Review

Psikiyatride Güncel Yaklaşımlar-Current Approaches in Psychiatry 2023; 15(3):407-417

doi: 10.18863/pgy.1140109

Effects of Chronotype and Social Jet-Lag on Neurocognitive Functioning

Kronotip ve Sosyal Jet-Lag'in Nörobilişsel İşlevler Üzerindeki Etkileri

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ABSTRACT

The chronotype, which reflects the circadian rhythm preferences of individuals in their daily activities and sleep-wake cycles, can be considered on a dimension of extreme morningism and extreme eveningism. Individuals with extreme morning and extreme evening chronotypes face many physical and psychological dangers due to accumulated sleep debt, short total sleep time and insufficient sleep efficiency. In extreme chronotypes, especially in extreme evening people, the social jet-lag effect due to the mismatch between social and circadian clocks is thought to exacerbate these dangers. More recent studies have suggested that social jet-lag and chronotype have many negative effects on cognitive functioning. The aim of this article is to review the impact of social jet-lag and chronotype on cognitive functioning.

Keywords: Cognition, chronotype, circadian rhythm, social jet-lag

ÖZ

Bireylerin günlük aktiviteleri ve uyku-uyanıklık döngülerindeki sirkadiyen ritim tercihlerini yansıtan kronotip, bir ucu aşırı sabahçıl ve bir ucu aşırı akşamcıl olan bir boyutta ele alınabilir. Aşırı sabahçıl ve aşırı akşamcıl kronotipe sahip bireylerin, biriken uyku borcu, toplam uyku süresinin kısalığı ve uykudan yeterince verim alınamaması gibi nedenler yüzünden birçok bedensel ve ruhsal tehlike ile karşı karşıya oldukları bilinmektedir. Uç kronotiplerde, özellikle de uç akşamcıllarda, sosyal ve sirkadiyen saatler arasındaki uyumsuzluk nedeniyle ortaya çıkan sosyal jet-lag etkisinin bu tehlikeleri daha da kötüleştirdiği düşünülmektedir. Son yıllardaki çalışmalar sosyal jet-lag ve kronotipin bilişsel işlevler üzerine birçok olumsuz etki yarattığını saptamıştır. Bu derlemenin amacı, sosyal jet-lag ve kronotipin bilişsel işlevler üzerine olan etkisini gözden geçirmektir.

Anahtar sözcükler: Biliş, kronotip, sirkadiyen ritim, sosyal jet-lag

Introduction

Before moving on to the concepts of “Chronotype” and “Social Jet-Lag” (SJL), it would be appropriate to define the two basic concepts, “zeitgebers” and “circadian rhythm” briefly. Human nature has temporal components. Rhythms can be found at various organization levels, from single cells to social behaviors, and nearly all physiological and psychological functions change periodically. The most investigated rhythms are circadian rhythms and refer to functions with a cycle of approximately 24 hours (Montaruli et al. 2021, Heyde and Oster 2022).

Circadian rhythm is regulated by the suprachiasmatic nucleus in the anterior hypothalamus and the pineal gland in the midbrain, which is responsible for the secretion of melatonin. It is possible to argue that the circadian rhythm, which varies between individuals, is affected both by genetic and environmental factors. Environmental external signals affecting endogenous rhythms are called “zeitgebers”. Aside from daylight, which is known as the most important “zeitgebers”, other stimuli such as exercise and food intake also affect circadian rhythms (Kivela et al. 2018, Heyde and Oster 2019).

The chronotype, which reflects the daily activities of individuals and their circadian rhythm preferences in sleep-wake cycles, can be discussed in one extreme morningness and one extreme eveningness dimension (Wittmann et al. 2006, Roenneberg et al. 2019). It is already known that individuals with extreme morningness and eveningness chronotypes are faced with many physical and mental dangers because of accumulated sleep debt, short total sleep time, and insufficient sleep efficiency (Selvi et al. 2012). SJL, which occurs in extreme chronotypes, especially in extreme eveningness, because of the discord between social and circadian clocks, deteriorates these dangers even more (Ong et al. 2021, Fárková et al. 2021, Al-Khatib et al. 2022). Recent studies

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Received: 06.07.2022 | **Accepted:** 24.10.2022

report that SJL and chronotype have many negative impacts on cognitive functions (Salfi et al. 2020, Venkat et al. 2020, Wang et al. 2022). The purpose of this paper was to review the impacts of SJL and chronotype concepts on cognitive functions.

Concept of Chronotype

Chronotype refers individual's circadian rhythm preference and differs among individuals depending on the preferred period during the day for sleep, cognitive and physiological functions. Individuals can be divided into 3 chronotypes as morningness chronotype (30%), intermediate type (60%), and eveningness type (10%) in terms of temporal differences in circadian rhythm such as body temperature cycle, secretion time of several hormones, eating-drinking times, and primarily sleep-wake cycles (Adan et al. 2012). Individuals in the morning chronotype are called "larks" as they prefer to wake up earlier and go to sleep earlier. Eveningness chronotypes, i.e. "owls", on the other hand, prefer to wake up late and sleep late (Roenneberg et al. 2019). Also to this simple classification, it is possible to argue that one end of the chronotype can be considered in a dimension expressing extreme eveningness and the other extreme morningness individual and that people are mostly positioned closer to the morning individual between these two extremes (Wittmann et al. 2006). There might be a phase difference of 2-12 hours between evening and morning chronotypes in situations regulated according to the circadian rhythm, such as sleep-wake and eating cycles (Adan et al. 2012).

Chronotype might change with age, the morning chronotype is generally dominant in childhood, a shift towards the eveningness type occurs in adulthood, and it turns back to the morningness chronotype as age advances (Roenneberg et al. 2007, Druiven et al. 2021). Although it is argued that age and gender also have impacts on chronotypes, the findings on this subject differ. Although some studies showed that women are more morningness chronotype and men are eveningness type, some studies reported the opposite (Natale et al. 2011, Randler 2011, Merikanto et al. 2012). It was reported in a large-scale study that females were more likely to have morningness chronotypes in young adulthood and males, more eveningness chronotypes. It is also possible to mention the time of birth as a possible variable for chronotypes. Many researchers argue that individuals born in spring and summer are more in the eveningness chronotype than those born in autumn and winter. It is considered that photoperiod duration might be effective in the relationship between birth season and chronotype. It was reported that those born in spring and summer have longer days than those born in autumn and winter, and their biological clocks are also affected by this (Mongrain et al. 2006, Alam et al. 2008, Tonetti et al. 2011). A 27-year longitudinal study conducted on 1449 individuals focused on gene-environment interactions between genetic factors, birth season, and age. Previous studies reported that the season of birth and age affect the chronotype with some epigenetic changes (Didikoglu et al. 2020).

Scales such as the Munich Chronotype Scale and the Children's Chronotype Scale evaluate subjective self-report (Horne and Ostberg, 1976, Carskadon et al. 1993, Roenneberg et al. 2003). Objective tools employed for chronotype evaluation consist of monitoring and analyzing the circadian clock-related rhythms of behavioral and physiological variables such as core temperature and melatonin secretion (Lack et al. 2009).

Concept of Social Jetlag (SJL)

Daily life is controlled by three clocks called the sundial, the circadian (biological) clock, and the social clock. The inconsistency between the social clock, which represents the local time in the world, and the circadian clock, which is the internal clock of individuals, which causes an alignment problem, brings the concept of SJL to the agenda (Williams 2000, Roenneberg, 2012). The social clock is the clock enabling individuals to interact with each other in agreement and is important in determining the times such as school, work, vehicles, and store opening hours. The social clock relates to the sundial that has existed since the earth formed its constant rotation around its axis and the Sun. The circadian clock, however, is the internal clock controlling all physiological processes from metabolism to behavior providing an internal temporal organization that is compatible with daily environmental cycles (Wittmann et al. 2006, Roenneberg et al. 2019). The social clock, which showed an external consistency with the sundial and internal consistency with the circadian clock, has lost both external and internal consistency in modern industrialized societies. Especially the widespread use of electricity, not benefiting from daylight adequately, living in buildings for most of the day, turning on artificial light after sunset, eating habits at night, and using phones and tablets are among the most important factors increasing the difference between the social clock and circadian clock. To define the SJL concept, which is formed as a result of the inability of the social clock and the circadian clock to keep up with each other, it must be said that SJL is an alignment problem that occurs as a result of individuals experiencing inconsistency between social hours and circadian hours on working days and complying with their circadian clocks on holidays (Roenneberg, 2012, Roenneberg et al. 2019, Caliandro et al. 2021).

The similarity of the definition with travel jet lag was effective in naming the SJL concept. Individuals oscillate between time zones in SJL, just as in travel jet lag. The only difference is that this time zone travel occurs without changing locations. Individuals prefer different sleeping and waking times on working days under the influence of the social clock and holidays under the influence of the circadian clock because of their jobs. They often receive help from an alarm clock to wake up and drugs to sleep on working days when the circadian clock is not taken into account. On holidays, both falling asleep and waking up are under the control of the circadian clock (Wittmann et al. 2006, Roenneberg et al. 2019). Thinking of individuals with SJL as if they took a trip between the meridians on Friday evening and returned on Monday morning might help in understanding the SJL concept (Wittmann et al. 2006, Roenneberg 2012).

SJL= (UOZ-T)-(UOZ-Ç)

Figure 1. Measurement of social jetlag
SJL: Social Jet Lagİ UOZ-T: Holiday Mid-Sleep Time; UOZ-C: Working Day Mid-Sleep Time

Sleep duration is shortened on working days because of early awakening with social hours and chronic sleep deprivation is experienced in this way. If the recommended sleep duration of 7-9 hours for adults and 8-10 hours for adolescents cannot be covered, sleep debt accumulates on weekdays, which is usually compensated by longer sleep times on weekends. Going to bed too late on Sunday night because of phase delay and waking up early on Monday morning because of social time causes a very short sleep on Sunday-Monday nights, which is considered a vicious cycle of sleep debt (Hirshkowitz et al. 2015, Skeldon et al. 2017). The absolute difference between the mid-sleep time on holidays and the mid-sleep time on working days is taken into account in determining the SJL (Roenneberg et al. 2019).

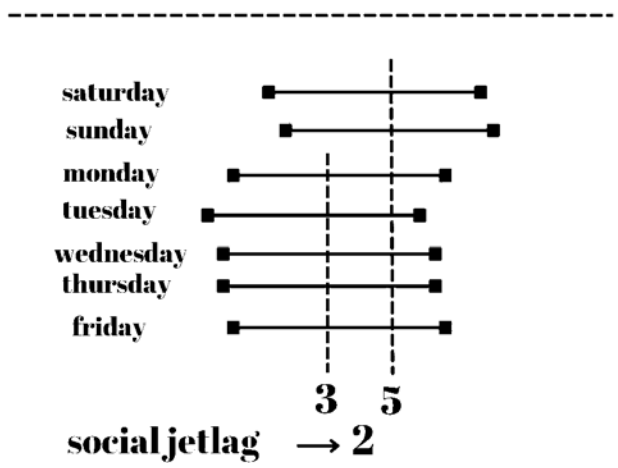

Figure 2. Calculation of social jetlag
The social jetlag value was calculated as 2 for an individual with an average of 3 mid-sleep times on working days during the week and 5 on average on holidays.

Mid-sleep is the value halfway between the time an individual falls asleep and the time wakes up. For example, if the individual sleeps at 10 p.m. on weekdays and wakes up at 8 a.m., the mid-sleep time of the working day is 3. If the sleep time for the weekend starts at 12 a.m. (i.e. midnight) and ends at 10 a.., the mid-sleep time will be 5 for the holiday. In such a case, the obtained SJL value is 2 (Figure 2).

Although some sources find this difference to be greater than 1 hour sufficient to talk about SJL, many sources consider values greater than 2 hours to be significant in this respect. Levandowski et al. reported that SJL can be mentioned at a "low" rate if it is ≤2 hours, "moderate" if it is >2 hours and ≤4 hours, and "high" if it is >4 hours (Levandowski et al. 2011).

Relationship between Chronotype and Social Jetlag

Today, working schedules typically start early in the day and are well-suited for the preferred sleep/wake times of morning chronotypes. However, late sleep onsets combined with these early awakenings for eveningness chronotypes that are found at a very high rate in the population cause late chronotypes to accumulate significant sleep debt during the work week (Ritonja et al. 2019, Leone et al. 2020). Eveningness chronotypes usually try to compensate for this sleep debt by extending the sleep time on the weekends. Eveningness people are affected by SJL much more than other chronotypes because of this great conflict between social and circadian clocks (Taylor et al. 2018, Liang et al. 2022, Mirghani et al. 2022). Eveningness chronotypes report poor sleep quality and daytime fatigue more frequently than morning chronotypes. It was reported that individuals with the eveningness chronotype have more psychological and psychosomatic disorders (Ong et al. 2021). Also, phone-tablet use, smoking, caffeine and alcohol consumption, both as a result of SJL and as a risk factor that worsens SJL, appear as a very important danger in eveningness chronotypes (Lang et al. 2018, Isabelle-Nolet et al. 2019).

How Does Chronotype and Social Jetlag Affect Neurocognitive Functions?

Neurocognition encompasses attention, memory, language, processing speed, orientation, judgment, visuospatial and executive functions, and is regulated 24 hours a day by three Central Nervous System processes called sleep inertia, sleep homeostasis, and the circadian system. Sleep inertia initially impairs cognition after individuals wake up at their usual waking time. The circadian rhythm, which then acts on brain stimulation, allows for a cognitive performance that remains relatively constant throughout the day, despite the homeostatic pressure of sleep. Most cognitive components show homeostatic and circadian differences (Fonseca and Genzel 2020, Taillard et al. 2021).

Controlled laboratory studies conducted on the impacts of sleep deprivation on cognition show that some complex tasks are more affected by sleep deprivation than other tasks. Some of the cognitive processes involved in a task might be more affected by sleep deprivation than others. For this reason, interpreting general performance measures without considering specific task requirements can lead to misleading results. Especially, studies conducted on attention, working memory, and executive functions report significant associations between sleep duration and sleep deprivation. In such a case, it is possible to argue that the prefrontal cortex is among the brain regions most affected by the sleep-wake cycle (Whitney and Hinson 2010, Borragán et al. 2019, Spruyt 2021).

Recent studies report that sleep deprivation not only gives rise to decreased alertness and attention but also impairs thinking and decision-making skills. Risk-taking propensity is an important component of decision-making, and neuroimaging studies reported that the brain regions most involved in risk decision-making are the limbic system, cingulate gyrus, and prefrontal cortex (especially the ventromedial prefrontal cortex). Gain-focused trials lead to increased ventromedial prefrontal cortex activation, reflecting increased sensitivity to gains after sleep deprivation. On the contrary, loss-focused trials cause a decrease in activation, which indicates a decreased sensitivity to losses in the same area. For this reason, sleep-deprived people can simplify a problem or focus on only a subset of information when making decisions on issues that they think will be profitable (Libedinsky et al. 2011, Salfi et al. 2020, Wang et al. 2022).

It is already known that the changes in qualitative and quantitative characteristics of sleep have impacts on cognitive functions. The fragmentation in total sleep time, which generally occurs more as individuals become older, harms cognitive functions in elderly adults (Gildner et al. 2019). It was hypothesized that age-related sleep changes increase the risk of cognitive decline in elderly adults and that short and long sleep durations are associated with impaired cognitive functions. Recurrent sleep problems, which affect the maintenance and duration of sleep negatively, might impair daily functioning, increase the risk of accidents, and affect the physical and psychosocial conditions of elderly individuals negatively (Chen et al. 2016, Fang et al. 2019). In a study conducted by the World Health Organization on global aging and adult health, it was reported that there are significant cross-sectional relationships between sleep duration and cognitive performance. In this study, it was reported that individuals who had intermittent sleep periods (6-9 hours/night) exhibited significantly higher cognitive scores than individuals with short (< 6 hours/night) and long (>9 hours/night) sleep periods (Gildner et al. 2014). The relationship of sleep with emotional regulation, growth, insulin resistance, and blood pressure, as well as cognition and academic achievement was also mentioned in previous studies conducted with children. It is especially important to examine the relationships between sleep and neurodevelopment in children because cortical structures that are still developing in childhood, especially the prefrontal cortex, are affected highly by the sleep-wake cycle in terms of functioning. In other words, these structures show a circadian rhythm just like the sleep process, and it is already known that sleep duration and continuity affect this rhythm (Chaput et al. 2016, 2017, Dutil et al. 2018). It is considered that insufficient sleep affects the developing brain structures and functions negatively, and for this reason, there is a relationship between sleep and neural plasticity in preschool children. It was reported in a study that was conducted with 158 children aged 3-6 years in Spain that the relationship between sleep and executive functions was especially significant in response inhibition and working memory. Participants who slept at the nighttime sleep time recommended for their age exhibited better inhibition and working memory capacities than their peers who had shorter nighttime sleep times (Nieto et al. 2022). Another important developmental step in adolescence, the sleep-wake cycle overlaps with synaptic pruning, which is an important neurodevelopmental step that occurs in this period and affects cognitive functions. Considering that there is a shift from morningness chronotype to eveningness chronotype during adolescence, both chronotype and SJL will change cognitive functions negatively. It was argued in a previous study that examined the relationship between chronotype and social cognition in adolescents that the eveningness chronotype might predict weaker reward-related inhibitory control and lower social status (Lunn et al. 2021). Also, as it is already known, the adolescence period is important in that it shows the first attacks of mental disorders such as schizophrenia. In their study in 2021, Lunsford-Avery et al. evaluated chronotypes in individuals at high risk for psychosis. As a result of their study, they reported that the eveningness chronotype was more common among individuals at high risk for psychosis. The results were associated with the neurodevelopmental impacts of the circadian system (Lunsford-Avery et al. 2021). It is still debated whether circadian dysfunctions are a risk factor for psychosis by affecting neural maturation or whether they are a result of psychosis symptomatology. Increasing evidence supports that there might be a common genetic predisposition between mental disorders and circadian rhythm disorders and that disruptions in circadian rhythm might predispose to mental illnesses (Delorme et al. 2020, Linke and Jankowski 2021).

Cognitive functions are assumed to fluctuate throughout the day with performances of different natures occurring at different times under the influence of sleep-wake regulation. According to the researchers, this “synchronicity effect” is considered to be the difference in performance between optimal and non-optimal times of the day, depending on chronotypes. Arguing that chronotype is associated with the optimal timing of daily performance in cognitive tasks, it was reported in previous studies that a “synchronicity effect” occurs between chronotypes and test times. In other words, it is considered that eveningness chronotypes exhibit optimal cognitive performance later in the day and morningness chronotypes show optimal cognitive performance in the early hours of the day with increased creativity at these times. It was also emphasized that evening people are less capable of adapting to non-optimal times than morning people since they have to deal with social jetlag and decreased self-control (Nowack and Van der Meer 2018, Kühnel et al. 2022). In some previous studies, it was argued that an asynchrony effect can be mentioned as opposed to the synchronicity effect (Carciofo et al. 2014, Martínez-Pérez et al. 2020, Bettencourt et al. 2022). In other words, it was proven in some studies that individuals can show higher functionality in times that are not optimal in terms of their chronotypes. In a previous study conducted with 351 adolescent participants by using facial and verbal emotional Stroop Test, it was found that late reactions to anger expressions were given in eveningness chronotypes regardless of test times. It was also found that a similar situation occurred in the mornings in the entire group, regardless of chronotypes (Lunn and Chen 2022). In another study, the effect of synchronicity in the evening and morning hours was evaluated by using the Psychomotor Vigilance Test (PVT). In this study, although a synchronicity effect was mentioned for eveningness people, it was found that this was not observed for morningness chronotypes (Martínez-Pérez et al. 2020). Although the effects of synchronicity on cognitive functions continue to be a controversial issue, the impacts of the methods used to determine chronotypes and the variety of tests measuring cognitive performance should not be overlooked (Carciofo et al. 2014, Lunn and Chen 2022).

SJL and chronotype might have some negative impacts on neurocognitive functions such as attention and memory via sleep and circadian disruption, and senior executive functions such as reaction inhibition and decision-making. In their study conducted in 2016, McGowan et al. reported that there is a relationship between high SJL values and attention deficit and hyperactivity disorder. Although high SJL values and deterioration of symptoms were found in parallel with the impulsivity subtype of attention deficit and hyperactivity disorder, this relationship was found to be relatively less significant in the attention subtype (McGowan et al. 2016). In another study that examined the relationship between SJL and attention functions, cognitive processes such as reaction inhibition and risky decision-making were evaluated with neuropsychological tests. As a result of this study, although SJL was associated with response inhibition, no effect was detected on risky decision-making (McGowan et al. 2020).

In a previous study that examined the relationship between the application time of cognitive tests and cognitive performance in extreme chronotypes, significant differences were detected in some sub-parameters of the Rey Auditory Verbal Learning Test (RAVLT) and the Stroop Test. Extreme morningness participants achieved significantly higher scores on the Stroop Color Naming Subtest when compared to extreme eveningness participants. Intermediate types, on the other hand, showed similar characteristics to the extreme eveningness participants in this regard. Both extreme morningness participants and extreme eveningness participants reached their performance peaks around 16:00, and executive functions were also affected by the time of day, regardless of their chronotypes. No effect of application time was detected on other cognitive tests between morning and evening hours in the same study (Evansová et al. 2022). In the study conducted by Nowack and Van der Meer, a chronotype effect was detected in line with the previous study. The authors evaluated this as a result of SJL, which is more common in eveningness chronotypes compared to morningness chronotypes (Nowack and Van der Meer, 2018). In the study that was conducted by Güzel Özdemir et al. in which they examined the effects of shift work on cognitive functions, it was found that night shift workers exhibited lower cognitive functions, especially in the immediate memory and verbal memory (Özdemir et al. 2013).

In a study that examined the effects of chronotypes on visuospatial functions, it was reported that visuospatial functions show daily changes depending on the chronotypes. Especially, the performances evaluated in the evening for the eveningness chronotype were greater than those evaluated in the morning for the morningness chronotype (Nishida et al. 2022).

In the study of Diaz-Morales and Escribano conducted in 2015 on 796 adolescents, social jetlag was found to be more associated with cognitive performance than all other sleep-wake variables. Also, the relationship between SJL and cognitive performance was found to be stronger in female adolescents in the study (Diaz-Morales and Escribano 2015).

The relationship between cortical excitability, neuroplasticity, and cognitive performance with chronotype was investigated in the study of Salehinejad et al. in 2021 with Transcranial Magnetic Stimulation (TMS), Electroencephalography (EEG), and neurocognitive tests on 32 people. It was found in the study that LTP/LTD (Long-Acting Potentiation/Long-Acting Depression)-like neuroplasticity, which is dependent on glutamatergic and GABAergic systems, was modulated by chronotype. Also, it was determined through various neurocognitive tests that chronotypes perform optimally in cognitive functions, especially working memory and attention, at times that are optimal for them (Salehinejad et al. 2021).

The relationship between chronotype and cognitive functions was evaluated with EEG, P300 wave, and Montreal Cognitive Assessment Test in a study that was conducted by Venkat et al. (MoCA). As a result of the study, it was found that morningness chronotypes had a better cognitive capacity than eveningness chronotypes, with reduced P300 delay observed for both frequent and rare stimuli (Venkat et al. 2020). In the study of Heimola et al. it was found that working memory was associated with chronotypes, and morningness chronotypes performed better (Heimola et al. 2021).

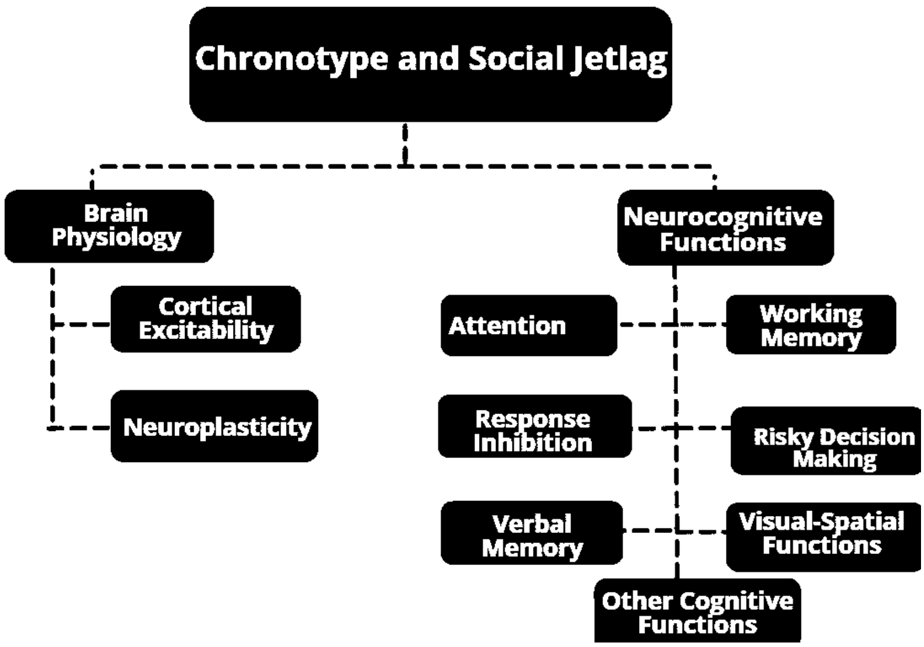

Figure 3. Chronotype and social jetlag affect brain physiology and neurocognitive functions both independently and by causing interactions.

A study conducted with adolescents in Japan found that 51.1% of the participants experienced ≥1 hour of social jetlag. The rate of SJL among Japanese adolescents was found to be significantly higher than that of the general population and was associated with insufficient sleep, daytime sleepiness, fatigue, mood swings, and poor academic performance. Also, the absolute value was not preferred in the formula used for SJL in this study, and negative and positive SJL were examined separately. It was found that negative SJL and positive SJL ≥2 hours had similar impacts on academic performance. In other words, extreme morningness people as well as extreme eveningness people appear to suffer similarly from the negative impacts of SJL on cognitive functions. It was discussed that this might be associated with sleep debt that cannot be compensated at the weekend in extreme morningness people (Tamura et al. 2022).

Although there are studies in the literature that generally show lower cognitive performance in eveningness types, there are also studies that argue that this is a result of the synchronicity effect and that evening people have a higher cognitive capacity (Kanazawa and Perina 2009, Ujma and Scherrer 2021). It was reported in the meta-analytic study of Preckel et al. that although evening people have a higher cognitive capacity, morning people show higher academic achievement (Preckel et al. 2011).

To summarize the effects of chronotype and SJL on cognitive functions, it can be argued that they have impacts on especially attention and working memory, reaction inhibition, risky decision-making, visual-spatial functions, memory, and other cognitive functions. It is seen that extreme chronotypes are riskier in this regard and SJL affects cognitive functions negatively both by interacting with the chronotype and independently of the chronotype (Figure 3).

Consequences of the Impairment in Neurocognitive Functions

Impairments occurring in neurocognitive functions cause adverse impacts on occupational and academic functionality and daily activities.

These negative impacts can be briefly listed as follows.

1. Decreased job performance,
2. Decreased academic performance,
3. Deterioration in interindividual-social relations,
4. Decreased physical performance,
5. Traffic accidents,
6. Work and workplace accidents,
7. Home accidents (Petitta et al. 2019, Trecroci et al. 2021, Tanasievici et al. 2022).

Therapeutic Adaptive Approaches

Regarding the impacts of chronotypes and SJL on neurocognitive functions, it is considered that individuals experience serious functional losses in daily, work, and academic areas. One of the arrangements that can be made to minimize this functional loss might be to observe the chronotype in working life and to arrange the shifts according to the chronotype in working areas, which usually require shifts. Such regulation can only be applied to a small number of individuals who can work in shifts since work and social life depend on social time (Guzel Özdemir et al. 2018, de Medeiros Lopes et al. 2022). Sleep hygiene comes first among the measures that can be taken to avoid social jet lag, which has impacts on neurocognitive functions as a more common factor in individuals with eveningness. Sleep hygiene involves various adjustments to daily activities, habits, and environmental conditions to improve sleep quality. Sleep hygiene training is an effective, inexpensive, and side-effect-free method used widely among strategies for coping with sleep disorders (Özdemir et al. 2015). Sleep environment is discussed in the sub-dimensions such as sleep time, daily activities and diet regulation, and improving mental control behaviors (Güneş, 2018).

Conclusion

Just like metabolic and mental disorders, chronotypes and SJL cause cognitive impacts in individuals. Social jetlag, which is more common in eveningness chronotypes, appears to contribute to cognitive negative impacts. Although it was proven that its cognitive negative impacts are more on attention, response inhibition, and working memory, there is evidence that it also has impacts on other cognitive functions as well. Lower academic achievement might occur because of these cognitive negative impacts during adolescence when susceptibility to eveningness chronotype is observed. Also, both quality of life and daily activities and work performance might deteriorate at older ages. In this respect, it is important to organize school and work programs to minimize the cognitive negative impacts of sleep deprivation caused by the chronotypes of individuals. It is already known that work and school schedules that start early in the morning and end in the evening cause a large sleep debt accumulation on weekdays in eveningness chronotypes. Combined with this, SJL causes a vicious circle. In this respect, it is recommended to inform individuals in terms of sleep hygiene, to apply sleep programs to reduce the effects of SJL at the weekend, benefit more from daylight, comply with regular exercise and diet programs, and reduce exposure to artificial light. Also, it is important to pay attention to test timing, which takes into account the effects of chronotype and synchronicity in cognitive performance measurements, especially for evening people.

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Authors Contributions: The author(s) have declared that they have made a significant scientific contribution to the study and have assisted in the preparation or revision of the manuscript

Peer-review: Externally peer-reviewed.

Conflict of Interest: No conflict of interest was declared.

Financial Disclosure: No financial support was declared for this study.