiological as well as psychological peak in the early hours of the day. On the other hand, “eveningness” people have a tendency to stay out late at night, get up later in the morning, and feel more conscious in the evening hours. “Neither-type” people are those who have been placed in the middle of these two extremes and have a fair circadian manner. Here we review some important variables affecting human’s chronotype and its association with academic achievement.

1.1. Genetic Aspects

Genes play an integral role in forming chronotypes (Katzenberg et al., 1998; Vink, Groot, Kerkho, & Boomsma, 2001; Archer et al., 2003; Carpen, Archer, Skene, Smits, & von Schantz, 2005, Jones et al., 2016). In two similar studies, it was indicated that about 50% of variance of chronotype was determined by genetic factors (Hur, 1998; Koskenvuo, Hublin, Partinen, Heikkilä, & Kaprio, 2007). The association between parent’s circadian preferences and their children is also evident in several researches (Leonhard & Randler, 2009; Werner & Jenni, 2011). Nevertheless, although genetics account for about half of the chronotype variability, other confounding factors such as environment, culture, and society moderate this relationship (Randler & Diaz- Morales, 2007; Roenneberg, Kumar, & Merrow, 2007; Randler, 2008a).

1.2. Hormones

The suprachiasmatic nucleus (SCN) is placed in the hypothalamus and is responsible for changes in circadian rhythms. Most people have an endogenous diurnal rhythm, which lasts about 24-25 hours (Czeisler et al., 1999). A group of hormones, including melatonin, cortisol, thyroid stimulating hormone (TSH), and prolactin (PRL) are secreted across the 24-hour day and are highly regulated by the circadian and sleep-wake cycles (Schechter & Boivin, 2010). The most well-known functioning hormone for adjusting the circadian rhythm is verified as the adrenal hormone cortisol (Born & Fehm, 2000). Various studies have suggested that there is a vivid relationship between social factors such as shift work, as well as biological factors like menstrual symptoms and hormonal functioning in circadian rhythms (Takeuchi, Oishi, & Harada, 2003; Negrif & Dorn, 2009; Harris et al. 2010).

1.3. Light and External Synchronization

Circadian rhythms are affected by the cycle of day and night and this rhythmicity puts human's life into the cycle of rest and activity (e.g., Enright, 1980; Minors & Waterhouse, 1985). The internal process of keeping track of the time and adjusting human's daily activity to a 24-hour rhythm is called "entrainment" (Panda, Hogenesch, & Kay, 2002). This process restarts every day with the signal of environmental light (i.e. sunlight or artificial light). Phenomenon such as sunlight is named "synchronizer" or the German word "Zeitgeber". The fact that individuals adapt their internal clock to environmental cues, they are also able to pace themselves according to an internal cycle of sleep-wake surprisingly without any extrinsic hint (Armstrong & Redman, 1993).

1.4. Social and Personality Factors

There has been growing interest in investigating the probable relationship between social and behavioral factors and chronotype. Many studies support that eveningness is more correlated with negative affects as well as physiological and psychological dysfunctions and morningness is more concerned with positive traits and psychophysiological health and well-being. For instance, a study (Mecacci & Rocchetti, 1998) showed that evening-like individuals

reported more severe and frequent psychological and psychosomatic disturbances than morning-like people and showed more problems in coping with environmental and social demands. Randler (2008b) indicated that morningness is positively correlated with satisfaction with life. In two other studies, a positive relationship between eveningness and behavioral problems, hyperactivity, and substance use was revealed (Lange & Randler, 2011; Negriff, Dorn, Pabst, & Susman, 2011) and, on the contrary, morningness people reported significantly more pro-social actions (Randler, 2009). Moreover, a series of studies suggested that eveningness is correlated with dysfunctional and antisocial behavior as well as adjustment problems (e.g., Hidalgo & Caumo, 2002; Goldstein, Hahn, Hasher, Wiprzyca & Zelazo, 2007; Randler, 2008c). In relation to previous findings, Díaz-Morales & Sánchez-López (2008) revealed that women with stronger tendency toward eveningness reported higher anxiety. Thus, several findings corroborate the correlation between psycho-social factors and chronotype.

Regarding the relationship between chronotypes and personality traits there have been several studies carried out. As Adan et al. (2012) summarize, evening types are more likely to report higher extraversion and neuroticism on the Eysenck Personality Inventory (EPI; Eysenck & Eysenck, 1975). Among the dimensions of the Five-Factor Model (The Big Five; Costa & McCrae, 1992), it turned out that morning individuals displayed higher agreeableness and conscientiousness constantly (Adan et al., 2012). According to Adan et al. (2012), conscientiousness was the only factor of Big Five that showed a consistent association with morningness in all the studies they reviewed.

1.5. Gender

Gender differences in chronotype seem to be controversial among the studies carried out so far. Most of the studies have claimed that females have a tendency to go to bed earlier and consequently, wake up in the early hours in the morning (Adan & Natale, 2002; Achari & Pati, 2007; Randler, 2007) However, there have been a few studies that did not to show such a difference. (Neubauer, 1992; Kim et al., 2002).

1.6. Age

Circadian rhythmicity alters in different stages of someone's life. It has previously been examined that, in early ages before thirteen, people tend to be more morning-oriented (Werner et al., 2009). A great number of studies have claimed that around the age of thirteen and by the emerge of puberty adolescents swap morningness for eveningness (Carskadon, Vieira, & Acebo, 1993; Roenneberg, 2004; Diaz-Morales & Gutiérrez, 2008; Randler, 2008a). This shift has three main characteristics; the sleep duration is shortened, bed time is delayed, and lastly, the sleep duration on weekends is increased compared to weekdays (Carskadon, 1990, 2002; Mercer, Merritt, & Cowell, 1998). The other studies suggest a shift toward morningness around the age of 20 again (Roenneberg et al., 2004, 2007). Gradually, the older people get, the more they become morning-type (Roenneberg et al., 2004; Taillard, Philip, Chastang, & Bioulac 2004; Roenneberg et al., 2007; Tonetti, Pasquini, Fabbri, Belluzzi, & Natale, 2008).

1.7. School Achievement and Its Correlates

The apparent and the most relevant predictor of academic achievement are cognitive abilities (e.g., Mayes et al., 2009). Intelligence has been found as the key variable of cognitive performance which directly affects academic achievement. In a plethora of studies, it has been strongly evidenced that IQ can solely predict about 50-70% of the changes in academic achievement's variance (Gustafsson & Undheim, 1996; Gottfredson, 2002). However, other factors such as motivation, sleep, gender, etc. accounted for the changes in the variance of achievement. Here we bring the relationship between educational outcome and our independent variables into focus.

Circadian preference. Circadian preferences seem to influence cognitive functions like attention (Matchock & Mordkoff, 2009), thinking style (Fabbri, Antonietti, Giorgetti, Tonetti, & Natale, 2007), visual search (Natale, Alzani, & Cicogna, 2003), cognitive failure (Mecacci, Righi, & Rocchetti, 2004), intelligence (Goldstein et al., 2007; Roberts & Kyllonen, 1999), and executive functions (Hahn et al., 2012). In spite of the fact that evening people are considered to be more

intelligent, the students with a morning orientation perform better in school achievement and attain higher grades (e.g., Hess, Sherman, & Goodman, 2000; Digdon & Howell, 2008; Beşoluk, 2011; Preckel, Lipnevich, Schneider, & Roberts, 2011; Vollmer, Pötsch, & Randler, 2013; Tonetti et al, 2015). In a study, Preckel and her colleagues (2011) showed that when other confounding factors such as cognitive ability, conscientiousness, need for cognition, achievement motivation, and gender were held constant, eveningness was still a significant negative predictor of General Grade Point Average (GPA). Morning-like students have a better function in either their daily routines or school activities (Wittmann, Dinich, Merrow, & Roenneberg 2006). This could be a result of schools' early starting time that morning students may benefit from (Randler & Frech, 2006, 2009; Randler, 2011). In the other words, it could be the outcome of the "synchrony effect" which refers to synchrony between one's preferred time of day and test time. Research suggested people with different chronotype would do their best at times fitting their preference (e.g., Hahn et al., 2012). "Social jetlag" would be another well-known phenomenon for describing the link between eveningness and achieving lower grades. This phenomenon addresses the asynchrony between social routine time plan and one's internal sleep-wake preference -that is- individuals with an evening orientation might be disadvantaged due to not fitting school or institutional temporal plans, which in turn eventuates in academic procrastination and worse school achievement.

Conscientiousness. As it turned out, among personality characteristics, conscientiousness is known as the strongest correlate of school achievement (e.g., Bratko, Chamorro-Premuzic, & Saks, 2006; Richardson & Abraham, 2009; Caprara, Vecchione, Alessandri, Gerbino, & Barbaranelli, 2011). In a meta-analysis, O'Connor & Paunonen (2007) have strongly corroborated a positive and consistent correlation between conscientiousness and academic performance, while other personality characteristics are unrelated or inconsistently related to academic performance (such as agreeableness). Conscientiousness is defined as a tendency toward self-regulation, order, punctuality, being organized and doing tasks well. In a study carried out by Wagerman and Funder (2007) on undergraduate students, results yielded conscientiousness' unique share in variance of senior GPA beyond the traditional predictors of academic

achievement such as High School Grade Point Average (HSGPA) and Scholastic Assessment Test (SAT) scores.

Test anxiety. Test anxiety is another important factor in achievement which is a worldwide phenomenon mostly experienced by teens (Beidel, Turner, & Taylor-Ferreira, 1999). A study reported that exams were the most common source of stress among British 16-years old students. Test anxiety is defined as the anxiety response to examinations or assessment situations. Studies have frequently shown that test anxiety has a negative impact on school performance. For instance, Hembree (1988) suggested a negative correlation between test anxiety and performance on many cognitive tests (r = -0.18). This was in line with Seipp's findings (1991) reporting a negative correlation between test anxiety and achievement (r = -0.23). These findings back this hypothesis that student with higher test anxiety achieve lower marks. Regarding the relationship between test anxiety and gender, research shows that girls report higher test anxiety than boys (see Hembree's review, 1988). Some researchers believe this difference lays in women overestimating environmental risks (Cassady & Johnson, 2002) and their doubts about their own ability to cope with them (Zohar, 1998).

Gender. Gender –another correlate of educational outcome—is supposed to play a critical role in achievement. It has been frequently reported that girls outperform boys in academic performance (USA: e.g., Epstein, Elwood, Hey, & Maw, 1998; Asia: e.g., Wong, Lam, & Ho, 2002; Europe: e.g., Van Houtte, 2004). However, the reasons of this difference are not well-understood because it is observed through a myriad number of studies that girls don't differ from boys in overall cognitive abilities (e.g., Feingold, 1988; Halpern, 2000). In a new try to find out the role of gender in academic affairs, Steinmayr & Spinath (2008) considered the role of gender by controlling for Intelligence, the Big Five of personality and motivational variables (achievement motives, goal orientation, task values and ability self-concepts). They concluded that after controlling for intelligence, the relationship between sex and academic achievement was still significant, however, personality characteristics (such as higher conscientiousness) and emotional variables could explain sex differences in school attainment.

In conclusion, here I summarize the reciprocal relationships between our independent variables and chronotype and school achievement, based on the literature reviewed so far. Morning individuals are advantaged in schools and outperform evening ones. Morning ones are more conscientious and students with higher conscientiousness perform better in the school. Girls tend to be more morning-oriented and achieve better grades than boys. Eveningness is related to higher anxiety in women and women display greater amounts of test anxiety, which negatively affects school achievement. Evening students tend to be more intelligent compared to morning ones and intelligent students have obviously better grades

2. State of Research

A considerable body of research has proved a consistent but small correlation between morningness and having better grades in school as well as universities (Vollmer, Pötsch, & Randler, 2013; Preckel et al., 2011; Beşoluk, 2011). In such studies, the researchers have drawn a direct line between morningness and a better academic performance, however, this approach does not fit the cognitive science methodology if one considers human phenomena as unidimensional. In the formation of an important variable like school achievement, there are many other variables involved. If one disregards other variables contributing to the school achievement, he or she would not be able to constitute an entire understanding of its nature. That is why many scientists try to include as many as variables they could in a research plan to maximize the accuracy of their estimation of the impact of independent variables on dependent variable. On the other hand, one cannot measure all the variables playing a role in the variance of the output variable; first because of the limitations in assessment's procedures such as too lengthy questionnaire batteries which make the participant unwilling to take part in the study, and second, because of the enormous interaction of variables when they are too many in number making the interpretation of the interactions impossible. Therefore, researchers try to employ those variables which have greater contribution to the variance of dependent variables. Linked with my studies, the main question emerged as: Is the relationship between morningness and better school performance a pure relationship or are there some covariates which influence school achievement but have not concurrently been measured yet? This question is important because of the lack of strength in the relationship between morningness and school achievement (r = .16) and eveningness and school achievement (r = -.14) according to Preckel et al.'s study (2011). An extension of the above question would be "what happens to this relationship if we involve critical variables in the context of educational achievement such as intelligence, conscientiousness, gender, and test anxiety?". Will the relationship between circadian preference and achievement remain still significant even when those variables are taken into account or is the effect spurious and just because of the existence of other variables and when we put them into the design, the significance of the effect will disappear? This big question led

me to design a model consisting of those variables plus chronotype to see how they interact with each other and the dependent variable, school achievement.

2.1. Research objectives

The present study aimed at:

- First of all, investigating the psychometric properties of the reduced Morningness-Eveningness Questionnaire (rMEQ) in an Iranian sample to check its validity and reliability.
- Looking for possible relationships between chronotype and performance in school as well as the other involved variables in this design.
- Controlling for the effects of intelligence, gender, test anxiety, and conscientiousness in the relationship between chronotype and school achievement.
- Developing a model of school achievement when chronotype, intelligence, gender, test anxiety, and conscientiousness play the role of predictors together.
- Testing the proposed model for gender and different chronotypes separately to see which model serves us the highest degree of prediction.

2.2. Research questions

- Is the reduced Morningness-Eveningness Questionnaire (rMEQ) is a valid and reliable measure in an Iranian population to assess chronotypes?
- Does a relationship exist between chronotype and academic achievement in high school's final grade students?
- Can chronotype predict school achievement significantly even after controlling for intelligence, gender, test anxiety, and conscientiousness?
- How can chronotype, intelligence, gender, test anxiety, and conscientiousness predict school achievement in a model using Structural Equation Modeling (SEM)?
- Which above-mentioned variables can explain the greatest portion of the variance of school achievement?

- Do separate models for boys and girls as well as the three chronotypes explain school achievement the best or the overall model solely?

3. An overview of Studies 1, 2, and 3

Study 1 was the most basic study among these three studies which dealt with testing the psychometric properties of Persian version of rMEQ which was our essential measure for assessing chronotypes. It was carried out on university students in Tehran and supported the validity and reliability of rMEQ for the future use on high school students.

Study 2 involved chronotype, gender, test anxiety, and conscientiousness as the independent variables and school achievement as dependent variable. This study was done on the last grade high school students in Gorgan, Iran. An overall model and two extra models based on gender and chronotype were proposed.

Study 3 included chronotype, gender, intelligence, and conscientiousness as the independent variables and school achievement was employed as dependent variable. This study was also carried out on the last grade high school students in Damghan, Iran. Compared to study 2, this study involved intelligence instead of test anxiety and corroborated the unique role of chronotype after being adjusted by the variable mentioned above (could be found in appendix).

One of the reason for not using test anxiety and intelligence together was the length of the measurements and also probable difficulties in the interpretation of the results. Having all the independent variables in one single research design could make it boring for the students and could have them provide intentionally wrong answer to the tests due to tiredness. So I decided to use one design in the second study and the other one in the third one.

3.1. Study 1: Psychometric Properties of the Persian Version of the Reduced Morningness-Eveningness Questionnaire: Further Evidence

Abstract

Circadian types are related to many physiological, cognitive, and behavioral variables and, therefore, a need for a questionnaire in Farsi language to assess those preferences is emerged. The present study aimed at exploring psychometric properties of the reduced version of the Persian Morningness-Eveningness Questionnaire (rMEQ). Participants were 268 students recruited from two different universities. Three questionnaires were used to investigate the additional validity data of the Persian version of the rMEQ: Beck Depression Inventory (BDI-II), Oxford Happiness Questionnaire (OHQ), and General Health Questionnaire (GHQ-12). The correlations between the rMEQ and the three other questionnaires were -.45, .48, -.41, respectively. Moreover, the factor analysis of the rMEQ resulted in a single-factor solution and the Cronbach's α was .71. In sum, the Persian rMEQ seemed to be a reliable and valid instrument to differentiate circadian types. We suggest that future studies focus on test-retest reliability of the rMEQ and an analysis of its unidimensionality with other methods like Item-Response Theory (IRT).

Keywords: reduced Morningness-Eveningness Questionnaire, circadian rhythms, validity

Introduction

In the study of human circadian typology there have been identified three differentiated types: on the one hand, “morningness” people tend to go to bed earlier, wake up early in the morning, and reach their cognitive and physiological peaks in early hours of the day. On the other hand, “eveningness” people have a tendency to stay out late at night, get up later in the morning, and feel more conscious in the evening hours. Finally, “neither-type” people are those who have a fair circadian manner.

It has been repeated in many studies that eveningness is correlated with negative states as well as physiological and psychological dysfunctions, and morningness is more concerned with positive states and psychophysiological welfare. For instance, a study showed that evening-like individuals reported more severe and frequent psychological and psychosomatic disturbances than morning-like people and showed more problems in coping with environmental and social demands (Mecacci & Rocchetti, 1998). Randler (2008b) indicated that morningness is positively correlated with satisfaction with life. In two later studies, there were positive relationships between eveningness and behavioral problems, hyperactivity, and substance use and, on the contrary, morningness was related to more pro-social (Lange & Randler, 2011; Negriff et al., 2011). Moreover, a series of studies suggested that eveningness is correlated with dysfunctional and antisocial behavior as well as adjustment problems (e.g., Goldstein et al., 2007; Randler, 2008c; Hidalgo & Caumo, 2002). In another study, Khaleque (1998) demonstrated that night shift workers had a lower quality of life. In relation to previous findings, Díaz-Morales & Sánchez-López (2008) revealed that the women with stronger tendency toward morningness reported lesser anxiety. Besides, in a chain of studies, a positive correlation between eveningness and mood disorders especially depression has been demonstrated (e.g., Takeuchi et al., 2002; Natale, Adan, & Scapellato, 2005; Lee et al. 2010; Hasler et al., 2010).

Although the most widely used instrument for assessing circadian typology is the Morningness-Eveningness Questionnaire (MEQ; Horne & Östberg, 1976), it concerns several issues such as lack of high homogeneity, not reporting the original scale reliability, and setting the cutoffs based on a small sample size and only adult participants (Di Milia et al., 2013).

Regarding the problems with MEQ, Adan & Almirall (1991) tried to create a reduced form of MEQ called rMEQ. This reconstructed short version consists of only 5 items of the original MEQ (items 1, 7, 10, 18, & 19), and seems to be unidimensional. In order to estimate psychometric properties of the rMEQ, it has been employed in several countries (Natale et al., 2006; Caci et al., 2009; Randler, 2013). A recent review (Di Milia et al., 2013) revealed that the rMEQ is highly correlated with the original MEQ ranging from .87 to .90, has a great sensitivity and coincidence to categorize individuals similar to MEQ categories (above .78%), and reports its test-retest reliability between .76 and .79. With regard to the importance of having a valid instrument and the relationship between circadian typology and other biopsychosocial variables, it seems that extra analyses to validate the Persian rMEQ are essential and needed. Thus, we decided to calculate construct validity of the rMEQ by performing a factor analysis using Principal Components (PC) as the method and with a varimax rotation and also exploring additional evidence of its validity using three other questionnaires: Beck Depression Inventory-2nd edition (Beck, Steer, & Brown, 1996), Oxford Happiness Questionnaire (Hills & Argyle, 2002), General Health Questionnaire-12 (Goldberg, 1972).

Materials and Methods

Participants were 300 student recruited from Allameh Tabataba'i University and Islamic Azad University (Tehran Science & Research Branch), who filled out our battery of questionnaires including rMEQ, BDI-ll, OHQ, and GHQ-12. Our exclusion criteria were sleep disorders and night shift works. At last, individuals with missing data were removed and then 268 university students remained and were entered into analyses using SPSS 19.

Reduced Morningness-Eveningness Questionnaire (rMEQ)

rMEQ is a 5-item self-report questionnaire extracted by Adan & Almirall (1991) to determine an individual's chronotype. Scores range from 4 to 25 and higher scores indicate a stronger shift toward morningness. Adan & Almirall (1991) divided the scores into three categories: 4-11 as eveningness, 12-17 as neither type, and 18-25 as morningness. Firstly, the original rMEQ was translated into Farsi language by the main author. Then, the translated

questionnaire was given to a bilingual translator to translate it back into English. Eventually, the differentiations between the two English versions were investigated and discussed precisely and, after applying all the considerations, the ultimate Persian edition was prepared and administrated.

Beck Depression Inventory 2nd edition (BDI-II)

BDI-II (Beck, Steer, & Brown, 1996) is a revised version of the original BDI which consists of 21 items evaluating depression symptoms. Scores can range from 0 to 63 and higher scores exhibit more depressive characteristics. In a study in Iran, α was reported as .78 and test-retest reliability during two weeks was .73 (Dastani et al, 2010).

Oxford Happiness Questionnaire (OHQ)

Hills & Argyle (2002) renewed their original OHQ by refining some old items. OHQ is a 29-item questionnaire based on a 6-degree Likert scale which could be varied from 29 to 174 and the more one gains score, the happier he/she would be. Hadinezhad & Zareie (2009) reported for its Persian version as .84 and test-retest reliability reached as .78. They also estimated the face and construct validity of OHQ and indicated its compatibility and usability for the Iranian population.

General Health Questionnaire-12 (GHQ-12)

GHQ-12 is a short-form version of original GHQ preliminarily designed by Goldberg (1972). GHQ assesses four different domains: somatic symptoms, anxiety/insomnia, social dysfunction, and severe depression. There are, also, different types of scoring. We used binary scoring method which with the two least symptomatic answers scoring 0 and the two most symptomatic answers scoring 1. Scores can range from 0 to 12 and greater scores correspond with unhealthier psychiatric conditions. Ebadi et al. (2002) investigated psychometric properties of the Persian version of GHQ-12 and showed both its reliability and validity. They reported α= .87.

Results

The sample indicated that out of 268 individuals, 167 (62.3%) were female and 101 (37.7%) were male and the average age was 24.70 ± 3.82 (X ± SD). Obtained means and SDs for the measures were as following: rMEQ (15.05 ± 3.71), BDI-ll (9.25 ± 9.22), OHQ (123 ± 25.32), and GHQ (3.37 ± 3.88). Moreover, Cronbach's α for rMEQ, BDI-II, OHQ, and GHQ-12 was .71, .91, .95, and .92, respectively.

The distribution of rMEQ scores of the sample is presented in Fig. 1.

Figure 1. The frequency distribution of rMEQ

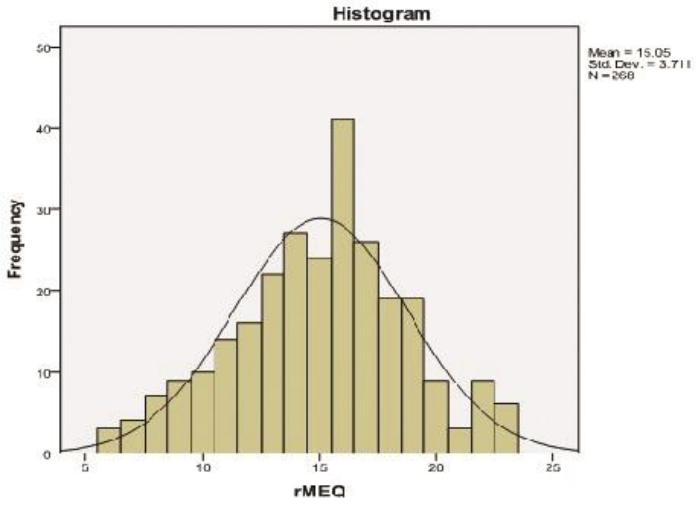


Figure 1 The frequency distribution of reduced Morningness-Eveningness Questionnaire (rMEQ).

As shown in Fig.1, the scale was left skewed with -.147 ± .149, and kurtosis was -.227 ± .297. The percentiles were 10% (10), 20% (12), 30% (13), 40% (14), 50% (15), 60% (16), 70% (17), 80% (18), and 90% (20). Based on cut-offs provided by Adan and Almiral16 17.5% of our sample was evening-type, 58.2% neither-type, and the rest 24.3% consisted of morning individuals.

In order to achieve additional information of the rMEQ validity, a series of correlations between all four measures was performed. Results are presented in table 1.

Table 1. Pearson correlations between rMEQ, BDI-II, GHQ, and OHQ

	rMEQ	BDI-II	GHQ-12	OHQ
rMEQ				
BDI-II	-.45*			
GHQ	-.41*	.76*		
OHQ	.48*	-.80*	-.74*	

*P< 0.01

As shown in Table 1, all the correlations are in accordance with the assumed directions and significant at .01 level. The rMEQ was positively correlated with OHQ (.48) and negatively with BDI-II (-.45) and GHQ-12 (-.41).

In the next step, factorial analyses were carried out in order to calculate the construct validity of the rMEQ. To indicate the suitability of data for structure detection, KMO and Bartlett's tests were executed. Both KMO (= 0.739) and Bartlett ($\chi 2$= 283.21, $p < 0.0001$) tests were significant. For further analyses, we employed principal components (PC) with varimax rotation simultaneously. Table 2 comprises the results of the emerged factors.

Table 2. Eigenvalues, % of variance explained, and % of cumulative variance for the Persian rMEQ

	Factors				
	1	2	3	4	5
Eigenvalues	2.39	.98	.66	.58	.37
% of variance explained	47.88	19.68	13.24	11.63	7.55
% of cumulative variance	47.88	67.56	80.81	92.44	100.00

After analyses, only one factor with the eigenvalue greater than 1 emerged which totally explained 47.88% of variance. The results of factor loadings are illustrated in Table 3.

Table 3. Principal component analysis with varimax rotation and factor loadings for the Persian rMEQ

Item	Original item No.	Item content	Loadings
1	1	Preferred time to get up freely	0.63
2	7	Morning affect during the first of hour after waking up	0.66
3	10	Time of feeling tired and need of sleep	0.47
4	18	Time of feeling best	0.79
5	19	Guessing the chronotype	0.83

As shown in table 3, in total, all five items loaded on a single factor. Item 5 showed the highest factor loading (0.83) and item 3 the lowest (0.47)

Cronbach's α for rMEQ was .71. Analyses of internal consistency for this measure showed that item 19 had the highest (0.64) and item 10 lowest (0.29) item-scale correlation. Further analyses indicated that removing item 10 lead to a higher alpha (however, very low; 0.72) and removing item 19 eventuated in an obvious fall in alpha (0.59). Detailed results are illustrated in Table 4.

Table 4. Corrected item-total correlation and effect of item deletion on Cronbach's alpha for the Persian rMEQ.

Discussion

item	Corrected item-total correlation	Cronbach's alpha if item deleted
1	.42	.68
2	.45	.68
3	.29	.72
4	.61	.61
5	.64	.59

It has been clearly declared that circadian rhythms are in relation to a variety of mental, behavioral, and physiological variables and their interaction has been the focus of interest of many studies.

Human circadian preferences affect a number of our critical behavioral, psychological, and physiological functions. Therefore, a need for an instrument to assess one's circadian type is highly emerged so that we could explore the possible relationships among different variables. Since there was a lack of a proper measure for assessing chronotypes in Iran, we tried to gather information about the construct validity of the Persian rMEQ. Thus, besides factor analyses, three additional questionnaires were used to find more evidence of the validity of the rMEQ in Iran.

Results indicated that all the correlations were consistent with the previous findings. The correlation between rMEQ and BDI-II was -.45 which confirms that morningness is inversely related to depressive symptoms and mood. rMEQ and OHQ were positively correlated (r=.51) which indicates that morning people are happier than evening ones. These findings were in accordance with the previous studies (e.g., Takeuchi et al., 2002; Natale et al., 2005; Rybak et al., 2007; Wood et al., 2009; Lee et al. 2010; Hasler et al., 2010). A negative relationship between rMEQ and GHQ-12 was observed (r = -.45) which suggests that morning-type individuals are in a more healthy psychological and physical state than evening people. Also, these results were in agreement with earlier findings (Mecacci & Rocchetti, 1998; Randler, 2008b; Goldstein et al., 2007; Hidalgo & Caumo, 2002; Khaleque, 1998; Sánchez-lópez & Díaz-Morales, 2008).

For additional validation of the rMEQ, a series of factor analyses were performed. Results indicated that all five items loaded on one single factor. This unidimensionality seems to be consistent with previous findings. For instance, Adan & Almirall (1991) after a set of analyses of MEQ came up with three factors, among them only one factor was representative of pure morningness which constructed the current rMEQ. In a recent study Randler (2013) performed a factor analysis to investigate the construct validity of rMEQ. Interestingly, in his study also a single-factor solution emerged. This is despite the fact that the rMEQ items assess not only morningness but also different aspects of circadian habits and feelings. These evidences for unidimensionality could be a marker of the validity of a chronotype test which asserts that it measures a single concept rather than a mixture of them. Although the item-scale correlations suggest that removing item 3 leads to a higher alpha, we suggest retaining all five items according to Adan & Almirall (1991). It is important to have an instrument that is comparable to the measures derived from different countries.

This study had some limitations in sampling and selecting variables. We used non-probability sampling with a method of convenience sampling which could be considered as a sloppy sample. So, the result should be treated with caution. Another limitation was the sample size which was however satisfying, but a larger sample in factorial analysis is more assuring. The last limitation was the lack of assessing sleep-wake variables that we could not include in our research design. We suggest that future studies take more evidences for reliability of rMEQ during the time, collecting sleep-wake variables as important related factors, expanding the participants to other than students, and analysis of the unidimensionality of rMEQ with Item-Response Theory (IRT) into account.

3.2. Study 2: The Role of Chronotype, Gender, Test Anxiety, and Conscientiousness in Academic Achievement of High School Students

Abstract

Previous findings have demonstrated that chronotype (morningness/intermediate/eveningness) is correlated with cognitive functions, that is, people show higher mental performance when they do a test at their preferred time of day. Empirical studies found a relationship between morningness and higher learning achievement at school and university. However, only a few of them controlled for other moderating and mediating variables. In this study, we included chronotype, gender, conscientiousness, and test anxiety in a structural equation model (SEM) with grade point average (GPA) as academic achievement outcome. Participants were 158 high school students and results revealed that boys and girls differed in GPA and test anxiety significantly with girls reporting better grades and higher test anxiety. Moreover, there was a positive correlation between conscientiousness and GPA (r = 0.17) and morningness (r = 0.29), respectively, and a negative correlation between conscientiousness and test anxiety (r = –0.22). The SEM demonstrated that gender was the strongest predictor of academic achievement. Lower test anxiety predicted higher GPA in girls but not in boys. Additionally, chronotype as moderator revealed a significant association between gender and GPA for evening-types and intermediate-types, while intermediate-types showed a significant relationship between test anxiety and GPA. Our results suggest that gender is an essential predictor of academic achievement even stronger than low or absent test anxiety. Future studies are needed to explore how gender and chronotype act together in a longitudinal panel design and how chronotype is mediated by conscientiousness in the prediction of academic achievement.

Keywords: academic achievement; chronotype; gender; test anxiety; conscientiousness

Introduction

Individuals form their lives in a cycle of rest and activity. Concerning human circadian preferences, three different types have been verified. “Morning” types are the people who feel fresh in the morning, go to bed early and wake up early. “Evening” types are characterized with a later sleep-wake time and they feel best in the evening. “Intermediate” types are the ones with a moderate circadian habit and are located between those two extremes.

One’s circadian preference has been considered to affect his/her cognitive functions like attention (Matchock & Mordkoff, 2009), thinking style (Fabbri et al., 2007), visual search (Natale et al., 2003), cognitive failure (Mecacci et al., 2004), intelligence (Goldstein et al., 2007; Roberts & Kyllonen, 1999) and academic achievement (e.g., Beşoluk, 2011; Digdon & Howell, 2008; Hess et al., 2000; Randler & Frech, 2006, 2009). Besides chronotype, we’ll have a closer look at other variables involved in the present study (gender, test anxiety and conscientiousness) which also are supposed to have an influence on academic achievement.

Chronotype

Research on the relationship between circadian preference and scholastic achievement has revealed a better performance by morning types (or a worse performance by evening types, respectively) in their exams or their GPA (e.g., Arbabi et al., 2014; Beşoluk et al., 2011; Escribano et al., 2012; Preckel et al., 2011; Vollmer et al., 2013;). In a meta-analysis (Preckel et al., 2011) by reviewing 13 studies, it was found that eveningness was negatively related with academic achievement (r = –0.14) and morningness correlated positively with it (r = 0.16). These results show that morning types are at an advantage since school starts in the early morning and therefore, get better grades than their evening classmates. Evening types have later sleep/wake habits and since schools mostly starts in the morning hours of the day, those with later chronotypes become gradually sleep-deprived and this reduction in sleep length leads to lower mood (e.g., Roberts et al., 2001) and lower cognitive performance (e.g., Wolfson & Carskadon, 1998).

Gender

Gender also plays a critical role in academic achievement. For instance, Nowell and Hedges (1998), in a review of the trends in gender differences in academic achievement from 1960 to

1994, claimed that the dominant pattern of males scoring higher on tests of mathematics, science, and the composite and females having better results on test of reading, perceptual speed, and writing has been consistent over time with an exception for science and mathematics with increasing gender equality. When considering GPA rather than single major subjects as indicator of academic achievement, research showed that girls had better grades than boys (Chee, Pino, & Smith, 2005; Freudenthaler et al., 2008).

Conscientiousness

Concerning the five-factor model of personality dimensions, conscientiousness is correlated positively to both morningness (e.g., Jackson & Gerard, 1996; Randler, 2008d; Russo, Leone, Penolazzi, & Natale, 2012; Tonetti, Fabri, & Natale, 2009; Walker et al., 2014) and academic achievement (e.g., Arbabi et al., 2014; Komarraju & Karau, 2005; Paunonen & Ashton, 2001; Wagerman & Funder, 2007). Tsaousis (2010), in a review of 35 independent samples, suggested that conscientiousness, among the other big-five personality dimensions, is the most related to morningness (r = 0.29). In addition, two independent reviews (O'Connor & Paunonen, 2007; Vedel, 2014) indicated that conscientiousness is the strongest predictor of scholastic achievement through all other personality factors, suggesting that this personality dimension needs to be considered more precisely in assessing educational process and outcome, especially when addressing chronotype.

Test anxiety

Another factor affecting the test performance is considered to be test anxiety which is defined as the set of phenomenological, physiological, and behavioral responses that accompany concern about possible negative consequences or loss of competence in an examination or similar evaluative situation (Zeidner, 1998). It is a consistent finding that the higher levels of test anxiety predict lower performance in a test (e.g., McIlory & Bunting, 2002; Zeidner, 1998). In a meta-analysis with 156 effect sizes from 126 different studies, Seipp (1991) yielded a population effect size of –0.21 for the correlation between test anxiety and academic achievement stating the notion of this construct in educational contexts. Additionally, concerned with the relationship of anxiety and chronotype, Díaz-Morales & Sánchez-López (2008) indicated a negative correlation

between anxiety and morningness in women and Matthews (1988) displayed the same tendency but only in men.

There are a few studies to evaluate the reciprocal effects of circadian preferences, conscientiousness, and test anxiety. For example, a research (McIlory & Bunting, 2002) suggested that academic conscientiousness, test anxiety, and previous achievement accounted for unique and shared variance on test performance. In a recent study, Arbabi and colleagues (2014) demonstrated morningness was positively correlated with conscientiousness, intelligence, and learning objectives. Moreover, conscientiousness was the second strongest predictor of learning achievement. To our knowledge, there is no study assessing the combined effects of chronotype, conscientiousness, and test anxiety on academic achievement. This lack of data led us in constructing a model of academic performance involving those variables simultaneously. We employed gender and chronotype as moderator in our two suggested models. A definition for "moderator variable" by Howitt & Cramer (2014) suggests that "a moderator variable is one which shows that the relationship between an independent variable and a dependent variable is not consistent throughout the data". As we will later see, gender performs a great role as moderator even though the role of chronotype might be under question.

Materials and Methods

Sample

158 students from three high schools in Gorgan city, Iran, in the last year of high school were asked to fill out our paper-and-pencil questionnaires. The sample consisted of 91 girls (57.6%) and 67 boys (42.4%) with an average age of 17.5 years (SD = 0.51). Informed consent was given by the participants and taking part in the study was voluntary. The research method met the ethical principles and standards of human research proclaimed by the University of Education Heidelberg and by the journal (Portaluppi et al., 2010). To have a uniform test and to avoid having several tests with different difficulty levels, only students from the final grade were selected. Since this was the last grade of high school and the students would achieve their high school diploma after passing the exams, their final achievement testing was nationwide.

Measures

GPA

To measure the GPA, we asked schools authorities to provide us with the officially reported GPAs recorded by the ministry of education. This measure consisted of several marks achieved in different major subjects. The exam for each major was held nationwide and then scored by two independent teachers. Scores could range from 0 to 20 with higher numbers representing higher learning achievement. As a result, students across high schools answered on a similar scale and therefore, final scores are comparable.

Reduced Morningness–Eveningness Questionnaire (rMEQ)

The rMEQ was developed by Adan & Almiral (1991) from the Morningness-Eveningness Questionnaire (MEQ; Horn & Östberg, 1976). This measure has five items asking about sleep/wake habits and the scores range from 4 to 25 with higher scores showing a pronounced morning tendency. Adan & Almirall (1991) divided the scores into three categories: 4-11 as evening type, 12-17 as intermediate type, and 18-25 as morning type. The Persian rMEQ is a reliable and valid instrument with Cronbach's α = 0.71 (Rahafar et al., 2014).

NEO Five–Factor Inventory (NEO–FFI)

In order to measure conscientiousness, the conscientiousness subscale of the NEO Five–Factor Inventory (NEO–FFI; Costa & McCrae, 1989) was used. This subscale consists of 12 items on a 5-point Likert scale with a minimum score of 12 and maximum 60. Achieving higher points on this subscale reflects being more conscientious. Nilforooshan et al. (2011) demonstrated its validity in an Iranian sample with Cronbach's α = 0.81 for the conscientiousness subscale.

Test Anxiety Inventory

The Test Anxiety Inventory (TAI; Abolghasemi et al., 1996) is a measurement to assess the anxiety perceived while taking an achievement test. This measure has 25 items with four possible options (never, rarely, sometimes, and often) and the scores range from 4 to 100. People with greater test anxiety reach higher scores on this scale. Abolghasemi and his colleagues (1996) showed that TAI was an accurate tool in an Iranian sample. The α in their study was 0.94 and test-retest reliability resulted as high as 0.77.

Students' grade point average (GPA) was employed as measure of scholastic achievement. Structural modeling Equation (SEM) was employed to provide a model of scholastic achievement using SPSS Amos version 22. These SEM analyses were conducted with the whole sample (models 1-3) and for models 2 and 3 each subgroup sample was analyzed separately (model 2: subgroups females and males; model 3: subgroups evening types, intermediate types, and morning types) to check for differences in association between TA, conscientiousness, and GPA between these subgroups.

Results

Descriptive analyses demonstrated the means and standard deviations of the measures as follows: GPA (12.44 ± 3.36), rMEQ (13.97 ± 4.38), Conscientiousness (46.63 ± 6.13), and TAI (55.30 ± 15.51). Internal consistency analyses indicated that all measures (except for rMEQ where Cronbach's α was below 0.7) were adequately reliable: Cronbach's α for rMEQ, conscientiousness, and TAI were 0.68, 0.77, and 0.92, respectively. Regarding the chronotypes, 47 people were evening type, 84 intermediate type, and 27 morning type.

A series of analyses of differences in mean revealed that boys and girls differed in GPA (t = 3.88; $p < 0.01$) and TA ($t = 5.83$; $p < 0.01$) significantly with girls having better grades and higher test anxiety. Besides, ANOVAs evidenced a significant difference in consciousness mean [F (2, 155) = 7.63 $p = 0.001$] between morning and evening ones ($p < 0.001$) and between morning ones and intermediate ones ($p = 0.009$) suggesting that morning ones seemed to be more conscious than those two other chronotypes. The mean differences and ANOVAs are depicted in tables 1 and 2.

Table 1. Gender differences in GPA, TA, chronotype, and conscientiousness.

	Girls		Boys		t-Test	
	Mean	**SD**	**Mean**	**SD**	**t**	**p**
GPA	13.29	3.33	11.28	3.05	**3.88**	**<0.001**
Test anxiety	60.91	14.76	47.67	13.13	**5.83**	**<0.001**
Chronotype	13.90	4.24	14.07	4.61	–0.24	0.80
Conscientiousness	46.84	6.44	46.34	5.72	0.49	0.62

Note: N = 91 girls / 67 boys.

Table 2. Chronotype differences in GPA, TA, and conscientiousness (N = 47 evening-types / 27 morning-types).

	Evening type		Intermediate type		Morning type		ANOVA	Post Hoc (Bonferroni)		
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	***p***	**ET-IT**	**ET-MT**	**IT-MT**
GPA	12.26	3.36	12.40	3.49	12.90	2.96	.722	1	1	1
Test anxiety	57.70	16.94	55.79	14.95	49.59	13.64	.087	1	.091	.211
Conscientiousness	44.85	6.27	46.42	5.65	50.37	5.94	**.001**	.440	**.000**	**.009**

Note: N = 47 people were evening type, 84 intermediate type, and 27 morning type

A set of correlations were performed in order to explore the bivariate relationship between these variables. Results revealed that there were significant positive correlations between conscientiousness and GPA (r = 0.17) and conscientiousness and rMEQ (0.29), respectively, and a negative correlation between conscientiousness and TA (r = –0.22). These findings are presented in table 3.

Table 3. Pearson's correlation coefficients between GPA, TA, chronotype, and conscientiousness.

	GPA	Test anxiety	Chronotype	Conscientiousness
GPA	1	–0.09	0.09	***0.17**
Test anxiety		1	–0.12	****–0.22**
Chronotype			1	****0.29**
Conscientiousness				1

*$p < 0.05$ **$p < 0.01$

We constructed three models to reveal the moderating role of gender and chronotype; a) the overall model (M1), b) the gender-as-moderator model (M2), and c) the chronotype-as-moderator model (M3). Goodness of fit statistics regarding the Comparative Fit Index (CFI) and the Normed Fit Index (NFI), the M1 (CFI = 1.00, NFI = 0.99), the M2 (CFI = 1.00, NFI = 1.00), and the M3 (CFI = 1.00, NFI = 0.97) showed good fit values with good RMSEA fit. A summary of goodness of fit statistics is presented in table 4.

Table 4. Goodness of fit statistics of the structural equation models.

	χ^2	χ^2/df	RMSEA	CFI	NFI
M1: Overall model	0.356	0.356	< .001	1.000	.996
M2: Gender as moderator (female / male)	0.000	-	-	1.000	1.000
M3: Chronotype as moderator (evening / intermediate / morning type)	2.455	0.818	< .001	1.000	.973

Note: The M2 has no degrees of freedom.

Based on the M1, we observed that gender was the strongest predictor (β = –0.42, p < 0.001) of learning achievement (GPA) followed by the test anxiety (β = –0.24, p = 0.004) and conscientiousness (β = 0.08, p = 0.27; although non-significant) and these variables together accounted for 15.8% of the GPA variance. Although chronotype did not relate to GPA directly, it was mediated by conscientiousness (β = 0.29, p < 0.001). The overall model is depicted in figure 1.

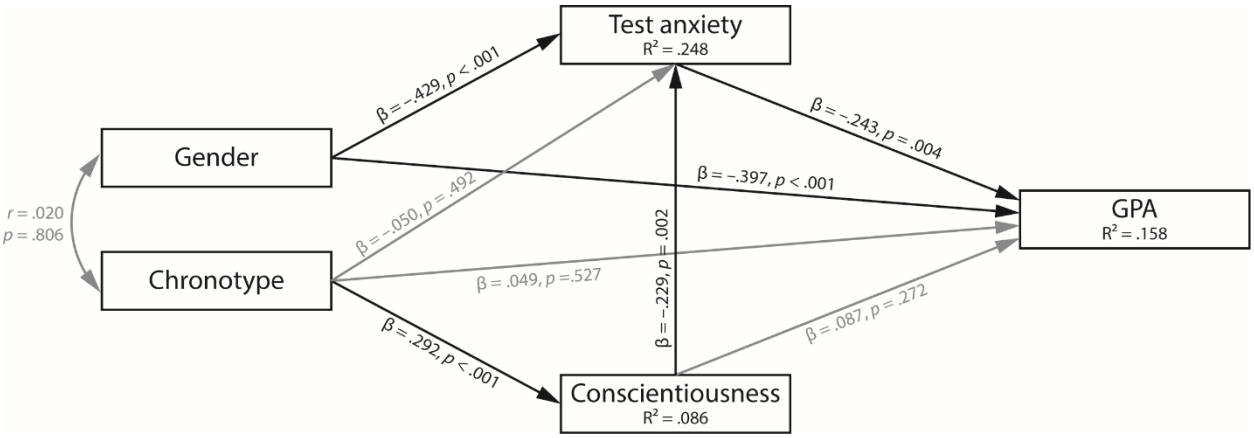


Figure 1. SEM, M1: Overall model.

Note: Non-significant coefficients are labelled in gray font color

As suggested by M2, lower test anxiety predicted higher GPA only in girls (β = –0.30, p < 0.01) and conscientiousness was a significant predictor of GPA only in girls (β = 0.20, p = 0.05). Chronotype remained still mediated by conscientiousness in its relationship with GPA only in girls (β = 0.35, p < 0.001). See figure 2 for more details on M2.

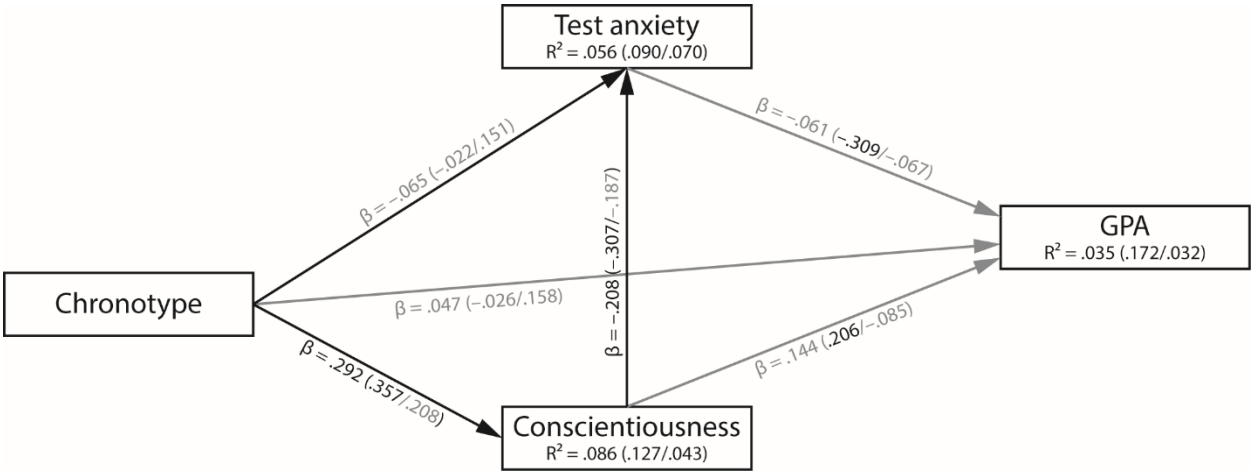


Figure 2. SEM, M2: Gender as moderator (female/male).

Note: Non-significant coefficients are labelled in gray font color; *g*irls = 0, boys = 1.

Additionally, considering chronotype as moderator revealed a significant value in evening-types and intermediate-types in the relationship between gender and GPA (β = –0.51, p < 0.001; β = –0.31, *p* = 0.004, respectively) and only a significant β in intermediate students in the relationship between test anxiety and GPA was observed (β = –0.32, *p* = 0.026). Further details can be found in Figure 3.

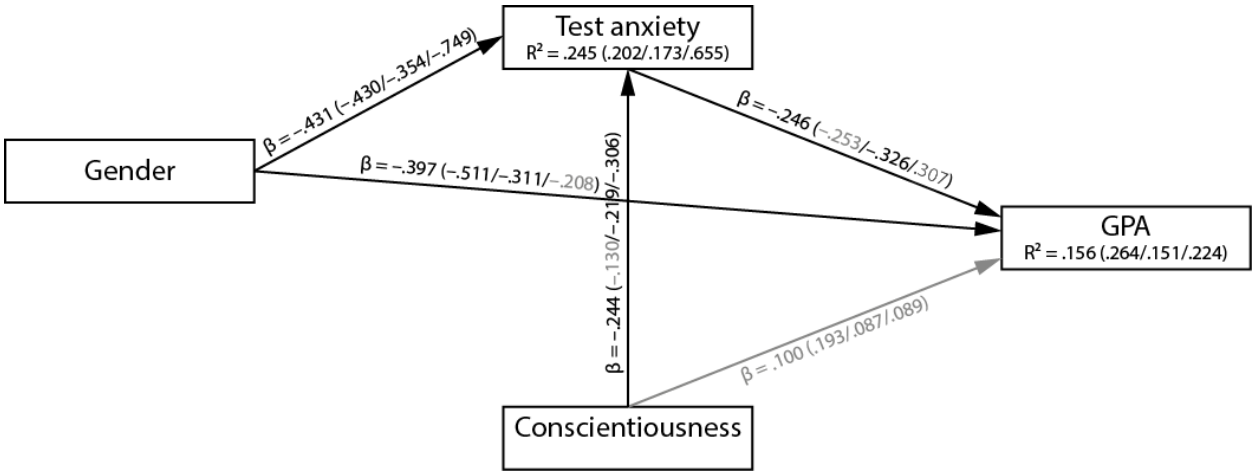


Figure 3. SEM, M3: Chronotype as moderator (evening/intermediate/morning type).

Note: Non-significant coefficients are labelled in gray font color; evening-types = 0, intermediate-types = 1, morning types = 2.

Discussion

In this study, we assessed a set of variables in the term of their importance in their relationship with academic achievement. This group of variables has never been taken into account together so far and this effort was made to provide us with an insight into the nature of attainment in an educational context. Circadian types, gender, test anxiety, and conscientiousness were employed to have a closer look into the biopsychological and behavioral correlates of academic achievement.

Mean difference statistics suggested that girls had higher levels of TA and higher GPA than boys. This could be entirely interesting and contrary to earlier findings that repeatedly showed that experiencing more anxious feelings during a test was in correlation with lower GPA (e.g., Seipp, 1991). This is interesting because it reveals the role of variables in this relationship that may neutralize the negative effect of TA on the final grades. However, the finding that girls performed better in their exams was consistent with a number of studies which employed GPA as indicator of academic achievement (e.g., Chee et al., 2005). Results could not support a significant difference between chronotypes in text Anxiety. Evening ones had tendentially higher levels of TA, but this difference was not significant. Possible gender effects might have contributed to this inconsistency because earlier Díaz-Morales and Sánchez-López (2008) showed this difference only in women, whereas Matthews (1988) revealed a difference only in men, and some other studies found no relationship (e.g., Willis et al., 2005; Alvaro et al., 2014). Moreover, morning types reported higher levels of conscientiousness than evening and intermediate types. This result was expected because it has been frequently shown in previous works (e.g., Jackson & Gerard, 1996; Randler, 2008d; Tonetti et al., 2009).

Correlation analyses demonstrated positive associations between conscientiousness, GPA and chronotype. Conscientiousness is considered as the one of the strongest behavioral correlate of academic achievement (e.g., Arbabi et al., 2014; Wagerman & Funder, 2006) and chronotype (Russo et al., 2012; Walker et al., 2013) and therefore our study was in accordance with earlier studies. There was also a negative correlation between TA and conscientiousness and this is interesting because morning ones displayed greater conscientiousness and evening ones showed higher levels of TA. In our study, this negative correlation between TA and conscientiousness was

present in intermediate and morning types. This negative correlation can be found in similar studies too (e.g., Chamorro-Premuzic et al., 2008).

Among all the variables involved in this study, gender was the strongest predictor of academic achievement. We believe that this finding needs further studies to discover the interactive and moderating role of gender. Based on what is stated in the introduction section, gender is a predictor of academic achievement, that is, males have better performance in mathematics and females outperform males in verbal abilities or generally girls have higher GPA. Nevertheless, it is worth a closer observation to find out why and how gender plays the most important role in this set of variables. The role of gender is more salient when it is taken as the moderator in this model. As noted earlier, group comparison statistics of model fit revealed a distinct effect of gender (i.e. girls) on the relationships; TA remained a significant predictor of academic achievement only in girls, conscientiousness became a significant predictor only in girls while it showed no significant relationship with academic achievement in the models M1 and M3, and chronotype remained still mediated by conscientiousness only in girls. As reported earlier, girls displayed better grades and greater TA which can explain to some extent why female gender played an integral role in this relationship. As depicted in figure 2, all the relationships remained significant only in girls and it is one of the most interesting findings of this study. This result is in accordance with the literature. For example, Freudenthaler and his colleagues (2008) suggested that, on average, girls have better GPAs than boys and this distinction was consistent even after controlling for intelligence as the strongest predictor of academic achievement (Steinmayr and Spinath 2008).

Conscientiousness could not significantly contribute to academic achievement except for the M2 and only in girls. As mentioned above, conscientiousness was positively correlated with GPA as well as chronotype and this was in accordance with previous studies. Moreover, conscientiousness mediated the relationship between chronotype and GPA.

Chronotype could not affect GPA directly but only in females when it was mediated by conscientiousness, it could be related to GPA through conscientiousness (see figure 2). While we know that a vast body of studies that supports the relationship between morningness and better grades (see Preckel et al., 2013; Tonetti et al., 2015), there are few contradicting studies. For

instance, a study by Thacher (2008) found no significant differences between chronotypes in their GPAs. In another study (Ziaei et al., 2007) carried out in Iran concerning with the relationship of reaction time and chronotype, there was no significant difference between chronotypes in reaction time according to time of day (during both morning and evening hours). This study is in line with our results to some extent.

In the third model with chronotype as moderator, gender was still the strongest variable because it not only affected the GPA in evening and intermediate ones, but also remained as the only significant correlate of the TA across the three chronotypes.

In sum, this study sheds light on the reciprocal relationships of a set of correlates on academic achievement. Gender, test anxiety, and conscientiousness (only in girls) could explain about 16% of variance in academic achievement. Gender played a differentiated role in the three models presented here and chronotype was a significant predictor when it was moderated by conscientiousness, but only in girls. One of the limitations of our work is the small sample size (n = 158). For instance, the number of morning individuals was quite low (n = 27) for its inclusion as a subgroup in SEM estimations and this might limit the generalization and reliability of the findings from this study. We assume that greater sample size leads to more assuring results. Another limitation we faced was the lack of control on other confounding variables which we could not measure in our study (for example, intelligence, motivation, need for cognition, etc.). However, the biggest limitation of this study is its cross-sectional design. To explain the predictors of the outcome variable learning achievement (GPA), a longitudinal design that assessed predictors at timepoint 0 and GPA and timepoint 1 would have been most appropriate. We believe that future studies are needed to explore the unique role of gender in a setting of biological and behavioral variables which can correlate with scholastic achievement in a longitudinal research design. Besides, we recommend future studies to measure actual sleep-wake patterns with actigraph to further investigate and highlight and validate the role of circadian rhythms in this research context. Strengths of this study are that GPA was used as a standardized measure and that it was taken from the records and not assessed by self-report. (see, e.g., discussion in Tonetti et al., 2015).

3.3. Study 3: Prediction of School Achievement through a Multi-Factorial Approach; Uniqueness of Chronotype in Academic Outcome

Abstract

The present study examined the predictability of school achievement with variables from biosocial, cognitive, psychological, and educational origins: intelligence, chronotype, conscientiousness, gender, and main subject of study. Results showed a positive relationship between GPA and chronotype (r = .13), GPA and intelligence (r = .34), and between chronotype and conscientiousness (r = .22). The predictors together explained 16% of variance in GPA. The variance in school achievement was explained the most by intelligence followed by gender, main subject of study, and chronotype. Chronotype was significantly correlated with school achievement even when controlled for the effects of intelligence and conscientiousness. These findings add to our knowledge about the nature of school achievement and also about the particular role of chronotype in learning.

Keywords: Morningness-eveningness, Learning, GPA, Intelligence, Conscientiousness

Prediction of school achievement through a multi-factorial approach - The unique role of chronotype

1. Introduction

When striving for a deeper understanding of human phenomena, it is advised to view them as multi-dimensional with manifold layers emerging on top of others. That is, more than one prerequisite is involved in the formation of biologically or culturally driven concepts. Therefore, variables contributing to school achievement vary from biological to cognitive, behavioral and social ones. Thus, in the present study, we examined the predictive power of biopsychological, cognitive, behavioral, and social variables for school achievement as outcome. Chronotype and gender were employed as biosocial predictors, intelligence as a cognitive one, conscientiousness as a personality variable, and main subject of study as an educational one. Another focus of this study was to assess the incremental contribution of chronotype to school achievement in a non-Western sample. To the present, this aspect has not been investigated in Iranian students, and we would like to elaborate on it, since Iran has a fairly different school system and cultural setting. Here we introduce the predictors and their explicit role in an academic outcome one by one and then explain how this study differs from earlier ones.

1.1. Chronotype

One important aspect of humans' sleep-wake behavior is their preferred sleep-wake time. Based on this distinction three differentiated chronotypes have been identified: 'Morning' ones are those who go to bed earlier and wake up early in the morning, feel fresh in the morning and get tired early in the evening; 'evening' types tend to have their sleep at a later time, get up later in the morning, and feel more energetic in evening hours; and finally, 'Neither' types are the ones with a fair sleep and rising time and locate in-between. Others (e.g., Natale & Cicogna, 2002) see these

variations as a continuum from extreme morningness to extreme eveningness. Research shows a constant but small correlation between being more shifted toward morningness and a better grade in school (Vollmer, Pötsch, & Randler, 2013; Preckel, Lipnevich, Schneider, & Roberts, 2011) or in university (Beşoluk, 2011). In two reviews (Preckel et al., 2011; Tonetti, Natale, & Randler, 2015), it was indicated that there was a constant negative correlation between eveningness and school achievement, however the relationship was weaker in university students (Tonetti, Natale, & Randler, 2015). This is probably because of the early schools starting times in the morning that make the school student get up early in the morning even though it might not fit their preferred time for learning.

1.2. Intelligence

Cattel (1971) differentiates between fluid and crystallized intelligence. Fluid intelligence is the ability of solving problems without relying on past experiences or learning. On the other hand, crystallized intelligence is the ability to employ tools and activate prior knowledge to solve problems. Among the most relevant predictors of academic achievement are cognitive abilities (e.g., Mayes et al., 2009) and intelligence has been identified as a key variable of cognitive performance which directly affects academic achievement. In a plethora of studies and several meta-analyses, it has been strongly evidenced that IQ can solely predict about 40-70% of the changes in academic achievement's variance (Makintosch, 1988; Brody, 1992; Gustafsson & Undheim, 1996; Jensen, 1998; Gottfredson, 2002). Rohde and Thompson (2007) examined the effect of intelligence as a general cognitive ability while some specific cognitive abilities like working memory, processing speed, and spatial speed were present. The results yielded a unique role of intelligence in prediction of academic achievement even when controlled for the specific cognitive abilities. In another study (Laidra, Pullmann, & Allik, 2007), intelligence and Big Five

personality traits have been employed to predict academic achievement. Findings indicated that, even when all the variables were entered into a regression model, intelligence was the strongest predictor of GPA.

1.3. Conscientiousness

Conscientiousness is characterized by the tendency to follow socially prescribed norms for impulse control, to be goal-directed, plan-oriented, able to delay gratification, and to follow norms and rules (Roberts, Jackson, Fayard, Edmonds, & Meints, 2009). Among the Big Five personality dimensions – alongside openness to experience, extraversion, agreeableness, and neuroticism (Costa & McCrae, 1989), conscientiousness is the only one which has a steady positive relationship with morningness (e.g. Randler, 2008; Adan et al., 2012, Walker, Kribs, Christopher, Shewach, & Wieth, 2014) and academic achievement (Arbabi, Vollmer, Dörfler, & Randler, 2014; Paunonen & Ashton, 2001). In connection with this research area, two meta-analyses (O'Connor & Paunonen, 2007; Vedel, 2014) have been performed, suggesting that conscientiousness is the strongest personality correlate of academic achievement among the other personality dimensions (r = .25). Since conscientiousness is tightly connected to both morningness and better grades in an academic environment, it has a high priority to be taken into account as one of the critical predictors of school achievement.

1.4. Gender

Gender also has an impact on school grades because girls and boys differ in certain cognitive abilities and school domains. For example, a review spanning over 24 years (Nowell & Hedges, 1998) exhibited a tendency in girls to achieve higher scores in tests of reading, perceptual speed, and writing whereas boys outperformed girls in mathematics, science, and the composite. This pattern was stable over the time period considered by Nowell and Hedges (1998). However,

the gender differences in mathematics and science were not as pronounced. Still, taking GPA into consideration as the main indicator of school achievement has eventuated in girls' grades exceeding boys' (Chee; Pino, & Smith, 2005; Freudenthaler, Spinath, & Neubauer, 2008). Others have pointed to a gender similarity hypothesis contending that boys and girls are similar on most, but not all psychological variables (see Hyde, 2005).

1.5. Other predictors of academic achievement

Aside from chronotype, intelligence, conscientiousness, and gender, there are relevant predictors which are not addressed by the present study. For example, a meta-analysis by Crede, Roch, and Kieszczynka (2010) concluded that class attendance has a strong relationship with class grades (r = .44) and GPA (r = .37). Also, academic motivational beliefs (Eccles et al., 1983), situational interest (learning emotions), subject-specific dispositional interest (Krapp, Hidi, & Renninger, 1992), and self-efficacy (Ferla, Valcke, & Cai, 2009; Robbins et al., 2004) are predictors of academic achievement.

1.6. The present study

The aim of this study was to gather relevant variables to maximize the power of prediction of school achievement. Since these variables originate from different areas of research and are all associated with achievement, we assume they could explain a notable share in the variance of GPA. In a recent study, Arbabi and colleagues (2014) estimated predictors of educational outcomes using almost the same variables as the present study (in addition, learning motivation and midpoint of sleep) in a group of 10-year old German pupils in primary school (N = 1125). Their findings revealed that intelligence was the strongest predictor of academic achievement followed by conscientiousness. Moreover, although chronotype did not contribute to GPA directly, it increased the share of GPA variance when mediated by midpoint of sleep and conscientiousness.

The uniqueness of our study was to test this set of variables among the students in the last grade of high school. At this age (17-18 years of age), the majority of teenagers are evening oriented (Roenneberg et al., 2004) and a great number of students experience sleep deprivation which influences their achievement, in turn (Andershed, 2005). Second, while most of the studies on chronotype and academic achievement are from Western countries (e.g., Preckel et al., 2013), the present study was implemented in a quite different cultural setting, in Iran, which, at the time that our participants started their schooling, had five years of elementary school, three years of middle school, and four years of high school (Since 2011 it changed to a 6-3-3 school system). In addition, a number of Iranian students have experienced weekly changing school shifts (i.e. one week morning-hours school time and the next week afternoon-hours school time) during their elementary or middle school, for which it is worthy to consider the effect of sleep habits in this context. Another interesting aspect which might justify entering gender as an important variable in this study might be the fact that boys and girls in Iran are segregated at school or they go to male or female schools based on their sex and this covers all the school years until they reunite again when they enter university. Third, we used GPA as a standard report of an Iranian nationwide test rather than relying on self-reported grades as in similar studies. The GPA here was an average score of 13 different subjects which reflects the academic outcome more precisely as compared to single subject grades or an average of a few of them. Fourth, the effect of different main subjects of study in high school (humanities, natural science, and mathematics according to Iran's educational system) on school achievement in a combination with other variables was tested. This is of interest because in Iran smarter students are encouraged and tend to choose mathematics and science as their main subject in high school, and humanities comes last. Lastly, another goal of this study is to see whether the relationship between morningness and school achievement still

remains significant when we control for confounding variables because this association might be due to an impact of a third variable like intelligence and conscientiousness, not only morningness.

We explicated the following hypotheses: (a) The positive relationships between morningness, intelligence, conscientiousness and school achievement, respectively, that were found in previous studies in Western countries can be reproduced in a sample of Iranian adolescents. (b) Chronotype uniquely contributes to school achievement.

2. Methods

2.1. Sample and data collection

The sample consisted of 269 high school students (120 males and 149 females) from 6 different schools (11th grade) in Damghan, Iran. Mean of age was 17.47 ± 2.10 (SD) and students' main subject of study varied from humanities (25.7%) to natural science (39%) and mathematics (35.3%). After obtaining the informed consent, the battery of questionnaires was applied to the students in the presence of a teacher and a researcher in the morning hours. Participation was voluntary and anonymous and sampling procedure complied with the ethical standards of the University of Education Heidelberg, the tenets of the Declaration of Helsinki and the international ethical standards of chronobiological research (Portaluppi, Smolensky, & Touitou, 2010).

2.2. Measures

2.2.1. Reduced Morningness–Eveningness Questionnaire (rMEQ). In 1991, Adan & Almirall developed the rMEQ from the Morningness-Eveningness Questionnaire (MEQ; Horne & Östberg, 1976). The rMEQ consists of five items asking about one's sleep-wake habits and the total score ranges from 4 to 25 with greater scores indicating a tendency toward morningness. The cut-off scores are as follows: 4-11 as evening type, 12-17 as neither type, and 18-25 as morning type (Adan & Almirall, 1991; Randler, 2013). There are different measures of chronotype that can

be applied in survey settings (Di Milia et al., 2013). We chose the rMEQ due to its brevity and clear one-dimensional factor structure. The rMEQ is a derivate of the MEQ, which has been validated against body temperature (Baehr et al., 2000), peak melatonin secretion (Kantermann, Sung, & Burgass, 2015) and actigraphy (Thun et al. 2012). Thus, it is well-known that it captures the biological basis of chronotype. There are other concepts of chronotype calling the unidimensionality into question (e.g., Preckel et al., 2013; Putilov, Donskaya, & Verevkin, 2015). Both approaches have merits in the analysis, but we decided to use the unidimensional concept because of the underlying physiological mechanism (see above), but feel that this question about measurement should developed further. The Persian rMEQ showed good reliability with Cronbach's $\alpha = .71$ and its unidimensionality, convergent, and divergent validity was corroborated in Iranian population (Rahafar, Sadeghi, Sadeghpour, Heidari, & Kasaeian, 2014). In this study Cronbach's alpha was .60.

2.2.2. Culture Fair Intelligence Test scale-III (CFIT-III). The CFIT-III was firstly designed by Cattell & Cattell (1960) in order to assess fluid and crystallized intelligence. This measure has two parallel form (Form A and B), each one consisting of 50 items. One can apply one form or another as alternative but we did apply both forms in Persian to all the participants and the IQ was measured by calculating the total score of form A because only the normative scores of form A were available for an Iranian population and the raw score of form B was used as a measure of parallel-forms reliability. CFIT-III encompasses four subscales: Series (13 items), Classifications (14 items), Matrices (13 items) and Topological Reasoning (10 items). We were unable to calculate Kuder-Richardson 20 (KR-20) reliability coefficient for CFIT-III because the questionnaire was manually scored and finally, only the subscale scores and total scores of the test were entered into SPSS. However, previous work in Iran (Ahouyi, 1996) reported the split-half coefficient as high

as .85 and KR-20 equal to .67. In this study the reliability coefficient using parallel-forms method reached a .45 ($p < 0.01$) correlation coefficient between the two forms of CFIT-III.

2.2.3. NEO Five–Factor Inventory (NEO–FFI). We assessed conscientiousness with the conscientiousness subscale of the NEO Five–Factor Inventory (NEO–FFI; Costa & McCrae, 1989). The conscientiousness subscale contains 12 items on a 5-point Likert scale with a minimum score of 12 and maximum of 60. Students are more conscientious when they achieve higher scores on this subscale. The convergent and factorial validity of the Persian version was earlier proved and Cronbach's $\alpha = .81$ for the conscientiousness subscale was reported (Nilforooshan, Ahmadi, Fatehizadeh, Abedi, & Ghasemi, 2011). Cronbach alpha of the conscientiousness subscale in this study reached .78.

2.2.4. Grade Point Average (GPA). All of the GPAs were reported officially by the ministry of education. This measure consisted of the average score of thirteen marks in different major subjects. The exam for each major was held nationwide and then scored by two independent teachers. Scores could range from 0 to 20 with higher numbers representing higher school achievement. In other words, all the students took exams on a similar scale and therefore, the GPAs were comparable across classrooms and schools.

2.3. Statistical analyses

Having school achievement as the single criterion variable and several predictors lead us to use multiple regression analysis. Besides, a set of bivariate comparison analyses (T-tests, chi-square tests and ANOVAs) were performed to compare gender, chronotype, and main subject of study groups across the other variables. Bivariate correlation was also estimated to reveal the relationship between variables. All analyses were carried out in SPSS 22

3. Results

Descriptive analyses unfolded the mean and SD of each measure as follows: conscientiousness (46.33 ± 6.23), rMEQ (13.64 ± 3.67), intelligence (99.67 ± 12.88), and GPA (16.67 ± 1.80).

Bivariate correlation analyses indicated significant positive relationship between GPA and chronotype (rMEQ; r = 0.13), GPA and intelligence (r = 0.34), and between chronotype and conscientiousness (r = 0.22). Intelligence and GPA had the highest correlation among the variables involved in this study but when we controlled for intelligence in the relationship between main subject of study and GPA using partial correlation, the correlation remained yet significant, however weaker (r = 0.14, $p < 0.05$) as compared to a correlation non-adjusted for intelligence (r = 0.24, $p < 0.001$). The correlations are presented in Table 1.

Table 1. Correlations between GPA, Intelligence, Chronotype, Conscientiousness, and Age.

	1	2	3	4
1 GPA				
2 Intelligence	.34 **			
3 Chronotype	.13 *	.04		
4 Conscientiousness	.08	.04	.22 **	
5 Age	-.01	.03	-.04	-.05

Note: Pearson's Correlation Coefficients; *$p < 0.05$, **$p < 0.01$

Regarding the relationship between gender and main subject of study, we ran a Pearson's chi-square test (51.13, $p < 0.001$; Cramer's V= 0.44, p < 0.001) revealing a positive correlation between the two variables. Results are depicted in Figure 1.

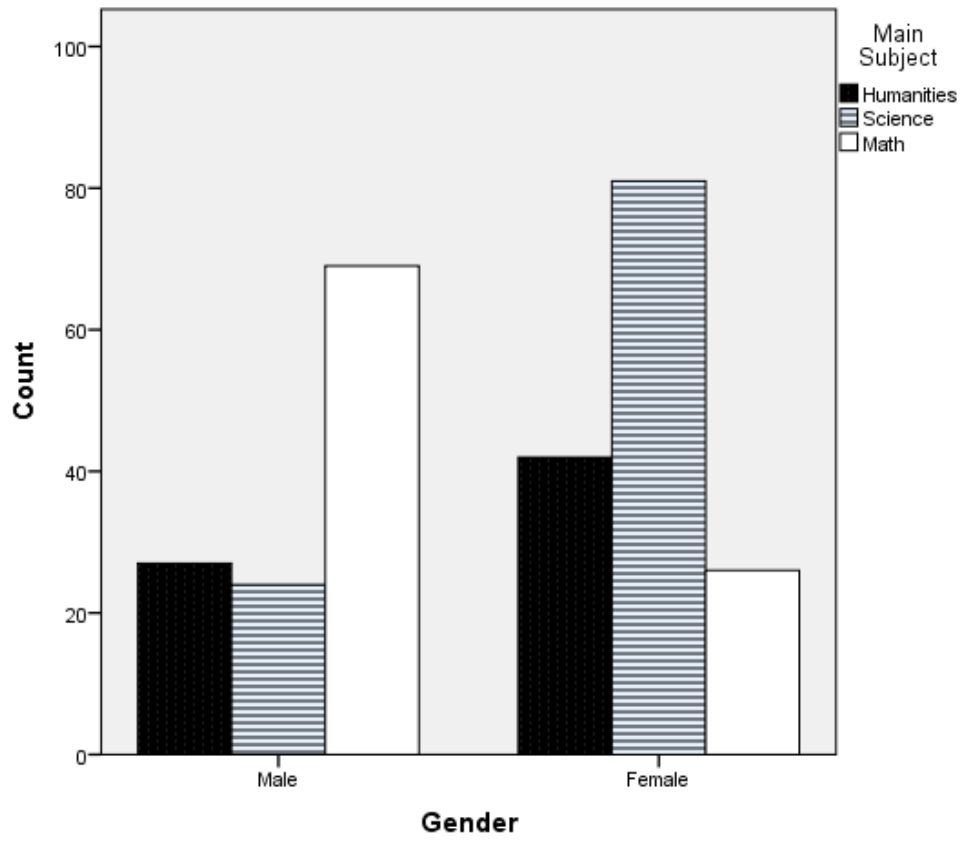


Figure 1. Male and female's preferences for main subject of study in high school.

Boys and girls differed only in main subject of study (see Table 2 and Figure 1). Variance analysis of main subject of study yielded significant differences in GPA [$F(2, 269) = 8.15$, $p < 0.001$; $\eta^2 = 0.06$] and intelligence [$F(2, 269) = 19.26$, $p < 0.001$; $\eta^2 = 0.13$]. Regarding GPA, there was a significant difference between those who studied humanities and math ($p < 0.001$) and humanities and natural science ($p = 0.05$) exhibiting lower marks for humanities students. Student with different main subject of study differed in all groups in terms of intelligence; humanities and math ($p < 0.001$), humanities and natural science ($p < 0.001$), and math and natural science ($p < 0.05$), that is, humanities students had the lowest intelligence followed by natural science and finally, math students. Results of analyses of variance are depicted in Table 3.

Table 2. Gender differences in GPA, Intelligence, Chronotype, Conscientiousness.

	Boys		Girls			
	Mean	SD	Mean	SD	*t*	*p*
GPA	16.48	1.79	16.81	1.80	-1.48	.138
Intelligence	101.03	13.22	98.57	12.52	1.56	.119
Chronotype	14	3.88	13.34	3.48	1.46	.145
Conscientiousness	46.07	6.51	46.55	6.01	-.63	.528

Table 3. Differences in GPA, Intelligence, Chronotype, and Conscientiousness by Main Subject of Study.

	Humanities		Science		Mathematics		ANOVA	Post Hoc (Bonferroni)		
	Mean	SD	Mean	SD	Mean	SD	*p*	Humanities-Science	Humanities-Mathematics	Science-Mathematics
GPA	16.01	1.91	16.67	1.88	17.14	1.47	<.001	.052	<.001	.180
Intelligence	93.42	11.52	98.82	12.23	105.15	12.29	<.001	.013	<.001	.001
Chronotype	13	3.43	13.78	3.82	13.94	3.64	.239	.511	.322	1
Conscientiousness	45.90	6.34	47.08	6.28	45.83	6.08	.269	.671	1	.478

Note: n = 69 humanities students, n = 105 natural science students, and n = 95 math students.

When we classified the rMEQ total score into three chronotype groups (morning type, neither type, evening type), the analysis of variance disclosed a difference between chronotypes only in conscientiousness [$F(2, 269) = 11.11$, $p < 0.001$; $\eta^2 = 0.08$] with morning types having higher levels of conscientiousness compared to evening ones ($p < 0.001$) and neither types ($p < 0.001$; Table 4).

Table 4. Differences in Conscientiousness, Intelligence, and GPA by Chronotype.

	Evening type		Neither type		Morning type		ANOVA	Post Hoc (Bonferroni)		
	Mean	SD	Mean	SD	Mean	SD	*p*	ET-NT	ET-MT	NT-MT
Conscientiousness	45.34	6.68	45.73	5.77	50.39	5.61	<.001	1	<.001	<.001
Intelligence	99.74	11.40	99.52	13.17	100.10	14.41	.967	1	1	1
GPA	16.23	1.99	16.73	1.77	16.69	1.79	.352	.450	.777	1

Note: n = 73 evening type (ET), n = 155 neither type (NT), and n = 41 morning type (MT).

Linear hierarchical multiple regression was carried out in order to predict academic outcome by considering age, gender, main subject of study, intelligence, and conscientiousness in first block, and then additionally chronotype in second block to see if it adds to the variance of school achievement when controlling for other predictors. To be able to use a categorical variable like main subject of study with more than two levels as a predictor in regression model, we converted this variable into two dummy-coded variables (humanities and science) where mathematics was the reference variable. Based on this conversion, the coefficients of the newly-constructed variables were compared to the coefficient of the reference group (mathematics) when judging about significance of their contribution to the variance of GPA. Results showed that age and conscientiousness were not significant predictors. The four remaining variables (model 1) all together explained 15% of variance of GPA [F (6, 267) = 8.65, $p < 0.001$; adjusted $R^2 = 0.15$]. Moreover, findings highlighted the particular role of chronotype as it contributed to the variance of GPA significantly even when adjusted for the other predictors (Model 2; [F (7, 267) = 8.07, p < 0.001, adjusted $R^2 = 0.16$], R^2 change = .013, $p < 0.05$, see table 5). In Sum, the variance of school achievement was explained the most by intelligence followed by gender, humanities, science, and chronotype.

Table 5. Predictors of School Achievement.

	Predictors	*B*	β	*t*	*p*		*B*	β	*t*	*p*
Model 1	Intelligence	.04	.29	4.81	.008	**Model 2**	.04	.29	4.86	<.001
	Gender	.68	.19	2.95	.003		.72	.20	3.15	.002
	Humanities	-.86	-.21	-2.93	.004		-.81	-.20	-2.79	.006
	Science	-.56	-.15	-2.07	.040		-.55	-.15	-2.07	.039
	Conscientiousness	.02	.06	1.09	.275		.01	.04	0.63	.529
	Age	.05	.01	0.22	.826		.06	.02	0.31	.754
	Chronotype	-	-	-	-		.06	.12	2.00	.046

Note: Adjusted R^2 (model 1) = .147, for model 2 = .157. Gender was coded 0 = male and 1 = female. Humanities was coded 1= humanities and 0 = otherwise. science was coded 1= science and 0 = otherwise.

4. Discussion

In the present study, we used variables with different origin to predict school achievement in Iranian high school students. To cover a wide area, we employed chronotype for the biological aspect, gender for the sociobiological aspect, conscientiousness for the psychological aspect, intelligence for the cognitive aspect, and main subject of study for the educational aspect. We tested different assumptions to check variability of categorical variables like gender, main subject of study, and grouped chronotype as groups across conscientiousness, intelligence, and GPA. Moreover, we proposed a regression model for the academic outcome. The last hypothesis was to check the significance of the relationship between morningness and school achievement after controlling for confounding variables.

There was a positive correlation between chronotype and GPA. This result was repeated in many studies (e.g. Beşoluk, 2011; Escribano, Díaz-Morales, Delgado, & Collado, 2012; Randler & Frech, 2006; Vollmer et al., 2013) and relates morningness to better grades. Another outcome of this study was a positive relationship between morningness and conscientiousness. As earlier

stated, conscientiousness is the strongest correlate of morningness among the big-five traits. Therefore, this result was in line with previous studies (e.g. Jackson & Gerard, 1996; Russo, Leone, Penolazzi, & Natale, 2012; Tonetti, Fabbri, & Natale, 2009). The other remaining significant correlation was between intelligence and GPA. This relationship is very pronounced and expectable since intelligence has the highest correlation with GPA among all other cognitive variables (Rohde & Thompson, 2007).

Boys and girls did not differ in overall school achievement. This could be because of having grade point average instead of single subjects as a marker of school assessment. This average point might have removed any possible difference in single subjects between boys and girls as described in introduction. This result was consistent with Arbabi et al.'s (2014) study. This also might highlight the fact that gender segregation at school has not affected the global pattern of similarity between boys and girls in terms of overall GPA. Another interesting result of the present study was that students with different main subjects of study had different levels of GPA and intelligence with math students having higher grades followed by natural science students and humanities students (with an exception for natural science and math students in GPA). We expected this outcome because in Iran the students are highly encouraged to choose first of all math and then natural science as their main subject in high school because the popular belief is that there are better working conditions and job market for math students after they graduate from university. Consequently, Students with lower GPAs decide for humanities because they think it is less likely for them to pass the subjects dealing mostly with math and physics. Although here the main subject of study was affected by intelligence level, it remained significant as a correlate of GPA even after intelligence was controlled for. This might be due to different educational material used for specific main subjects, parents' expectations, and other possible variables not being assessed in

this study. The last result of comparison analysis indicated that morning ones possessed higher levels of conscientiousness compared to neither types and evening types. This was also highly remarkable in earlier studies which showed a positive relationship between morningness and conscientiousness (e.g. Randler, 2008; Walker et al., 2014).

The independent variables together explained 14% of the variance of school achievement. As anticipated, intelligence was the strongest predictor followed by gender, humanities, science (main subject area of the study) and chronotype, respectively. Age and conscientiousness were not significant predictors of academic outcome. We assume that since the sample was recruited from 11th grade students, age had a quite low variance to influence the variance in GPA. Regarding conscientiousness, although a vast body of research supports the positive relationship between conscientiousness and achievement, there are some others reporting no association between conscientiousness and single subject grades (Hendriks, Kuyper, Lubbers, & Van der Werf, 2011; Lipnevich, Preckel, & Krumm, 2016) or overall achievement (Diseth, 2003; Zuffianò et al., 2013). Another study carried out in Iran also backed a lack of relationship between school achievement and conscientiousness among last grade male high school students (Jarareh, 2013). However, the relationship between school achievement and conscientiousness was also positive in our sample (r = .08), albeit non-significant. Another explanation would be using the adult version of Big-Five (NEO–FFI) instead of a validated scale of Big-Five on adolescents (e.g., NEO Personality Inventory-3; McCrae, Martin & Costa, 2005) which might have not been able to reflect the changes in conscientiousness in adolescents. Unfortunately, the adolescent version was neither translated nor validated across an Iranian sample.

Gender being a significant predictor of GPA was seen in similar studies as well, when GPA was used as main academic outcome measure (Chee et al., 2005; Freudenthaler et al., 2008). The

concluding finding of this study was that chronotype exhibited its unique role in academic achievement even when controlled for intelligence and conscientiousness (about 1% additional variability in school achievement). This finding can be linked to Preckel et al. (2013), indicating that eveningness is a significant (negative) predictor of GPA, math–science GPA, and language GPA, even after cognitive ability, conscientiousness, need for cognition, achievement motivation, and gender were controlled for (additional variability about 2 to 4%). This finding highlights the importance of school timing adjustment to our chronotype independent of other important variables involved in academic outcome. Additional variability of chronotype in school achievement emphasizes the role of sleep habits and importance of synchrony effect independent of students' overall cognitive ability, gender, and other relevant factors contributing to a higher achievement. However, the synchrony effect is only one explanation and evidence for the assumption that synchrony effects explain the relation between chronotype and academic achievement in school is scarce (see, for example, Itzek-Greulich et al., 2016), and Randler, Bechtold and Vogel (2016) did not find any support for the synchrony effect. Therefore, other aspects such as the link between morningness and conscientiousness or eveningness and sleep deprivation (Roenneberg et al., 2004), may be additional explanations for the different performance of students with different chronotypes.

One of the limitations of this study was the fixed testing time (morning hours). If the exams were held in different daytime hours, we could control for the effect of testing time as a critical variable involved in test results because students perform better when they do a test at a time in synch with their chronotype preference (Itzek-Greulich, Randler, & Vollmer, 2016). Another limitation of this study was its cross-sectional design in which we could not follow the results over a specific period of time. We would like also to mention that having a specific validated measure

of Big-Five on adolescents could eventuate in a more precise assessment of conscientiousness. Moreover, we were unable to assess the other important factors in school achievement such as motivation, self-efficiency, need for cognition, and class attendance in this particular design. Concerning the rMEQ, the modest Cronbach's α value (.60) might be due to its short length containing only 5 items. The last limitation of this study was to score the CFIT-III manually which made us fail to calculate the internal consistency of the measurement using KR-20. Nevertheless, this study had also some advantages; a) using GPA as the marker of school achievement assured us of its validation which was not based on a self-report measure, b) both forms of CFIT-III were applied to have a more robust IQ estimation rather than assessing it only with one form, and c) the study had an almost gender-balanced sample which could represent the results less biased. We suggest future studies take different testing time into consideration, use actual sleep-wake habit measures like actigraphy, and recruit a broader age range to reflect the impact of age on academic achievement and chronotype.

4. General Discussion

School achievement is a key concept in education which serves as a criterion for evaluating competency in the contribution of academic careers and job opportunities in the future of person's life. Performance in school is affected by many diverse factors such as personal, social, biological, cultural, economic, cognitive, etc. A combination of such diverse factors plays role in the outcome variable –here, school achievement. Having this viewpoint, we decided to measure school achievement through a set of diverse variable to reach a broader approach toward understanding its nature.

Sleepiness in school is a common phenomenon. Loss of sleep in student could occur due to short sleep duration which in adolescents is an outcome of the circadian asynchrony. Teenagers at this age are more evening-oriented and therefore, they tend to go to bed later in the evening. On the other hand, most of the schools start early in the morning and those late sleepers must get up early, be prepared, and head to school. Going to bed late needs a later wake-time as well in order to have enough sleep and recover body strengths. However, these students do not have enough sleep and they feel drowsy during school time. Learning does not occur optimal when body circadian preference does not match learning time. In the other words, a synchrony between chronotype (morningness/eveningness) and learning time of the day eventuates in the most effective school achievement in terms of circadian preferences. To the present, many studies have worked on cognitive correlates of school achievement, while the other factors such as biological ones have been paid less attention. That is the reason I targeted chronotype as the main independent variable in this study and tried to explore its interaction with some other variables with different natures like personality and cognition to optimize school achievement through suggesting some well-fitted models.

In the first study, I investigated the validity and reliability of rMEQ in an Iranian sample. Results supported its unidimensionality, internal consistency, and factorial validity. rMEQ is a 5-item measure and its validity and reliability are shown in different countries like Spain, Italy, China, and Germany. The big advantage of using rMEQ would be its short length which facilitates sampling and increases the probability of people's participation in the study. However, its few

items always increase the probability of having lower Cronbach's alpha. Another disadvantage of rMEQ is that it is mostly considered as a "morningness" measure since three out of five items only deal with questions asking about activities in morning hours, one deals with tiredness in evening hours, and the last one requires the participant to identify his/her own chronotype. Another disregarded point about rMEQ is that it does not measure daily circadian fluctuation which is an important aspect of circadian behavior. As a conclusion, I encourage using rMEQ when there are many other measures in the design to prevent it from being too lengthy and to have less nonresponse. My suggestion for measuring chronotypes and daily circadian fluctuations in future studies would be MESSi (Morningness-Eveningness Stability Scale improved; Randler, Díaz-Morales, Rahafar, & Vollmer, 2016). This questionnaire has 15 items consisting of three distinguished subscales: "Morningness", "Eveningness", and "Distinctness", each one possessing 5 items. For having a comprehensive assessment of chronotypes and daily amplitude (fluctuation) MESSi might be the best measure to the present.

Regarding study 2, I tried to propose a model for school achievement which could explain it the best. I employed test anxiety, conscientiousness, gender, and chronotype as the independent variables and school achievement as the only dependent variable. As expected, girls had higher scores in GPA than boys did. This was consistent with previous studies (e.g., Epstein et al., 1998; Wong et al., 2002). Beside this, findings revealed that gender was the strongest predictor of school achievement. The effect of gender (being a female) was so powerful that when we modeled the variables for boys and girls separately (model 2), some relationships became significant only for girls. For example, lower test anxiety and higher conscientiousness could explain a share in the variance of GPA only in girls and only girls' morningness explained the shared variance in conscientiousness. So, the findings of this study need more explanations in terms of gender differences in achievement.

Research does not support any stable difference in boys and girls in general intelligence (Hyde, 2005, Halpern, 2012) but in specific intelligences. In a meta-analysis, Hyde (2005) showed girls outperformed boys in verbal abilities, while boys had a better performance in numerical tasks. So, the first point is although girls achieve better GPAs, it can't be explained by the

difference in intelligence solely since both boys and girls do not differ in general cognitive ability. Based on the research, Nowell and Hedges (1998), in a review of the trends in gender differences in academic achievement from 1960 to 1994, corroborated the dominant pattern of boys' higher scores on tests of mathematics, science, and the composite and females' better results on test of reading, perceptual speed, and writing with an exception for science and mathematics with increasing similar performance in both genders. This study supports the idea of boys and girls having specific cognitive abilities which are reflected in specific majors as well. However, this does not tell the whole story. Girls possess higher verbal abilities and better grades in language tests and boys have greater numerical abilities and higher marks in mathematics, but this does not fully explain the gender differences in school achievement (Freudenthaler, Spinath, and Neubauer, 2008; Steinmayr and Spinath, 2008). Steinmayr and Spinath (2008) showed that after controlling for intelligence, girls still got better marks than boys did. So, we should look for variables other than intelligence which could explain the difference in school achievement between boys and girls.

In a study, Duckworth and Seligman (2006) indicated the relationship between gender and school achievement became non-significant when self-discipline was entered as the mediator and at the same time intelligence was controlled for. In this study self-discipline could explain about 50% of the relationship between gender and achievement. In line with this study, Steinmayr and Spinath (2008) suggested that girls' outperformance in school achievement could be partly ascribed to girls' higher agreeableness and lower work avoidance. Having higher levels of self-discipline leads to do things which even might look unpleasant but useful for one's development like learning. In addition, higher agreeableness eventuates in having more friendly relationship with peers and teachers which makes school and learning a much pleasant place. Altogether, the difference in achievement between girls and boys is not caused only by one or two factors (Spinath and Steinmayr, 2014). Factors like motivation (especially intrinsic values and ability self-concept; Steinmayr and Spinath, 2008), social demands, classroom settings, educational materials etc. should be taken into account while investigating the gender role in school achievement. We believe one should not look for causality in a complicated concept like

education but for interactions of many different factors playing roles and affecting each other concurrently.

Another important finding of study 2 was that the relationship between gender and school achievement was only significant in neither-types and evening types. This result could be explained well by Preckel's et al.'s study (2013). In this study he and his colleagues employed a set of variables including cognitive ability, conscientiousness, morningness-eveningness, need for cognition, gender, and achievement motivation as independent variables and GPA as the dependent one. They found out after controlling for all independent variables except for chronotype, only eveningness —and not morningness— negatively predicted overall GPA, math-science GPA, and language GPA. This finding shows where both morningness (positively) and eveningness (negatively) have a relationship with school achievement (Preckel et al., 2011), if we could control for salient factors involved in achievement, eveningness would remain the only significant negative predictor of school achievement. This might be in consistency with synchrony effect which suggests individuals do their best at times that match best their sleep-wake preferences. Another explanation would be the sleep deprivation in evening ones (Andershed, 2005). Early school start time makes morning ones benefited and evening ones disadvantaged. Those evening students who have later bed times have to wake up as early as morning ones in the morning, although they have had shorter sleep length. This sleep loss leads to students being more sleepy and tired during the school time. The last explanation suggested by Preckel et al. (2011) for the relationship between eveningness and lower grades was the behavioral problems which are more evident in evening individuals (Mecacci & Rocchetti, 1998; Lange & Randler, 2011; Negriff et al., 2011; Goldstein et al. 2007; Randler, 2008c; Hidalgo & Caumo, 2002) and in turn affect school achievement and attitude toward school negatively. For instance, Randler and Vollmer (2013) claimed short sleepers (evening students) were highly reported to display verbal aggression, physical aggression, and anger.

Referring to study 3, I should mention that morning students exhibited higher levels of conscientiousness, in line with study 2. This is a consistent finding over years (Tsaousis, 2010, Adan et al., 2012) which needs to look for possible reasons. Conscientiousness is defined as the

tendency to follow socially prescribed norms for impulse control, to be goal-directed, plan-oriented, able to delay gratification, and to follow norms and rules (Roberts, Jackson, Fayard, Edmonds, & Meints, 2009). People with higher levels of conscientiousness are more vigilant and punctual (Back, Schmukle, & Egloff, 2006; Werner, Geisler, & Randler, 2015) show planned behavior, and act more dutifully compared to others. Jackson et al. (2010) defines conscientious behaviors as follows: "Conscientious individuals are clean and tidy, work hard, follow the rules of society and social decorum, think before acting, and are organized. For example, conscientious people tend to write down important dates, comb their hair, polish their shoes, stand up straight, and scrub floors. People who are less conscientious exceed their credit limit, watch more television, cancel plans, curse, oversleep, and break promises". They also suggested responsibility, order, impulse control, and laziness (inversely) as a four-factor solution for behavioral manifests of conscientiousness.

On the other hand, there are morning individuals with some specific personality traits. Morning-oriented people display more proactive behaviors (Randler, 2009), higher energetic arousal and life satisfaction (Jankowski, 2015), and positive affect (Biss & Hasher, 2012). Morning people have sleep-wake habits which are consistent with society-imposed activity-rest cycle. The Society encourages earlier sleep and wake time and daily schedules adjusted to daytime hours. In this regard, morning ones are those who go to school or work early in the morning and are more fit to the educational and work plans provided by the society. They also seem to be more stable (De Young, Hasher, Djikic, Criger, & Peterson, 2007). Vollmer and Randler (2012) argue that while evening students possessed more individual values (openness to change and self-enhancement), the morning ones exhibited a preference for social values (conservation and self-transcendence) rather than individual values. That is, morning people are more prepared to adjust themselves to social norms and standards because they have higher levels of internal locus of control compared to their evening counterparts (Jackson & Gerard, 1996). They try to accept the rules and follow them as conscientious people do. That might be an explanation why morning people have proclivity for showing conscientious behaviors.

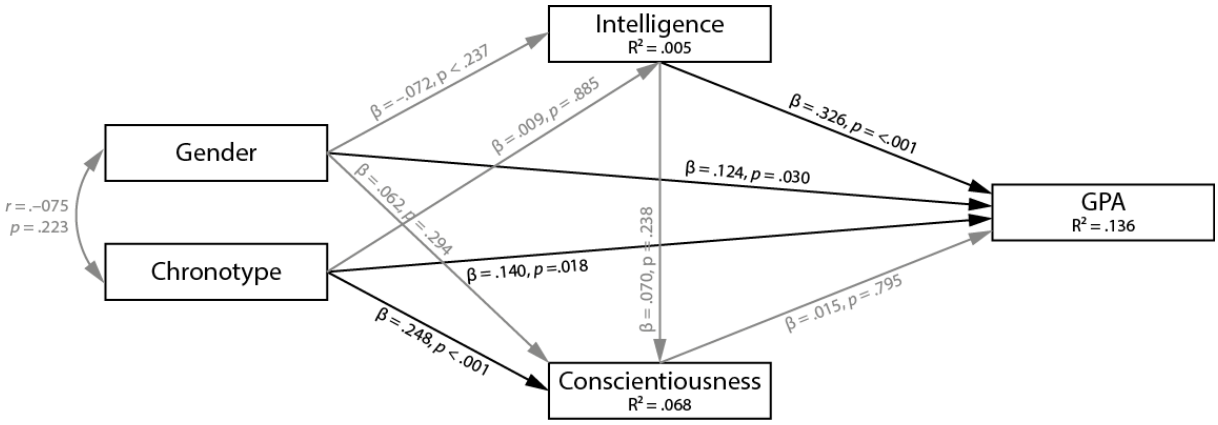
Having Study 3 in focus, I proposed two additional models for school achievement with contributions of chronotype, intelligence, conscientiousness, and gender; first, an overall model and second, a model with gender as moderator. Goodness of fit indices are presented in the Table 1 below.

Table 1. Goodness of fit statistics of the structural equation models

	χ^2	χ^2/df	RMSEA	CFI	NFI
Model 1: Overall model	61.0	6.1	.138	1.000	1.000
Model 2: Gender as moderator	64.7	5.4	.128	1.000	1.000

As suggested by the table, both models are somehow equally evaluated in terms of goodness of fit. Figure 1 represents the overall model for achievement.

Figure 1. Structural equation model (model 1)

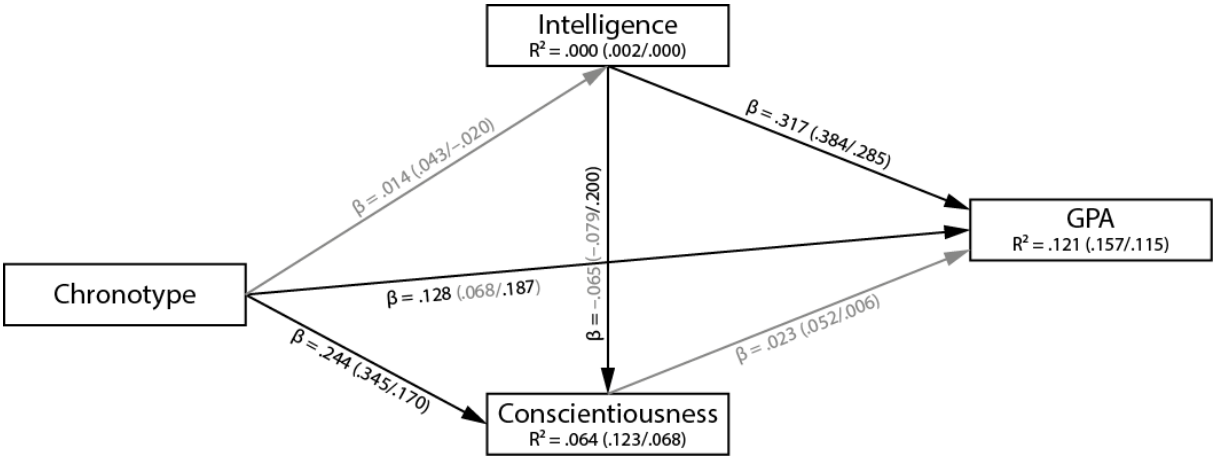


Note: Non-significant coefficients are labelled in gray font color; boys = 0, girls = 1.

As seen in figure one, intelligence, chronotype, and gender were the strongest predictor of GPA, respectively. Chronotype predicted conscientiousness significantly, although conscientiousness did not affect GPA. The variables together explained about 14% of the variance of GPA and the rest could be explained by the variables not assessed in this study.

Additionally, model 2 was designed to explore gender-specific coefficients regarding the above-mentioned variables.

Figure 2. Structural equation model (model 2) – Gender as moderator



Note: Gender as moderator (male/female). Non-significant coefficients are labelled in gray font color; boys = 0, girls = 1.

As proposed by figure 2, intelligence was the strongest significant predictor of GPA followed by chronotype but only in girls. Moreover, chronotype was a significant predictor of conscientiousness in both males and females and conscientiousness reached very close at .05 significance level for girls (.052), however statistically still non-significant. Gender moderating the independent variables resulted in a $R^2 = .12$.

Study 3 demonstrated the uniqueness of role of chronotype in predicting school achievement even when controlling for gender, conscientiousness, and Intelligence. So, a closer look at the role of circadian types in achievement seems necessary. In an early meta-analysis, Preckel et al. (2011) by reviewing 13 studies concluded both morningness ($\hat{\mu}\rho = .156$, $p < .001$) and eveningness ($\hat{\mu}\rho = -.141$, $p < .001$) were associated to academic achievement. In another very recent study, Tonetti et al. (2015) aimed at calculating an overall effect size regarding 31 studies in connection with morningness-eveningness and academic achievement. Based on simple descriptive statistics, they reported 22 studies showed a positive relationship between morningness and achievement, eight appeared to be uncorrelated, and one revealed a negative

relationship. The meta-analysis yielded a small overall effect size of 0.143 under a fixed effects model and of 0.145 under a random effects model, suggesting that morning tendency was associated with better grades in both school and university. A random model effect based on 15 studies on school pupils and 16 studies on university students revealed a greater effect size in school pupils (0.166) compared to university students (0.121) suggesting the effect becomes smaller as individuals enter university. They also found no difference between girls and boys in the relationship between eveningness and academic achievement. Preckel and her colleagues (2013) focused on the unique role chronotype in a research design where cognitive ability, need for cognition, gender, achievement motivation, and conscientiousness were controlled for. They suggested after the above-mentioned variables were held constant, eveningness was the significant predictor of overall GPA, math-science GPA, and language GPA. In a later study (Ruffing, Hahn, Spinath, Brünken, & Karbach, 2015) it was suggested that chronotype explained incremental variance in student's learning strategies over and above personality traits (big five) and therefore, they could show that the power of chronotype as the predictor of learning strategies was not limited to its shared variance with personality.

Here I would like to elaborate on the possible reasons of the relationship of circadian types and educational outcome. Individuals shape their sleep-wake habits into a 24-hour cycle. Based on the preferences for sleep and wake time people are categorized into larks (morning ones), owls (evening ones), and neither-types. Morning ones prefer an earlier bed and wake time whereas evening ones tends to go to bed and wake up later in the day. According to their chronotype they experience various cognitive performances throughout the day. Morning individuals perform better when the cognitive task takes place in morning hours and evening ones have better results in evening-hours tasks (Hasher, Goldstein, & May, 2005; Hahn et al, 2012). This is well known as "synchrony effect" and is a prominent explanation for the differences between chronotypes in functionality during different hours of day. This also could be explained by "social jetlag" which points to asynchrony between body internal clock and social clock. As suggested by Preckel et al. (2011) in their meta-analysis, eveningness is associated with higher intelligence, however evening ones get lower marks which is probably because of the sleep deprivation they suffer from (Merikanto et al., 2012) which in turn results in poorer academic

achievement (Taras & Potts-Datema, 2005). Pagel, Forister, and Kwiatkowki (2007) claimed that those students with lower grades were more likely to report difficulty in concentrating during the day and waking up in the morning, sleepiness, and falling asleep in class. In addition, a meta-analysis (Dewald, Meijer, Oort, Kerkhof, & Bögels, 2010) reported sleepiness as the strongest sleep correlate of school performance followed by sleep quality and sleep duration. Another study mentioned that later bed times (11:30 PM and later) increased the odds ratio for depressive symptoms and negative health consequences (Merikanto, Lahti, Puusniekka, & Partonen, 2013). Roeser, Schlarb, and Kübler (2013) suggested Chronotype-Academic Performance Model (CAM) stating chronotype may not directly affect academic performance, but be mediated by daytime sleepiness and learning motivation. They concluded evening students report more daytime sleepiness and have dysfunctional attitudes toward work. These studies made me search for the other explanation of evening ones' receiving lower grades –psychological and behavioral problems.

Some researchers (e.g., Preckel et al., 2011, 2013) suggest that achieving lower marks by evening individuals originates from their behavioral and mood problems which consequently will affect their performance. For instance, a study on children aged 7-12 (Van der Heijden, de Sonneville, & Swaab, 2013) showed eveningness predicted behavioral problems over and above demographic variables such as gender and age. Another study demonstrated eveningness in adolescents were more likely to have behavioral/emotional problems, suicidality, and habitual substance use compared to their morning and neither-type counterparts (Gau et al., 2007). Others also linked eveningness to poorer coping with stress (Digdon & Landry, 2013), higher depressive symptoms (Levandovski et al., 2011), lower levels of conscientiousness (see Adan et al., 2012), impulsive behavior (Adan, Natale, Caci, & Prat, 2010), and negative attitude toward school (Andershed, 2005) which affect school achievement negatively, in turn.

This research together has some implications in the real world and educational environments. The first point to pay attention would be gender differences in learning and education. Schools and academic institutions should consider gender-specific needs and skills when programming for educational content and material. Girls and boys have different strengths

and weaknesses which should be taken into account when evaluating their achievement. Generally, Girls have better language skills while boys display higher predispositions for mathematics. So, for example, if a boy achieves lower mark in math compared to a girl achieving the same mark, it's worth paying greater attention to his special needs and probably weaknesses in learning. On the other hand, since it is proven that girls outperform boys in overall GPA, if in a classroom, girls, on average, receive lower grades, the causing factors such as cultural and social context should be taken into consideration.

Regarding sleep pattern and school schedule there are some points to be discussed. Some studies claim having later class starting times leads to longer sleep (Lima, Medeiros, & Araujo, 2002; Koscec, Radosevic-Vidacek & Bakotic, 2014) and better cognitive performance (e.g., Hansen, Janssen, Schiff, Zee, & Dubokovic, 2005). For instance, in Hansen et al.'s study, adolescents lost up to 2 hours sleep in weekdays and weekend sleep time postponed to 30 minutes during the first week of school starting. All the students performed better in the afternoon hours than in the morning hours and students in early morning classes reported higher degrees of being wearier and less alert, and having to put greater effort into learning. In another study (Wahlstrom, Wrobel, & Kubow, 1998), it was found delaying in school starting time for two weeks eventuated in lower self- reported depression, lesser sick days, and better grades in high school students compared to control group. These findings promote suggestions for later school start time by which students can sleep longer, feel more alert in the morning, and improve their learning and school achievement. This change in school schedule needs to be accompanied by extra-scholastic systems (such as public transport, and work schedule). However, some middle-school teacher in the Unites States believed by delaying later school start time, it was difficult to keep students alert during the final hours of school day because the students felt more fatigue and impatient (Kubow, Wahlstrom, & Bemis (1999). Consequently, they expressed lower willingness for a change in school start time due to overlapping of school schedule with after-school activities and also remaining fewer time for teacher-parent communication. On the other hand, 57% of high school teachers reported an increase in alertness related to new school schedule (shifting from 07:15 to 08:40), whereas 27% of them disagreed and 16% remained neutral. They also believed that optimal school start was at or before 08:30 a.m. (Wahlstrom &

Freeman, 1997). Mitru, Millrood, and Mateika (2002) suggest that as the first step in decreasing the negative effects of sleepiness and sleep deprivation, students should get familiar with their sleep patterns. This could be done by schools to reflect the unique sleep pattern of each student to them. Parents also could help in some extent by having schedule for sleep-wake time. They also suggest raising the awareness about negative outcomes of sleep deprivation which in turn could be led to legislation to ensure that high schools do not start before 09:00 a.m. (e.g., the Z's to A's Act proposed by Zoe Lofgren, suggesting later school starting time in the United States). Tonetti et al. (2015) also suggest implanting of the daylighting into school buildings which consequently, results in better school achievement (Heschong, Wright, & Okura, 2002).

My studies faced some limitations as follows:

- The first and the biggest limitation of these studies are their cross-sectional designs. I could not follow up the changes over one semester or the whole academic year.
- I assessed chronotypes and their circadian rhythms using paper-pencil tests (subjective measurements) which measure an individual's circadian preference and are however correlated with biological measurements (such as actigraph or saliva test), but might not reflect the subjects' diurnal fluctuations.
- I did not assess the midpoint of sleep during weekdays and weekend which could give us more information about social jetlag and sleep length of the students.
- I was unable to include more variables in my design. Variables such as motivation have high importance in school achievement.
- The testing time was only in morning hours. I was unable to alter the testing time because the exams were held nationwide. Therefore, I could not adjust the results for testing time and compare the school achievement in morning and evening hours.
- The intelligence test I used is a measurement for general intelligence rather than specific cognitive abilities. So, I could not reflect the possible differences between morning and evening types in specific cognitive abilities.
- My samples were limited to a narrow age variance. Thus, I could not calculate the age effect on the variables and their relationships involved in the design.

- I used only GPA as the measure of school achievement. Although it was an average point of all subjects and was not a self-reported score, I failed to consider single subjects as subscales of school achievement and repeat the analyses for them as well.

Here, I also provide other scientists with some suggestions which should be taken into account for future research:

- I highly encourage other researchers to carry out longitudinal research rather than cross-sectional ones. We need to see how much the effect of our circadian preferences stays stable over a longer period of time. To my knowledge, all the studies performed so far have had a cross-sectional design which could have probably resulted in missing the more consistent impacts of circadian preferences on overall educational outcome.
- My next suggestion would be using biological measurements of circadian preferences rather than subjective ones or at least beside them.
- Having broader and varied set of variables might help to explore latent mediated relationships between chronotype and school achievement. With regard to this, we suggest future studies employ mediational analysis to reveal if chronotype stands alone for the estimated changes in the variance of the school achievement.
- Replicating the design throughout all the grades in schools might present better understanding of the nature of school achievement in connection with age.
- Employing different measures of cognitive abilities, creativity, as well as emotional intelligence is highly demanded to reflect the real effects of circadian types and their sleep-wake habits on cognitive performance.
- Testing participants in different hours of the day might reduce the negative effect of being eveningness in school achievement tests. This needs to be considered carefully in future works.

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6. Appendix

1. Reduced Morningness-Eveningness Questionnaire

2. Test Anxiety Inventory

3. Overview of the published study 1 (only the first page)

4. Overview of the published study 2 (only the first page)

5. Author’s Curriculum Vitae

6.1. Reduced Morningness-Eveningness Questionnaire

For each question, please select the answer that best describes you by circling the point value that best indicates how you have felt in recent weeks.

1. *Approximately* what time would you get up if you were entirely free to plan your day?

[5] 5:00 AM–6:30 AM *(05:00–06:30 h)*

[4] 6:30 AM–7:45 AM *(06:30–07:45 h)*

[3] 7:45 AM–9:45 AM *(07:45–09:45 h)*

[2] 9:45 AM–11:00 AM *(09:45–11:00 h)*

[1] 11:00 AM–12 noon *(11:00–12:00 h)*

3. If you usually have to get up at a specific time in the morning, how much do you depend on an alarm clock?

[4] Not at all

[3] Slightly

[2] Somewhat

[1] Very much

7. During the first half hour after you wake up in the morning, how do you feel?

[1] Very tired

[2] Fairly tired

[3] Fairly refreshed

[4] Very refreshed

10. At *approximately* what time in the evening do you feel tired, and, as a result, in need of sleep?

[5] 8:00 PM–9:00 PM *(20:00–21:00 h)*

[4] 9:00 PM–10:15 PM *(21:00–22:15 h)*

[3] 10:15 PM–12:45 AM *(22:15–00:45 h)*

[2] 12:45 AM–2:00 AM *(00:45–02:00 h)*

[1] 2:00 AM–3:00 AM *(02:00–03:00 h)*

18. At *approximately* what time of day do you usually feel your best?

[5] 5–8 AM *(05–08 h)*

[4] 8–10 AM *(08–10 h)*

[3] 10 AM–5 PM *(10–17 h)*

[2] 5–10 PM *(17–22 h)*

[1] 10 PM–5 AM *(22–05 h)*

19. One hears about “morning types” and “evening types.” Which one of these types do you consider yourself to be?

[6] Definitely a morning type

[4] Rather more a morning type than an evening type

[2] Rather more an evening type than a morning type

[1] Definitely an evening type

6.2. Test Anxiety Inventory (Persian, English translation not present)

دانش آموز گرامی:

لطفا عبارات زیر را به دقت بخوانید و یکی از گزینه هایی را که به بهترین شکل ویژگی های شما را بیان می کند علامت بزنید. برای پاسخگویی راحت تر به سوالات، خود را در حال امتحان یا آمادگی برای آن تصور کنید و با توجه به احساسات، افکار، و رفتارهایی که در حین یا قبل از آن از شما سر می زند، پاسخ دهید.

عبارت	هرگز	به ندرت	گاهی اوقات	اغلب اوقات
۱- با وجود تلاش زیاد باز هم نمی توانم موقع امتحان تمرکز حواس داشته باشم.				
۲- هرچه به روز امتحان نزدیک تر می شوم یادگیری مطالب برایم دشوارتر می شود.				
۳- قبل از شروع امتحان خیلی ناآرام و بی قرار می شوم.				
٤- حتی وقتی درسی را خوب خوانده ام باز هم موقع امتحان دچار دلهره می شوم.				
٥- دلواپسم که مبادا در امتحاناتم نمره خوبی نگیرم.				
٦- در جلسه امتحان برای جواب دادن به سوالات احساس ناتوانی می کنم.				
۷- هرچه سوالات امتحان دشوارتر باشد نگرانی و دلهره ام در جلسه امتحان بیشتر می شود.				
۸- درباره شکست در امتحان زیاد فکر می کنم.				
۹- در ایام امتحانات دچار ناآرامی و بی قراری می شوم.				
۱۰- به محض اینکه چشم هایم به سوالات می افتد حس می کنم که هیچکدام را بلد نیستم.				
۱۱- هنگام امتحان انقدر عصبی میشوم که نمی توانم سوالات را به درستی بخوانم.				
۱۲- به خاطر دستپاچگی در جلسه امتحان، در پاسخ دادن به سوالات اشتباه می کنم.				
۱۳- نگرانم که مبادا از عهده امتحانات برنیایم.				
١٤- هنگام امتحان نمی توانم آرامش خود را حفظ کنم.				
۱٥- به خاطر نگرانی زیاد در مورد امتحان، یک مطلب را بارها می خوانم ولی باز خوب یاد نمی گیرم.				
١٦- موقع امتحان دچار دلشوره می شوم.				
۱۷- اگر در یک امتحان نمره کم بگیرم در مورد شایستگی و لیاقتم دچار تردید می شوم.				
۱۸- امتحانات سخت تر مرا مضطرب تر می کند.				
۱۹- به علت عصبی شدن در جلسه امتحان، نمره امتحانم خوب نمی شود.				
۲۰- هنگام امتحان احساس می کنم که قلبم به شدت می زند.				
۲۱-در امتحان نمی توانم آنچنان که هستم خود را نشان دهم.				
۲۲- هنگام امتحان دستپاچه می شوم.				
۲۳- هنگام امتحان تمام بدنم می لرزد.				
٢٤- نگرانی و ترس از امتحان باعث می شود که سوالات را جابجا جواب دهم.				
۲٥- ترس از امتحان باعث می شود که حقم ضایع گردد.				

6.3. Overview of the published study 1 (only the first page)

SLEEP AND BIOLOGICAL RHYTHMS
THE JAPANESE SOCIETY OF SLEEP RESEARCH

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ORIGINAL ARTICLE

Psychometric properties of the Persian version of the reduced Morningness-Eveningness Questionnaire: Further evidence

Arash RAHAFAR,[1] Meysam SADEGHI J,[2] Atousa SADEGHPOUR,[3] Zeinab HEIDARI[4] and Ali KASAEIAN[5]

[1]*University of Education, Heidelberg, Germany,* [2]*Allameh Tabataba'i University,* [4]*Alzahra University, Tehran,* [3]*Islamic Azad University, Kermanshah, and* [5]*Semnan University, Semnan, Iran*

Abstract

Circadian types are related to many physiological, cognitive, and behavioral variables and, therefore, a need for a questionnaire in Farsi language to assess those preferences has emerged. The present study aimed at exploring psychometric properties of the reduced version of the Persian Morningness-Eveningness Questionnaire (rMEQ). Participants were 268 students recruited from two different universities. Three questionnaires were used to investigate the additional validity data of the Persian version of the rMEQ: Beck Depression Inventory (BDI-II), Oxford Happiness Questionnaire (OHQ), and General Health Questionnaire (GHQ-12). The correlations between the rMEQ and the three other questionnaires were −0.45, 0.48, −0.41, respectively. Moreover, the factor analysis of the rMEQ resulted in a single-factor solution and the Cronbach's α was 0.71. In sum, the Persian rMEQ seemed to be a reliable and valid instrument to differentiate circadian types. We suggest that future studies focus on test-retest reliability of the rMEQ and an analysis of its unidimensionality with other methods like Item-Response Theory (IRT).

Key words: circadian rhythms, reduced Morningness-Eveningness Questionnaire, validity.

INTRODUCTION

In the study of human circadian typology three differentiated types have been identified: on the one hand, "morningness" people tend to go to bed earlier, wake up early in the morning, and reach their cognitive and physiological peaks in early hours of the day. On the other hand, "eveningness" people have a tendency to stay out late at night, get up later in the morning, and feel more conscious in the evening hours. Finally, "neither-type" people are those who have a fair circadian manner.

Correspondence: Mr Arash Rahafar, Im Neuenheimer Feld 681, 69120 Heidelberg, Germany. Email: rahafara@ph-heidelberg.de

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It has been repeated in many studies that eveningness is correlated with negative states as well as physiological and psychological dysfunctions, and morningness is more concerned with positive states and psychophysiological welfare. For instance, a study showed that evening-like individuals reported more severe and frequent psychological and psychosomatic disturbances than morning-like people and showed more problems in coping with environmental and social demands.[1] Randler indicated that morningness is positively correlated with satisfaction with life.[2] In two later studies, there were positive relationships between eveningness and behavioral problems, hyperactivity, and substance use and, on the contrary, morningness was related to being more pro-social.[3,4] Moreover, a series of studies suggested that eveningness is correlated with dysfunctional and antisocial behavior as well as adjustment

6.4. Overview of the published study 2 (only the first page)

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The role of chronotype, gender, test anxiety, and conscientiousness in academic achievement of high school students

Arash Rahafar[a], Mahdis Maghsudloo[b], Sajedeh Farhangnia[c], Christian Vollmer[d], and Christoph Randler[a]

[a]Department of Biology, University of Education Heidelberg, Heidelberg, Germany; [b]Department of Pedagogy & Psychology, Shahid Beheshti University, Tehran, Iran; [c]Deparment of Pedagogy & Psychology, Islamic Azad University, Sari, Iran; [d]Department of Psychology, University of Education Heidelberg, Heidelberg, Germany

ABSTRACT

Previous findings have demonstrated that chronotype (morningness/intermediate/eveningness) is correlated with cognitive functions, that is, people show higher mental performance when they do a test at their preferred time of day. Empirical studies found a relationship between morningness and higher learning achievement at school and university. However, only a few of them controlled for other moderating and mediating variables. In this study, we included chronotype, gender, conscientiousness and test anxiety in a structural equation model (SEM) with grade point average (GPA) as academic achievement outcome. Participants were 158 high school students and results revealed that boys and girls differed in GPA and test anxiety significantly, with girls reporting better grades and higher test anxiety. Moreover, there was a positive correlation between conscientiousness and GPA (r = 0.17) and morningness (r = 0.29), respectively, and a negative correlation between conscientiousness and test anxiety (r = −0.22). The SEM demonstrated that gender was the strongest predictor of academic achievement. Lower test anxiety predicted higher GPA in girls but not in boys. Additionally, chronotype as moderator revealed a significant association between gender and GPA for evening types and intermediate types, while intermediate types showed a significant relationship between test anxiety and GPA. Our results suggest that gender is an essential predictor of academic achievement even stronger than low or absent test anxiety. Future studies are needed to explore how gender and chronotype act together in a longitudinal panel design and how chronotype is mediated by conscientiousness in the prediction of academic achievement.

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Academic achievement; conscientiousness; chronotype; gender; test anxiety

Introduction

Individuals form their lives in a cycle of rest and activity. Concerning human circadian preferences, three different types have been verified. "Morning" types are the people who feel fresh in the morning, go to bed early and wake up early. "Evening" types are characterized with a later sleep–wake time and they feel best in the evening. "Intermediate" types are the ones with a moderate circadian habit and are located between those two extremes.

One's circadian preference has been considered to affect his/her cognitive functions like attention (Matchock & Mordkoff, 2009), thinking style (Fabbri et al., 2007), visual search (Natale et al., 2003), cognitive failure (Mecacci et al., 2004), intelligence (Goldstein et al., 2007; Roberts & Kyllonen, 1999) and academic achievement (e.g. Beşoluk, 2011; Digdon & Howell, 2008; Hess et al., 2000; Randler & Frech, 2006, 2009). Besides chronotype, we'll have a closer look at other variables involved in the present study (gender, test anxiety and conscientiousness) which also are supposed to have an influence on academic achievement.

Chronotype

Research on the relationship between circadian preference and scholastic achievement has revealed a better performance by morning types (or a worse performance by evening types, respectively) in their exams or their GPA (e.g. Arbabi et al., 2014; Beşoluk et al., 2011; Escribano et al., 2012; Preckel et al., 2011; Vollmer et al., 2013). In a meta-analysis (Preckel et al., 2011) by reviewing 13 studies, it was found that eveningness was negatively related with academic achievement (r = −0.14) and morningness correlated positively

CONTACT Arash Rahafar rahafara@ph-heidelberg.de University of Education Heidelberg, Heidelberg, Germany.

6.5. Author's Curriculum Vitae

Arash Rahafar

Psychologist • Dr. rer. nat. Biology

Personal Profile:

First Name:	Arash
Surname:	Rahafar
Date of Birth:	February 25th, 1988
Marital status:	Single
E-Mail:	ar.ra.rhythm@gmail.com

Education & Qualifications:

Jan 2014 - Dec 2016	Doctorate study in Biology at University of Tübingen, Germany
Oct 2010 - Jan 2013	M.A. degree, Psychometrics**.** Allameh Tabataba'i University, Tehran, Iran
Oct 2006 - Jul 2010	Bachelor degree, Clinical Psychology. Shahed University, Tehran, Iran

Professional Experiences:

July 2014 & July 2015	Performing an "Analysis data with SPSS" workshop for some graduate students from Mozambique at Pädagogische Hochschule Heidelberg.
July 2011 – July 2013	**Psychologist, Project leader, Project "Play Therapy" Iran- Tehran. Mahak Hospital and rehabilitation complex (a society to support children suffering from cancer)**
Sept 2011 - July 2012	**Research assistant, diverse psychological studies, Azmonyarpooya (a psychological research-oriented institute)**
Oct 2009 - July 2011	**Researcher, validating measures inside the country (project-based), Ravantajhiz (Sina) (a psychological research-oriented institute)**

Publications:

2017	**Rahafar, A.**, Randler, C., Castellana, I., & Kausch, I. (2017). How does chronotype mediate gender effect on Dark Triad?. *Personality and Individual Differences*, *108*, 35-39.
2017	**Rahafar, A.**, Randler, C., Díaz-Morales, J. F., Kasaeian, A., & Heidari, Z. (2017). Cross-cultural validity of Morningness-Eveningness Stability Scale improved (MESSi) in Iran, Spain and Germany. *Chronobiology International*, 1-7.
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2012 **Rahafar, A**., Asghari, A., Mohammadi, B., Constructing a child pain coping strategies questionnaire in the Iranian population: A preliminary study (oral presentation at the 1st Psychological Congress on Children with Cancer in Iran. Tehran, Iran)

2011 **Rahafar, A**., Heydarinasab, L., The relationship between ego strengths and triangular love in a group of students (poster presentation at the 5th Congress on Family and Sexual Health. Tehran, Iran)

In Progress

Rahafar, A., Vollmer, C., & Randler, C., Prediction of School Achievement Through a Multi-Factorial Approach; Uniqueness of Chronotype Role in Academic Outcome (submitted to *Learning and individual differences*)

Rahafar, A., Castellana, I., & Randler, C., Antunez, J. M., Conscientiousness but Not Agreeableness Mediates Females' Tendency Toward Being a Morning Person (submitted to *Scandinavian Journal of Psychology*)

Awards:

Fazit-Stiftung scholarship to support my doctorate study (2015-2016)