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The relationship between morningness – eveningness preference and online learning

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Abstract
This study explored whether circadian preference is related to students' attitudes and choices to attend lectures or watch them online, and whether these variables relate to course performance. The subjects were 847 students enrolled in an introductory psychology course who completed an online survey that contained the Morningness – Eveningness Questionnaire and that ascertained their attitudes towards online lectures and the extent to which they attended lectures or watched them online; course performance was also recorded. The results revealed that evening-type students were significantly more likely to have a positive attitude toward online lectures and to choose to watch lectures online. Course performance was not linked to morningness – eveningness preference, lecture mode choice, or their interaction. The results suggest that online lectures appeal differentially to students with a morning or evening orientation, but that watching lectures in a modality that does not accommodate a student's circadian preference does not handicap performance.

Keywords: *Morningness – eveningness, circadian preference, MEQ, online learning, lecture mode*

Introduction

The past few decades have seen an unprecedented expansion in the role of information and media technologies in our daily lives. Such development has extended to large corporations and small businesses alike, hospitals, and even the classroom. Indeed, over the last few years there has been a tremendous increase in student enrolment in online courses: according to a recently published report, 1.9 million students were enrolled in online courses in the fall of 2003, 19% more than the previous year (Carlson 2004). Moreover, the survey predicted an additional 24% growth in online enrollment for 2004, particularly at public and for-profit institutions.

This enrolment ''boom'' in online courses has resulted in increased interest in the research literature on the effectiveness of this relatively new medium for learning. However, research on the learning outcomes associated with online courses has met with mixed results. For instance, some studies comparing performance in traditional lecture courses with Web-based courses have found that students enrolled in the online course achieved higher grades (Maki et al. 2000; Maki & Maki 2002); another study found lower final exam scores for Web-based

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students (Wang & Newlin 2000); and still other studies have found no performance differences between students in the two lecture modes (Hiltz 1993; Sankaran et al. 2000).

Inconsistent findings have also been noted in the literature on another important variable in the realm of research on online learning: student satisfaction. For instance, Wang and Newlin (2000) found non-significant differences in course ratings between the Web-based and lecture courses. Waschull (2001) found higher ratings in his Web-based introductory psychology course compared to the lecture course although the difference was not statistically significant. On the other hand, Maki and colleagues (Maki et al. 2000; Maki & Maki 2002) have consistently found that students preferred the lecture courses to the Web-based versions, despite obtaining higher grades in the latter medium.

A whole host of factors may be responsible for the inconsistent findings in the studies outlined above. One factor that may be related to the higher satisfaction ratings in online courses found in some studies is that online education offers the obvious advantage of convenience over face-to-face lectures. While some students may not find Web-based courses to be more convenient (Maki & Maki 2002), by and large convenience is often cited as the primary advantage that students find with online learning (Kvavik & Caruso 2005).

Other factors that could explain these inconsistencies may have more to do with the characteristics of the student samples than with the medium type. Indeed, a relatively fruitful area of study in the realm of online learning has been to explore the individual difference variables associated with course performance and student ratings of satisfaction. Some of these studies have shown performance and satisfaction outcomes in the two lecture formats to be related to various personality and cognitive variables, such as introvertedness and openness to new experiences (Maki & Maki 2003), conscientiousness and a convenient learning orientation (Bassili 2005), comprehension skill (Maki & Maki 2002), and ability level (Hiltz 1993).

The focus of the present study was on determining whether another individual difference variable, chronotype or circadian preference, would be related to the student's choice of instructional mode, their attitude towards online lectures, and course performance. The literature on the sleep–wake cycle has identified definite types corresponding to diurnal preference (Tankova et al. 1994). This preference has been formally conceptualized as a trait lying along a continuum known as the morningness–eveningness (M–E) dimension. M–E preference is regarded as one of the most marked individual differences. Morning-types (M-types or larks) and evening-types (E-types or owls) have different endogenous circadian phases and have been shown to differ in daily rhythms of many physiological variables, such as subjective alertness, core body temperature, blood pressure, heart rate, and hormone secretion (Bailey & Heitkemper 1991; Monk et al. 1997; Smyth et al. 1997; Baehr et al. 2000). Despite these differences in endogenous factors, however, real life may not afford individuals the ability to plan their day according to their trait-like disposition toward a particular circadian preference. Indeed, the requirements of one's daily life, including work, caregiving, and school schedules must often take precedence over their preferred time of day, at least for most people. Hence, how one organizes their activities according to a 24-hour cycle is the result of the interaction between endogenous and environmental factors.

It can be argued that university students may be particularly affected by the conflict between M–E preference and external influences. Researchers have consistently reported that university students are biased towards eveningness (e.g. Mecacci & Zani 1983). This is likely related to a phase delay in melatonin secretion which has been reported in adolescence (Carskadon et al. 1997; Laberge et al. 2000), coinciding with the finding that adolescence is a stage in which the sleep–wake cycle tends to become delayed such that adolescents tend to

stay up progressively later and to sleep later in the morning when compared to preadolescents. Thus, while many university students experience this delay in sleep–wake cycle, their school schedules often consist of classes which begin early in the morning when many students are not ''at their peak''. Indeed, there is an abundance of research documenting so-called ''time-of-day'' effects on various cognitive processes (e.g. memory, alertness, etc.) associated with intelligent behaviour, whereby performance on at least some cognitive tasks improves during one's optimal time of day (May et al. 1993; May & Hasher 1998; Hidalgo et al. 2004). The literature on the role of circadian typology in education has found that E-types tend to have poorer class attendance and school achievement and are less alert during class than M-types (Giannotti et al. 2002). Hence, it is of interest in this study to determine whether circadian preference is linked to course performance when face-to-face lectures take place early in the morning while these lectures can be viewed online at any time of day.

The current study involved an introductory psychology course in which students could choose on a lecture-by-lecture basis to attend a lecture or watch it online. This instructional approach is called the WebOption. The lectures take place at 9:10 a.m. three times per week, a time that is likely to be unattractive to students with an evening preference. As such, circadian preference is potentially related to attitudes toward the WebOption, the choice to attend lectures or watch them online, as well as with course performance. For instance, it is possible that E-type students are more likely than M-type students to choose to watch lectures online at the time that is more compatible with their circadian inclination than to attend a morning lecture. As such, these students may also have a more positive attitude towards online lectures when compared to M-type students. Also of interest in this study is the question of whether the effect of M–E preference is the same on attitudes towards the WebOption and on the choice to attend lectures or watch them online. It is possible, for instance, that M–E preference may be associated with students' attitudes towards online lectures and that these attitudes, in turn, influence the choice to attend lectures or watch them online. Indeed, there is a long line of research in the social sciences which suggests that attitudes mediate a wide range of behavioural choices (e.g. Berger & Mitchell 1989; Bassili 1995).

Finally, this study will explore whether any or all of these variables influence performance outcomes. In particular, the joint influence of circadian preference and mode of lecture viewing or attitude towards the WebOption can potentially interact to influence course performance. A possibility is that E-type students may perform better when they choose to watch most if not all lectures online. Therefore, any cognitive advantages M-types may have with respect to better memory and alertness, which would aid the learning process, would be eliminated because E-type students are likely to choose to view lectures during a more optimal time of day. By contrast, M-type students may perform better when they choose to attend lectures, during which they may benefit from the experience of being amongst their peers as well as having direct access to the professor during lecture. These possible associations can be uncovered by interactions between instructional mode choice or attitude towards the WebOption on the one hand, and M–E preference on the other, in predicting course performance.

Method

Participants

Our sample consisted of students enrolled in an introductory psychology course at a Canadian University. A total of 1071 students were enrolled in the course during the session,

446 being registered in the class section and 625 in the online section. Of these, 847 students (572 females) completed most items on the questionnaire.

Lecture format

Classes in the lecture section of the course met three times a week at 9:10 a.m. and were taught by a member of the psychology faculty who had over 25 years of teaching experience. Online lectures were created by utilizing the WebOption, a method involving the dual-mode presentation of large lecture in large courses (see Bassili 2005 for a detailed description of the WebOption; a brief summary of the method is presented here). Although students in this introductory course must enroll in either the face-to-face or the online section of the course, all students are told that they have the choice to attend lectures in class or watch them online. This choice can be made on a lecture-by-lecture basis, so that students often attend some face-to-face lectures while viewing other lectures online.

Lectures were taped and uploaded to the Web within a few hours after the class meeting and were available to be downloaded by students in Real Media format by way of streaming video. The video window had a size of 320×213 pixels and appeared on the right of the screen. The same PowerPoint slides shown in the live lecture (along with shuttle buttons) appeared on the left of the video window. The slides could also be downloaded and pre-printed for students to annotate while viewing lectures. Online lectures were available for viewing for only one week after the lecture was presented in class. All students, irrespective of the section they were enrolled in, could exchange views on learning content through a discussion forum. Students in the online and face-to-face section took exams in the course at the same time.

Procedure

The questionnaire consisted of a total of 100 items and was posted on a commercial Web survey host. A link to the survey was provided on the course web page. This questionnaire could be completed by students at any time during the last three weeks of classes.

Measures

Of the 100 questionnaire items, 24 questions pertained to the present study. These items included the Morningness–Eveningness Questionnaire (MEQ), the choice to attend live lectures or to watch them online, and attitudes toward the WebOption.

MEQ. Preference for Morningness–Eveningness was measured using the 19 self-report items from the MEQ (Horne & Ostberg 1976). Previous studies have found the questionnaire to have good reliability (Smith et al. 1989; Buela-Casal et al. 1990). Moreover, MEQ scores have been shown to correlate with sleep–wake behaviour, circadian variations in oral temperature, periods of perceived alertness and performance, and the cognitive performance of younger adults on various tasks (Horne & Ostberg 1977; Mecacci & Zani 1983; Smith et al. 1989; Bodenhausen 1990; Buela-Casal et al. 1990; Petros et al. 1990; Anderson et al. 1991). All MEQ items require participants to evaluate the degree to which they prefer definite morning (or evening) activities. For example, Question 5 asks: ''How alert do you feel during the first half hour after having woken in the morning?'' (1, not at all alert; 2, not very alert; 3, fairly alert; 4, very alert). The MEQ total score ranges from 16 to 86, with scores above 58 classifying participants as M-type and scores below 41 as E-type. M-types with scores below

70 are classified as moderate while those with scores of 70 or above are classified as definitely M-types. E-types with scores below 31 are classified as definitely evening-types while those with scores of 31 – 41 are classified as moderately E-types. Participants with scores of 42 – 58 are classified as neutral.

Instructional mode choice. The WebOption model provides students with substantial flexibility with regard to the mode they choose to view lectures. Students in both the class and Web section of the course were made aware of this flexibility so that they knew they could come to class or watch lectures on the Web at will. By the time the questionnaire was posted on the website, 25 one-hour lectures had been delivered. The number of lectures attended in class and watched online was measured by the following two items: ''How many of the 25 lectures did you attend in class?'' and ''How many of the 25 lectures did you watch online?'' The response options for both questions were: None, 1, 2, 3, 24, and All Lectures. In addition, a preamble to these questions was provided to students in order to clarify the date by which the lectures had been delivered in the course.

Attitudes towards the WebOption. Three items asked students to rate their attitudes towards the WebOption: ''I think that the presentation of lectures online is a great idea and that it should be used in more courses''; ''Overall it is really good to be able to take some courses like PSYA02 online, and others in class''; ''I am very happy to have had the option to watch lectures online in PSYA02 this semester''. All three questions used a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

Grades. Grades were computed as the sum of student marks on the midterm and final exams. As these exams each consisted of 48 multiple-choice questions, they only accounted for 96% of the student's final grade. Participation in the discussion forum accounted for the remaining 4% of the grade; this portion of their grade was not included as an index of course performance in this study.

Results

Morningness – eveningness preference

The composition of students according to circadian typology is as follows: No students were classified as ''Definitely Morning'' types; 20 students were classified as ''Moderately Morning'' types; 417 students were classified as ''Neutral''; 250 students were classified as ''Moderately Evening'' types; and 55 students were classified as ''Definitely Evening'' types (the remaining students did not complete all of the questionnaire items and therefore a total score was not computed for them). These results reveal that the overwhelming majority of the students in our sample cannot be described as ''morning people'' and that, while half of our sample have no particular diurnal preference, over 35% of them favour the evening hours of the day.

Instructional mode choice

It is noteworthy that many students, regardless of the lecture section they were enrolled in, viewed at least some lectures in the modality of the other section. This was particularly true for students enrolled in the class section of the course who opted to watch lectures online. Only 10.2% of students enrolled in the class section reported that they attended all lectures in

class, while 94.2% of these students reported that they watched at least some lectures online (the sum of these percentages are greater than 100 because some students watched some lectures both ways). Students enrolled in the Web section were not as likely to watch lectures in the other format: 42.7% of them reported that they watched all lectures online, while 39.8% of these students reported that they attended at least some lectures in class (the percentages add to less than 100 because some students watched some but not all of their lectures online).

The variable *Instructional Mode Choice* was computed by dividing the number of lectures watched online by the number of lectures watched online *plus* the number of lectures attended in class. This variable is reflective of the extent to which a student viewed lectures in class or on the Web. A similar dichotomous variable was also created by identifying students who watched all lectures online and students who attended at least 16 of the 25 lectures in class, a proportion that was deemed to reflect a strong desire to attend class. The correlation between these two variables is $r = 0.91$ ($p < 0.001$). Both measures produced substantially the same results. Hence, because continuous scores are available for many more cases than dichotomous scores and also because potentially meaningful variance is lost when dichotomizing a variable, the results reported will be those that utilized the continuous variable of ratio of lectures watched online to total number of lectures viewed.

Morningness–eveningness preference, instructional mode choice, liking for the WebOption, and grades

The three items used to measure students' feelings toward online lectures were highly interrelated (Alpha = 0.84) and were averaged to produce an index called *WebOption Attitude*. Zero-order correlations were then calculated between M–E preference, instructional mode choice and WebOption attitude (see Table I). The relationship between M–E preference and instructional mode choice was significant ($r = -0.209$, $p < 0.01$), revealing that students who prefer the evening were significantly more likely to choose to watch lectures online. Attitude toward the WebOption was significantly correlated with instructional mode choice ($r = 0.18$, $p < 0.01$), revealing that students who had a positive attitude toward the WebOption were more likely to choose to watch lectures online. WebOption attitude was also related to M–E preference ($r = -0.074$, $p < 0.05$), indicating that there was an association between eveningness and greater liking for online lectures.

The next step was to explore whether WebOption attitude mediated the relationship between M–E preference and instructional mode choice as Baron and Kenny (1986) have noted that there is potential for mediation in instances where three variables are intercorrelated. Following their four-step approach, our linear regression analyses revealed

Table I. Zero-order correlations between grade, attitude toward the webOption, instructional mode choice, and morningness–eveningness preference.

	Dependent variables			
Individual difference variable	Grade	Liking for WebOption	Instructional mode choice	*M* (*SD*)
M–E Preference	−0.03	−0.07*	−0.21**	42.91 (8.43)
Liking for WebOption	0.15**	1.00	0.18**	4.58 (0.65)
Instructional Mode Choice	0.04	0.18**	1.00	0.67 (0.31)

*$p < 0.05$. **$p < 0.01$ (all tests two-tailed).

that when M–E preference and liking for the WebOption were both regressed on instructional mode choice, the amount of variance that could be explained by M–E preference decreased slightly when compared to regressing M–E preference alone on instructional mode choice (Beta = −0.197, $p < 0.01$ and Beta = −0.209, $p < 0.01$, respectively; see Figure 1 for an illustration of the mediational relationships). Liking for the WebOption also explained less of the variance in instructional mode choice when it was regressed along with M–E preference in comparison to when it was regressed alone (Beta = 0.168, $p < 0.01$ and Beta = 0.182, $p < 0.01$, respectively). The regression analysis with WebOption attitude regressed on M–E preference was also significant (Beta = −0.074, $p < 0.05$). According to the Baron and Kenny approach, the model is consistent with *partial* mediation (i.e. the regression analysis with liking for the WebOption predicting Instructional Mode Choice is significant after controlling for the direct effect of M–E preference, but the regression analysis with M–E preference predicting Instructional Mode Choice is still significant). The final step of our mediational analysis was to calculate the indirect effect and test its significance using the Sobel test. This analysis revealed that the indirect effect of M–E preference on instructional mode choice via the mediating variable of liking for the WebOption was not significant (z = −1.817, $p = 0.069$). From this it can be concluded that M–E preference and WebOption attitude both contribute independently to the choice to attend lectures or watch them online.

The preceding results pertain to attitudes and choices relevant to the WebOption as they relate to M–E preferences. Further analyses investigated the relation between these variables and performance in the course. A linear regression analysis was conducted to explore whether M–E preference, instructional mode choice, WebOption attitude, or any interaction between these variables, are related to performance in the course. The interaction terms were created

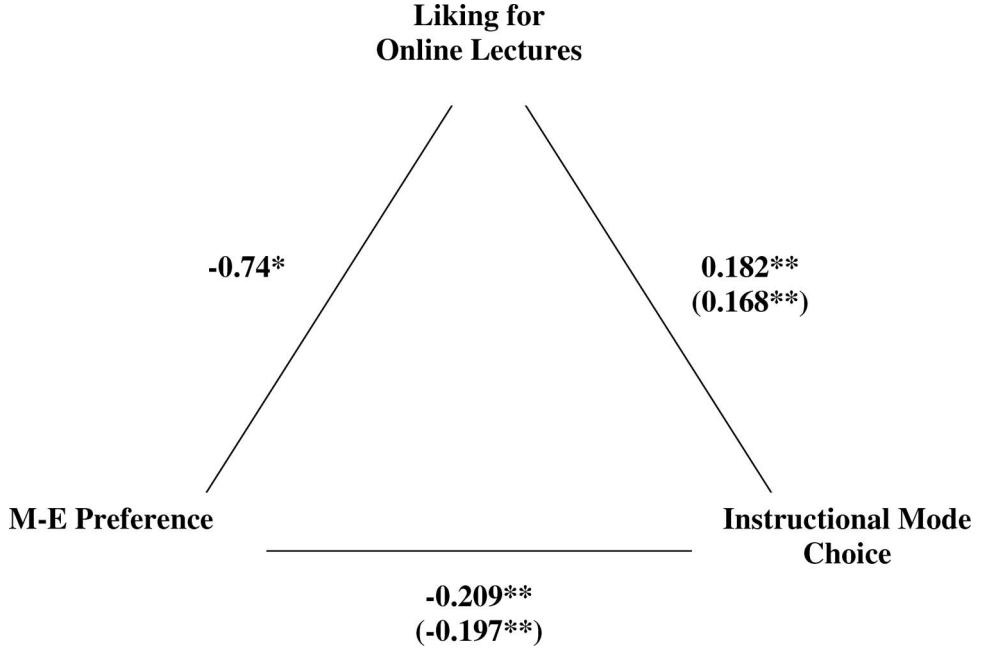

Figure 1. Mediational effect of Liking for the WebOption on the relation between morningness–eveningness preference and instructional mode choice.

by multiplying M – E preference scores by instructional mode choice and by liking for the WebOption, along with a three-way interaction term whereby all three variables were multiplied together. These interaction terms were created to determine the extent to which specific associations between student grades and their circadian preference are moderated by the choice to attend lectures or watch them online, or by their attitudes toward the web option. The three variables were standardized in order to centre them prior to the creation of the interaction terms. The regression analyses were conducted in two steps: First, grades were regressed on M – E preference, instructional mode choice, and WebOption attitude; second, an evaluation of the incremental contribution of the interaction terms with regard to predicting outcome was conducted by introducing all three interaction terms in addition to the ''main effects'' in the second step of the regression analysis. In the first analysis, the model was significant (adjusted R square $= 0.012$, $F(3, 728) = 4.04$, $p < 0.01$), revealing a significant relation between grades and liking for the WebOption (Beta $= 0.121$, $p < 0.01$). There was no significant relation between grades and M – E preference or grades and instructional mode choice (Beta $= -0.020$, $p = 0.603$ and Beta $= 0.015$, $p = 0.697$, respectively). Adding the three interaction terms in the second step of the analysis did not result in a significant increase in R square (R square change $= 0.002$, F Change $(3, 725) = 0.58$, $p = 0.628$).

Discussion

The present study sought to determine the association between students' circadian preference and their attitudes and choices relating to online lecture viewing and performance outcomes by capitalizing on the close match between face-to-face and online lectures created by the WebOption. With regard to M – E preference, half of the student sample was ''neutral'', indicating no particular day or evening preference. However, a sizeable portion of the students could be classified on the evening part of the continuum whereas there were no ''definitely morning'' type students and a negligible number of ''moderately morning'' types. This finding is in line with previous research showing that university students are often biased towards the evening.

The most noteworthy findings for the purposes of the present research were that students who prefer the evening were significantly more likely to choose to watch lectures online and to report feeling more positively about online lectures than those closer to the ''morning'' end of the continuum. The finding that evening types were more likely to choose to watch lectures online was particularly true for those classified as ''definitely evening'' types.

Analyses exploring the theoretical question of whether attitudes towards the WebOption mediated the relation between M – E preference and instructional mode choice were conducted. These analyses hinted to partial mediation according to the approach proposed by Baron and Kenny (1986). Further analyses, however, revealed that the mediational effect was not significant. Thus, it appears that there is a link between students' circadian preference and their choice to attend lectures or view them online and that this link is not mediated by their attitude towards the WebOption. Indeed, the lack of mediation is revealing as the significance of the correlation between a liking for the WebOption and choosing to attend lectures online was equal to that between the latter variable and circadian preference. This finding suggests that student attitudes about online learning are just as important as biological factors (i.e. circadian rhythms) in determining choice of instructional mode.

Interestingly, circadian preference was not found to be associated with course performance. This finding contrasts with a previous study, in which evening preference was shown to significantly increase the risk of poor school achievement (Giannotti et al. 2002). In that

study, E-types were found to show more difficulty adjusting to school life and accommodating to early sleep schedules. They were even more likely to report school-related attention problems and a tendency to fall asleep in the morning at school. The fact that there was no relationship between performance outcomes and circadian preference in this study may reflect the fact that both M-types and E-types had different advantages over the other that may have cancelled out this effect. E-types have consistently been found to have irregular sleep – wake schedules when compared to M-types, who show a more regular sleep – wake cycle (e.g. Carskadon et al. 1993; Monk et al. 1994; Medeiros et al. 2001). Thus, it is possible that while E-types benefited from being able to watch lectures later than their scheduled time in class, M-types may have benefited from the ''regularity'' of their sleep – wake cycles and their better sleep quality.

The only factor associated with a better grade in the course was a positive attitude toward the WebOption. While this result does not pertain directly to M – E preference, it is revealing. As pointed out earlier, most students in our sample had a preference for evening, and most students in the sample also liked the WebOption and partook of the opportunity to watch lectures online. While M – E preference was not itself associated with grades in the course, it is possible that the availability of the WebOption provided a level of flexibility and reassurance that benefited students with a positive attitude towards online learning. The match between circadian preference and mode of lecture viewing may not, therefore, be as important for course performance as the availability for a student of appealing technological supports that can be used when needed.

This study has important implications for our educational institutions. If a goal of higher education is to promote learning in optimal conditions for all students, then these institutions should incorporate the findings from the research literature into the temporal organization of class schedules. As noted above, university students generally show a preference towards eveningness, yet many university classes begin relatively early in the morning. The present study has shown that most students, when given the choice to attend a lecture that takes place early in the morning or watch the same lecture online at their leisure, choose the latter. In addition, most students report positive feelings about online lectures, and these positive feelings towards a supportive technology may in themselves have beneficial effects on performance outcomes.

The fact that E-types were not at a disadvantage academically because of their tendency to have irregular sleep – wake cycles and daytime sleepiness speaks to the possible benefit of online lectures. Offering students the choice to watch lectures online may serve to level the playing field for students with an evening orientation. Thus, the present study highlights how offering the option of online lectures in our educational institutions can accommodate all students, irrespective of circadian preference, in ways that may improve learning, satisfaction, and academic performance.

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References

Anderson M, Petros TV, Beckwith BE, Mitchell WW, Fritz S. 1991. Individual differences in the effect of time of day on long-term memory access. Am J Psychol 104:241 – 255.

Baehr EK, Revelle W, Eastman CJ. 2000. Individual differences in the phase and amplitude of the human circadian temperature rhythm: With an emphasis on morningness-eveningness. J Sleep Res 9:117 – 127.

Bailey S, Heitkemper M. 1991. Morning-evening and early morning salivatory cortisol level. Biol Psychol 32:181–192.

Baron RM, Kenny DA. 1986. The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. J Pers Soc Psychol 51:117–1182.

Bassili JN. 1995. Response latency and the accessibility of voting intentions: What contributes to accessibility and how it affects vote choice. Pers Soc Psychol Bull 21:686–695.

Bassili JN. 2005. Student characteristics associated with the choice to attend lectures or watch them online: The WebOption, who opts for it, with what outcomes? Manuscript submitted for publication.

Berger I, Mitchell A. 1989. The effect of advertising on attitude accessibility, attitude confidence, and the attitude behavior relationship. J Consum Res 16:269–279.

Bodenhausen GV. 1990. Stereotypes as judgmental heuristics: Evidence of circadian variations in discrimination. Psychol Sci 1:319–322.

Buela-Casal G, Caballo VE, Cueto EG. 1990. Differences between morning and evening types in performance. Pers Individ Dif 11:447–450.

Carlson S. 2004. Online-education survey finds boom in enrollment and broad satisfaction with courses. The Chron High Educ; November 26. Available: http://chronicle.com/weekly/v51/i14/14a03001.htm via the INTERNET. Accessed 20 Dec 2005.

Carskadon MA, Acebo C, Richardson GS, Tate BA, Seifer R. 1997. An approach to studying circadian rhythms of adolescent humans. J Biol Rhythms 12:278–289.

Carskadon MA, Viera C, Acebo C. 1993. Association between puberty and delayed phase preference. Sleep 16:258–262.

Giannotti F, Cortesi F, Sebastiani T, Ottaviano S. 2002. Circadian preference, sleep and daytime behaviour in adolescence. J Sleep Res 11:191–199.

Hidalgo MP, Zanette CB, Pedrotti M, Souza CM, Nunes PV, Chaves ML. 2004. Performance of chronotypes on memory tests during the morning and the evening shifts. Psychol Rep 95:75–85.

Hiltz SR. 1993. Correlates of learning in a virtual classroom. Int J Man-Mach Stud 39:71–98.

Horne JA, Ostberg O. 1976. A self-assessment questionnaire to determine morningness-eveningness in human circadian rhythms. Int J Chronobiol 4:97–110.

Horne JA, Ostberg O. 1977. Individual differences in human circadian rhythms. Biol Psychol 5:179–190.

Kvavik RB, Caruso JB. 2005. ECAR study of students and information technology, 2005: Convenience, connection, control, and learning. Boulder, CO: Educause Center for Applied Research. Available: http://www.educause.edu/LibraryDetailPage/666?ID=ERS0506 via the INTERNET. Accessed 27 Dec 2005.

Laberge L, Carrier J, Lesperance P, Lambert C, Vitaro F, Tremblay RE, Montplaisir J. 2000. Sleep and circadian phase characteristics of adolescents and young adult males in a naturalistic summertime condition. Chronobiol Int 17:489–501.

Maki WS, Maki RH. 2002. Multimedia comprehension skill predicts differential outcomes of Web-based and lecture courses. J Exp Psychol: Appl 8:85–98.

Maki RH, Maki WS. 2003. Prediction of learning and satisfaction in Web-based and lecture courses. Journal of Educational Computing Research 28:197–219.

Maki RH, Maki WS, Patterson M, Whittaker PD. 2000. Evaluation of a Web-based introductory psychology course: 1. Learning and satisfaction in on-line versus lecture courses. Behav Res Methods, Instrum Comp 32:230–239.

May CP, Hasher L. 1998. Synchrony effects in inhibitory control over thought and action. J Exp Psychol/Hum Percept Perform 24:363–379.

May CP, Hasher L, Stoltzfus ER. 1993. Optimal time of day and the magnitude of age differences in memory. Psychol Sci 4:326–330.

Mecacci L, Zani A. 1983. Morningness–eveningness preferences and sleep-waking diary data of morning and evening types in student and worker samples. Ergonomics 26:1147–1153.

Medeiros ALD, Mendes DBF, Lima PF, Araujo JF. 2001. The relationships between sleep-wake cycle and academic performance in medical students. Biol Rhythm Res 32:263–270.

Monk TH, Buysse DJ, Reynorld CF III, Berga SL, Jarre Bergley AE, Kupfer DJ. 1997. Circadian rhythms in human performance mood under constant conditions. J Sleep Res 6:9–18.

Monk TH, Petrie SR, Hayes AJ, Kupfer DJ. 1994. Regularity of daily life in relation to personality, age, gender, sleep quality and circadian rhythms. J Sleep Res 3:196–205.

Petros TV, Beckwith BE, Anderson M. 1990. Individual differences in the effects of time of day and passage difficulty on prose memory in adults. Br J Psychol 81:63–72.

Sankaran SR, Sankaran D, Bui TX. 2000. Effect of student attitude to course format on learning performance: An empirical study in Web vs. lecture instruction. J Inst Psychol 27:66–73.

Smith CS, Reilly C, Midkiff K. 1989. Evaluation of three circadian rhythm questionnaires with suggestions for an improved measure of morningness. J Appl Psychol 74:728 – 738.

Smyth J, Ockenfels M, Gorin A, Catley D. 1997. Individual differences in the diurnal cycle of cortisol. Psychoneuroendocrinology 22:89 – 105.

Tankova I, Adan A, Buela-Casal G. 1994. Circadian typology and individual differences. A review. Pers Individ Dif 16:671 – 684.

Wang AY, Newlin MH. 2000. Characteristics of students who enrol and succeed in psychology Web-based courses. J Educ Psychol 92:137 – 143.

Waschull SB. 2001. The online delivery of psychology courses: Attrition, performance, and evaluation. Teach Psychol 28:143 – 147.