The early bird catches the worm! The impact of chronotype and learning style on academic success in university students.

Abstract

In high school students, eveningness is a significant negative predictor of Grade Point Average (Preckel et al., 2013). Various explanations for this relationship have been proposed, including conflicting learning preferences between morning and evening types impacting ability to process and repeat lecture material (Diaz-Morales, 2007). These associations have yet to be established in a university population. This study investigates whether chronotype continues to influence academic success in first year university students and potential factors that may contribute to any academic contrast between morning types (Larks) and evening types (Owls). Data was gathered from students enrolled in Biological Concepts of Health at the University of Guelph, from 2012-2014. Students completed the modified Morningness-Eveningness Questionnaire (chronotype) and the VARK Questionnaire (learning style preferences). As predicted, self reported Owls earned significantly lower overall grades than Larks (76.9% vs. 80.0%, $p<0.05$). Surprisingly, lecture time (8:30am vs. 4:30pm) did not significantly impact grades in Larks or Owls. Larks also produced higher grades on both the midterm (76.7%, 70.2%, $p<0.05$) and exam (73.0%, 68.1%, $p<0.05$). In order to explain these relationships, the influence of varying learning styles was investigated. Larks indicated a preference for Read/Writing learning styles over Kinesthetic, Auditory, or Visual, while Owls preferred Kinesthetic learning. This research suggests that traditional instructional practice in higher education may favour the success of morning type individuals. Investigations into novel strategies to expand creative practices in the educational system could be beneficial in order to better address both dispositions.

Key Words: Morningness-Eveningness, Chronotype, Learning-styles, Academic Performance, Higher Education

Introduction

Most individuals possess an inclination toward either morning activity (Larks) or evening activity (Owls). This tendency to prefer to function at differing times of day is often referred to as Chronotype (Horne and Ostberg 1976). Chronotype has been shown to play an influential role in academic performance in high school and middle school students, with Owls having a significant disadvantage academically compared to Larks (Randler and Frech 2009, Preckel *et al.* 2011, Preckel *et al.* 2013). A study done by Randler and Frech (2009) evaluated middle school students in Germany and found that Grade Point Average (GPA) worsened in students who shifted towards eveningness. Preckel (2013) also found similar results in high school students, noting that eveningness was a significant negative predictor for GPA, after controlling for both tiredness and work attitudes. Interestingly, research in the United States conducted on individuals ages 17-34 revealed that evening type people are actually more likely to have higher intelligence scores on standardized tests than morning type people (Roberts and Kyllonen 1999). Furthermore, meta-analysis on cognitive ability, academic success, and chronotype has revealed that Owls have higher cognitive ability than Larks, yet eveningness is negatively correlated to school performance and morningness is positively correlated to school performance (Preckel *et al.* 2011). This poses the question of why eveningness is hindering academic performance when it does not appear to suppress cognitive ability. These findings on intelligence suggest that the disadvantage to Owls may be directly associated with some aspect of the type or method of education they are receiving. The goal of the present study is to investigate the impact that chronotypic preference has on academic success in university students, and to determine if teaching techniques in higher education may also be influencing that relationship.

The concept of an altered nature of development in the late teens and early twenties has recently been classified as emerging adulthood (Arnett 2000). This period of time includes ages 18-25, where individuals are neither adolescence nor young adults (Arnett 2000). Research has just begun to focus on and explore this rich, complex, and dynamic period of life, which is vital to development. Studies have shown that, when compared to individuals who self identify as adults, emerging adults have a poor sense of identity, are under more pressure, and engage in more risky behavior (Nelson 2005). University is a large component of lifestyle for emerging adults and it is possible that poor academic performance may contribute to their struggles and insecurities. For this reason, it is important to consider what may be influencing academic success in emerging adults. Additionally, most research regarding sleep cycles and academics has largely focused on high school students and school start times (Preckel *et al.* 2013, Preckel *et al.* 2011, Noland *et al.* 2009). These studies have shown increasing evidence that adolescents develop an evening preference as they age through high school (Kirby, Maggi, and D'Angiulli 2011, Randler and Frech 2009). This suggests that as students begin university they are more likely to have acquired an evening oriented chronotype. Therefore, it is important to investigate whether chronotype continues to play a role in educational success at a post-secondary level.

Interesting research in Madrid targeted university students, with an age range of 18-30 years old, in order to study personality and learning styles of morning and evening types (Diaz-Morales 2007). The Million Index of Personality Styles (MIPS) survey was used to assess personality and the Composite Scale of Morningness (CSM) was administered for chronotype. This research determined that, on average, Owls and Larks possess very different thinking styles.

Specifically, Larks preferred direct, tangible, concrete sources, with observable data, and use logic and analysis to learn. Whereas Owls preferred imaginative, intuitive thinking styles, based on symbolism and unknown data (Diaz-Morales 2007). This suggests that Owls may struggle to learn information when presented in a typical lecture based format, or reproduce this information on typical fact-based assessments (eg: multiple choice exams) due to conflicting thinking or learning characteristics.

Although research indicates that Owls achieve higher intelligence scores on standardized tests than Larks, it can still be suggested that Owls are merely unmotivated to apply themselves (Roberts and Kyllonen 1999). Interestingly, recent research by Onder *et al.* (2014) found that academic motivation is higher in morning type university students. Findings indicated that higher motivation in Larks also had a strong positive influence on their academic performance (Onder *et al.* 2014). However, contrasting research in high school students has shown that, even when controlling for achievement motivation, tiredness, and attitude, eveningness is still a negative predictor of GPA (Preckel *et al.* 2013). Therefore, the relationship between chronotype and GPA cannot be attributed solely to work ethic. It is clear that more research is needed in order to investigate what may influence the relationship between chronotype and academic performance.

Collectively, the purpose of the current study is to determine if self-identified chronotype has an influence on academic performance in 1st year university students. We hypothesize that chronotype will influence grade averages, particularly that Larks will have higher overall achievement than Owls. We also anticipate that students with poor academic performance will possess a learning style that does not fit with traditional university teaching. If Owls continue to show an academic disadvantage in higher education, then we believe it is important for universities and colleges to consider altering teaching styles and campus resources to better cater towards all types of students.

Methods

Study Design and Participants

This cross-sectional study was conducted at the University of Guelph from the winter semester of 2012 to the winter semester of 2014. A total of 2880 students enrolled in the first year BIOL*1080 course entitled 'Biological Concepts of Health' were sampled. Students were between the ages of 18-25 and from various programs in the College of Biological Science. Of these students, 1002 gave consent for their data to be used in research. Students were organized based on the lecture time they attended, either 8:30am or 4:30pm. Over the three-year period, all students always wrote the midterm at 5:30pm (i.e. outside of regular lecture) and exams were written at either 8:30am or 11:30am. Final grades for the entire course, midterm test, and exam test were also collected. Additional components of the course included seminar assignments, lab assignments, online quizzes, and an interdisciplinary project (Figure 1).

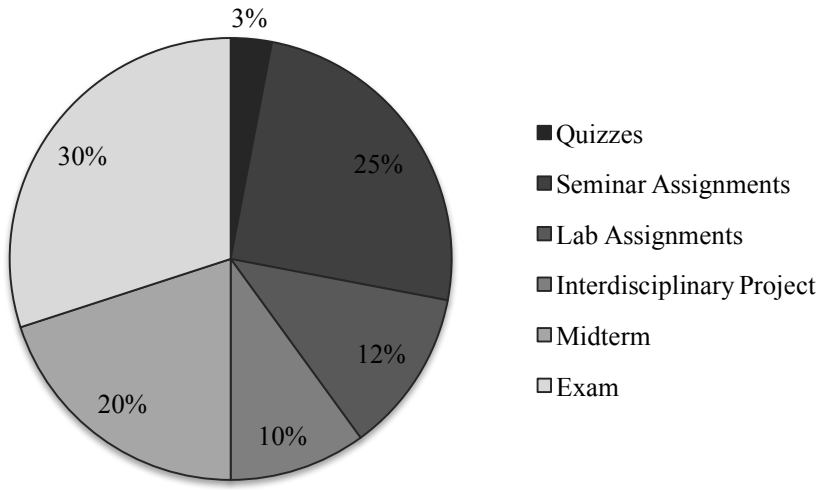

Figure 1: Weighting of all assessments that comprise the overall final grade for the Biological Concepts of Health course.

Materials

All participants completed several surveys offered on their course website for class credit. Subjects completed the questionnaires during their free time over 10 days at the beginning of the course, with no time constraints. For the purposes of this study, only the chronotype questionnaire (mMEQ) and the VARK questionnaire were considered.

The modified Morningness-Eveningness Questionnaire (mMEQ) was used to rank the participants based on sleep-wake preferences. The mMEQ was reduced to 7 questions from the original 19 question long MEQ. The modified version has been shown to accurately represent the results of the longer version (Adan and Almirall 1991). Questions investigated time preferences for daily activities, such as physical activity, going to sleep, waking up, and test taking, and a final score from 6-32 was calculated. Based on the range that their final score fell into, students were classified on a scale as either Definitely Morning, Moderately Morning, Neither, Moderately Evening, or Definitely Evening. Morning categories were then grouped together as 'Larks', evening categories as 'Owls', and the individuals who classified as Neither remained as 'Neutrals'.

The VARK questionnaire is 16 questions long and is used to assess whether individuals possess a preference for visual, auditory, reading-writing, or kinesthetic learning. There are four potential responses to each question, which individually pertain to either V, A, R, or K. The category with the highest score signifies the individuals learning preference. Each question on the survey provides the option to select multiple answers, which often results in a range of scores over the learning styles.

Completion of the quizzes was counted as participation marks towards each student's final grade. Consent was gathered during class in the last week of lectures by a researcher who requested written informed consent for the use of the completed questionnaires in research.

Participation was voluntary and their decision did not impact final grades. The Research Ethics Board (REB) at the University of Guelph reviewed and approved this research.

Data Management & Statistical analysis

All data analyses were done using the Statistical Package for Social Sciences (SPSS) version 22 for Mac. All data are reported as mean +/- standard error. Comparisons were made between the three chronotypes (Larks, Owls, and Neutrals) and grades using one-way ANOVAs followed by a Tukey's post hoc multiple comparisons test in order to determine relationships between the subgroups. An independent sample T-test was used to compare the difference in VARK scores between Larks and Owls and paired sample T-tests were used to assess the differences between scores within chronotypes. A significance level of 5% ($p=0.05$) was set for all analyses.

Results

Population Under Study

A total of 2880 first year students were surveyed in BIOL*1080 between 2012 and 2014. Of these students 35% (n=1002) consented to have their data used in research. Only consenting data was used for the purposes of this study. Students were classified by the mMEQ as Definitely Morning (n=8), Moderately Morning (n=115), Neither (n=495), Moderately Evening (n=302), and Definitely Evening (n=82). Due to the small sample sizes in the 'Definitely' categories, the morning and evening preferences have been grouped into Larks (morning-type) and Owls (evening-type). Thus, the distribution of chronotype was 12.3% Larks, 38.3% Owls, and 49.4% Neutrals.

Academic Performance

The mean final grade for all participants was 78.4% +/- 6.8%. As hypothesized, Larks had significantly higher grades than both Neutrals and Owls, and Neutrals also had higher grades than Owls (80.0%, 78.5%, 76.0%, $p<0.05$) (Figure 2). This pattern was also true of the midterm (76.7%, 73.4%, 70.2%, $p<0.05$) and final exam grades (73.0%, 70.1%, 68.1%, $p<0.05$) (Figure 3). There was no mean effect of lecture time on academic performance. All students performed equally as well in the 8:30am (78.6% +/- 7.8%) and 4:30pm (78.3% +/- 7.8%) lectures across chronotypes (Figure 2).

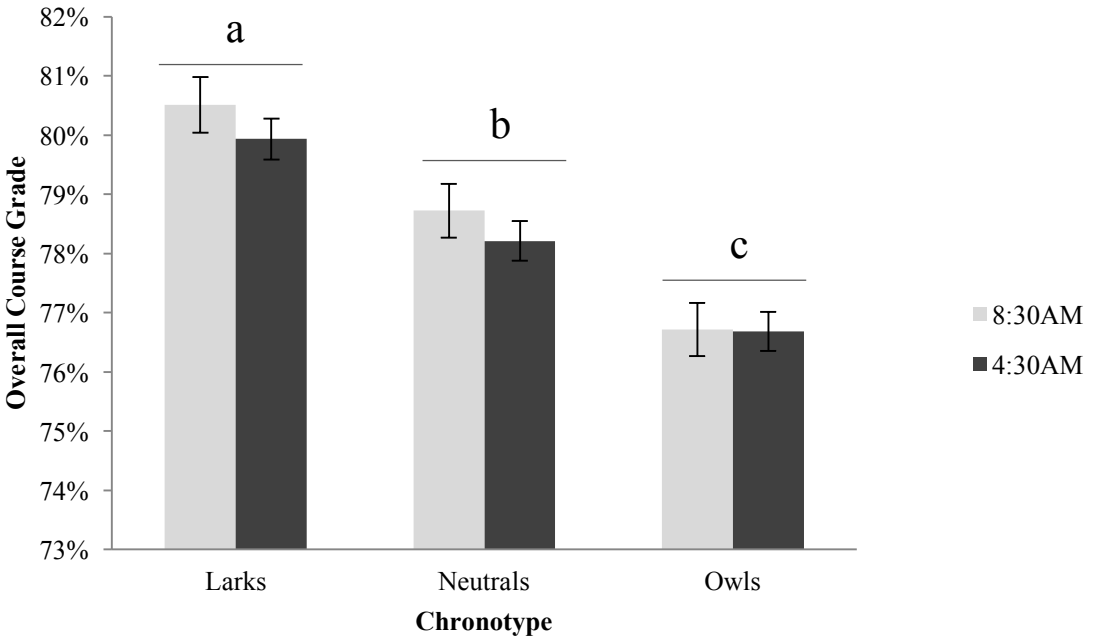

Figure 2: Comparison of the final grade averages for Larks, Owls, and Neutrals enrolled in BIOL*1080 (n=1002). Students were further categorized by the lecture time they attended, either 8:30am (n=446) or 4:30pm (n=556). Differing lower case letters above chronotype columns indicate statistically significant differences for the main effect of chronotype on academic success ($p<0.05$). Error bars represent standard error for each grade average.

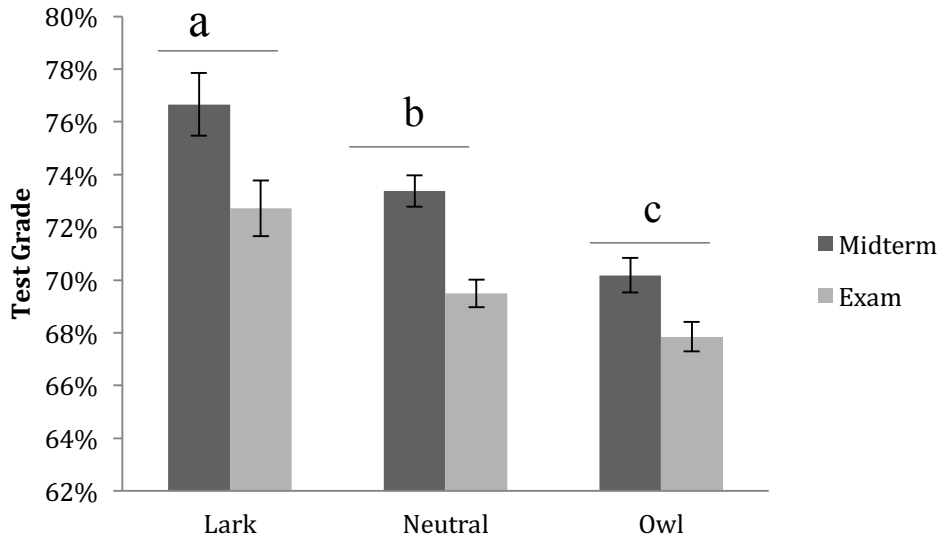

Figure 3: Comparison of midterm grade averages and exam grade averages for Larks, Owls, and Neutrals enrolled in BIOL*1080 (n=1002). Letters above chronotype columns indicate statistically significant differences for the main effect of chronotype on grades ($p<0.05$). Error bars represent standard error for each grade average.

Learning Styles

VARK learning style surveys were administered to students in the winter 2012 semester and discontinued thereafter. Therefore, only these students (n=190) were considered for analysis of learning styles. The relationship between chronotype and academic performance remained significant in the refined population, and the sample accurately represents the patterns seen with academic success and chronotype distribution in the full population. Larks had significantly higher final grades than Owls (79.0%, 75.7%, $p<0.05$). The VARK survey ranked students on a scale from 1-16 for each potential learning style, which included Visual, Auditory, Reading/Writing, or Kinesthetic. Students were able to pick multiple responses for each question, which resulted in a range of preferences across chronotypes. Interestingly, Larks reported to prefer Reading/Writing learning significantly more than Owls (8.87, 8.12, $p<0.05$). Larks also showed a significant preference for Reading/Writing over Visual, Auditory, and Kinesthetic (8.87, 7.04, 7.46, 7.48, $p<0.05$). Additionally, Owls indicated a significant preference for Kinesthetic learning over Visual and Auditory (8.63, 7.90, 7.49, $p<0.05$) (Figure 4). Neutrals did not show a significant preference for any particular learning style.

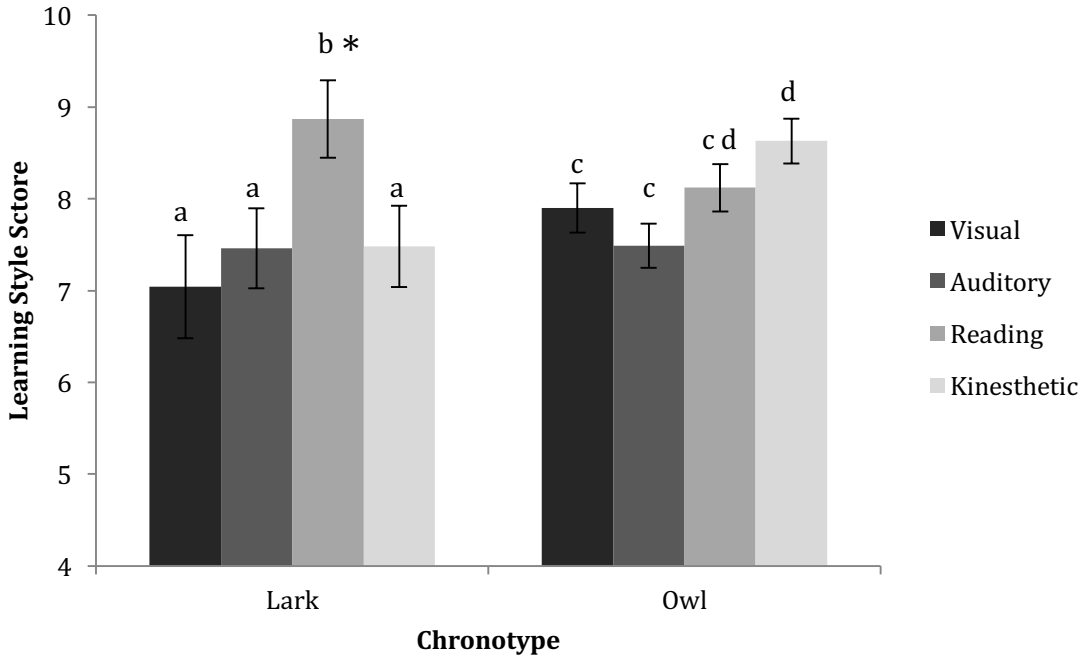

Figure 4: Distribution of learning style preference assessed by the VARK survey for Lark and Owl BIOL*1080 students (n=190). Scores range from 1-16 for each learning style, which allows for classification of students based on an inclination for visual, auditory, reading/writing, or kinesthetic learning. Bars that do not share a lower case letter indicate significant differences in score within each chronotype ($p<0.05$), and the asterisk denotes a significant difference in the reading/writing score between Larks (n=46) and Owls (n=144) ($p<0.05$). Error bars represent standard error for each score.

Discussion

The primary objective of this study was to examine the relationship between chronotype and academic success within a first year university student population. Our results indicate that chronotype does significantly impact grades. Specifically, morning type students have significantly better academic performance than evening types students.

In attempt to explain why Larks are more successful in school than Owls, we investigated the learning preferences of each chronotype. Morning and evening types have already been shown to possess very different learning preferences, which could have a considerable impact on their abilities to process and repeat lecture material (Diaz-Morales 2007). Consistent with this, Fabbri *et al*. (2007), investigated a large group of undergraduate students and determined that morning type individuals scored higher in left-brain thinking than evening types, and evening types had significantly higher scores for right-brain thinking styles. Left-brain thinking indicates processing information logically and sequentially, and dealing with verbal, and analytical materials, whereas right-brain thinking is involved in processing information nonlinearly and dealing with spatial, emotional, and aesthetic materials (Fabbri *et al*. 2007). Our study was able to further support these findings by confirming that Larks have a significant inclination for reading/writing learning styles, whereas Owls show a preference for kinesthetic learning. Importantly, we were able to extend this difference in learning styles to a difference in performance on academic tests and overall grades in a University course setting.

Our main results prompt one to consider the possibility that higher education is tailored towards the learning styles of morning-type people. We hypothesized that Larks would possess a learning style that was better suited to traditional education teaching methods. The most common teaching method employed in higher education is still the lecture-style model (Freeman *et al.* 2014, McGarr 2009), which is heavily based on the use of language and words and appeals to those that are linguistic learners (Gardner 1999). The BIOL*1080 course investigated in this study is taught using a fairly traditional, in-class instructor-led lecture style. Therefore, our findings support our original hypothesis and suggest that the lower grades seen in Owls may be a result of these teaching techniques, which do not meet the needs of evening type students. Our findings are also in line with research performed on first year Canadian university students which reported that Owls prefer diverse learning styles more than traditional styles, and online lectures over in class lectures, when compared to Larks (Jovanovski and Bassili 2007). It is worth noting that the midterm and final exam grades reported here are based on an entirely multiple-choice assessment, although these components only make up 50% of the course. The other 50% of the course grade is earned through seminars, labs, and projects, which provide a more hands on learning approach. Regardless, the grades from the midterm and exam indicate that Owls may be at a disadvantage for multiple-choice testing, and this pattern continues even when the final overall grade is considered. Based on these findings, it would be valuable for future research to investigate whether or not the method of assessment has a significant impact on the difference in academic success between Larks and Owls, in addition to teaching style. Overall, our findings indicate that common university teaching and assessment methods may unfairly disadvantage evening type students. Furthermore, this research suggests that higher education should focus on implementing active learning approaches into lecture style courses, which have been shown to enable students to absorb and retain information better than traditional methods (McCarthy and

Anderson 2000). An area of future research to consider would be whether Owls display enhanced academic performance in specific courses that employ kinesthetic based learning, such as anatomy dissection or research projects.

A few important limitations concerning this study must also be noted. Firstly, the consenting population had significantly higher grades than non-consenters. Consent was gathered in lecture during the last week of class. Therefore, the students present in class are more likely to achieve higher academic success than those who do not attend class (Crede, Roch, and Kieszczynka 2010). Furthermore, research has shown that individuals who volunteer to be involved in studies are more likely to have higher intelligence than those who do not (Heiman 2002). These considerations introduce non-response bias. Regardless of this difference, consenting data was only considered in analysis. As a result, grade point averages appear falsely elevated across all chronotypes in the reported data. Secondly, the correlational nature of a cross-sectional study design does not provide cause and affect data. Therefore, relationships can be established between factors, but not causality. Finally, convenience sampling was used in the selection of BIOL*1080 students at the University of Guelph. This impacts the external validity of the study results. Thus, the study sample is reasonably representative of the first year sciences student body in Guelph, however, may be poorly representative of the entire emerging adult target population.

This study was able to determine that chronotype continues to play a significant role in post-secondary education. Morning type individuals show higher academic success than evening types within this first year university student population. Additionally, Larks and Owls appear to possess distinct learning style preferences, which can help to explain why Owls are at a disadvantage academically in higher education. Future research should work towards confirming this deduction by investigating whether kinesthetic courses show higher grades for Owls. All together, this research determines that there is an imbalance in several interactive and educational factors that create inconsistencies in academic success between chronotypes. Furthermore, these inconsistencies may provide opportunity for interventions in higher education to expand teaching and assessment methods to become better suited to all types of students. Ultimately, this may help to alleviate the significant differences in academic achievement between Larks and Owls.

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