The Correlation Between Chronotype and Executive Function in Young Adults

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Abstract

The purpose of this research is to determine if chronotype is associated with executive function in young adults. We found chronotype to be significantly associated with differences in executive function, after controlling for differences in age. The research results show evening-type demonstrating greater difficulties with executive function.

Background

- Sleep chronotype: Sleep chronotypes distinguish the timing of a person's wakefulness and sleep preference, due to their inherent internal circadian clocks, which in turn affect the human body at both the biological and behavioral level (Roenneberg, Wirz-Justice, & Merrow, 2003).
- Executive function: The processes that manage and regulate thought and action, for example suppressing habitual responses (Friedman et al., 2006).
- Previous research implies that in high school students, chronotype is associated with executive function (Hahn et al., 2012) and school achievement (Díaz-Morales & Escobar, 2013).
- College-age students undergo a transition (“advanced phase shift”) in their chronotypes towards evening, and those with “eveningness” chronotypes appear to be out-performed academically by their morning-type peers (Önder et al., 2014).

Introduction

- Through my research I aim to find if the relationship between college students’ executive function abilities and their preferred time of day is maintained through the advanced phase shift.
- The motivation behind this is to see if the known link between chronotypes and academic performance is instead based off of the relationship between chronotypes and executive function abilities, which would make this link predictive of academic achievement.
- This is important because if there is a correlation, the clinical implications could possibly include showing young adults how to be more self aware when it comes to using sleep chronotype to do daily tasks that involve executive functioning.

Participants

- Participants in this research were enrolled through a larger study conducted by the memory and perception of speech (MAPS) lab that was run by the University of Delaware.
- 27 participants, made up of 4 males and 23 females.
- The range of ages was 18 years old to 24 years (mean age of 20 and 11 months).
- Participants did not have any hearing, attentional, neurological or socio-emotional impairments.

Methodology

- As part of the larger study, participants were administered a standardized testing battery 1:1 with a trained experimenter. The testing spanned approximately 2 hours, in a quiet room and were conducted at any time of day. Of the tests administered, interest to the current research question were assessments of executive function and of chronotype.
- The tests administered were:
  - Morningness-Eveningness Questionnaire (MEQ; Horne & Östberg, 1976):
  - Behavior Rating Inventory of Executive Function – Adult (BRIEF-A; Roth, Isquith, & Gioia, 2005).
- Once participants filled out these questionnaires, the record forms were scored by two independent scorers to ensure accuracy.

Morningness-Eveningness Questionnaire:

- The morningness-eveningness questionnaire (MEQ) is a self assessment consisting of 19 different questions.
- The questions are matched to a scoring system that reveals the difference in the participants chronotypes.
- Possible scores on this scale range from 16 (definite evening) to 86 (definite morning).
- The higher the score, the more likely one is of being a morning-type.

Behavior Rating Inventory of Executive Function – Adult:

- The BRIEF questionnaire gauges the executive function of participants with a more evening-oriented chronotype.
- There are 86 questions on the assessment that judge Behavioral skills (basing off of the ability to inhibit, shift, and control emotions) and Metacognition.
- The Metacognition scale is created using a score derived from the ability the participant has to organize materials and monitor as well as use initiative, working memory, and planning skills.
- The Global Executive Composite (GEC) score is generated using both the clinical scales, and constitutes the participants overall executive function. Higher scores on this scale indicate greater difficulties with the assessed construct.

Correlation Matrix of Measures in Study

<table>
<thead>
<tr>
<th>Score</th>
<th>16-30</th>
<th>31-41</th>
<th>42-58</th>
<th>59-69</th>
<th>70-86</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleep Onset</td>
<td>2:00-3:00 AM (02:00-03:00 h)</td>
<td>12:45-01:00 AM (00:45-01:00 h)</td>
<td>10:45 PM-12:45 AM (22:45-00:45 h)</td>
<td>00:30-01:45 AM (21:30-22:45 h)</td>
<td>09:00-09:30 PM (21:00-21:30 h)</td>
</tr>
<tr>
<td>Wake-Up</td>
<td>02:00-03:30 AM (02:00-03:30 h)</td>
<td>12:30-01:30 AM (00:30-01:30 h)</td>
<td>10:30-11:00 AM (10:30-11:00 h)</td>
<td>09:00-10:00 AM (09:00-10:00 h)</td>
<td>08:00-09:00 AM (08:00-09:00 h)</td>
</tr>
<tr>
<td>Label of Chronotype</td>
<td>Definite Evening</td>
<td>Moderate Evening</td>
<td>Intermediate</td>
<td>Moderate Morning</td>
<td>Definite Morning</td>
</tr>
</tbody>
</table>

Table 1: The table shows the frequencies of the scores on the MEQ, breaking down the range of each category and what the corresponding chronotype is labeled.

Discussion

- In order to determine if there were specific constructs within the GEC that were particularly associated with chronotype (and thus, driving this effect), we ran an additional correlation matrix with all the subtest scores of the BRIEF along with the MES.
- We conducted a linear regression analyses on the Global Executive Composite (GEC) score of the BRIEF, with each participant’s Morningness-Eveningness (MES) score as a predictor, and age as a covariate.
- We found that MES was significantly predictive of GEC (r(12.24)=.5.15, p<.013), suggesting that college students’ chronotypes are a significant predictor of executive function beyond differences in age.
- Specifically, elevated difficulty with executive function was associated with a more evening-oriented chronotype.

Conclusions

We found that chronotypes in young adults were associated with differences in executive function. Specifically, those who tended to be evening-types demonstrated greater difficulties with executive function. This may mean that in the future, taking a person’s sleep chronotype into consideration may benefit their own choices when it comes to using executive functioning skills.

References