LAIDLAW SCHOLARS

Laidlaw Scholars Undergraduate Leadership and Research Programme
Research Proposal

How do environmental factors impact sleep patterns of the adolescent BaYaka population?

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STUDENT LIFE | Centre for International Experience

UNIVERSITY OF TORONTO

Abstract

This research project investigates the sleep patterns of BaYaka children, and how present environmental factors impact their sleep. The BaYaka people are located the Republic of Congo, an indigenous population that thrive in a mobile forager society. BaYaka adolescents may exhibit distinct sleeping patterns from the adults, which have been previously found to be poor in terms of sleep quality and total sleep time. This project will utilize actigraphy data collected from BaYaka participants, measuring physical activity, light exposure, and sleep time. This data will undergo time-series analysis and linear functional modelling to determine what sleep patterns are observed. In addition to this, literature review will be conducted on how to create a standardized measure for using nap data, through the incorporation of it in the R time-series analysis. This additional component provides a comparison of sleep data with and without naptime data, thereby providing insight into how validated actigraphy use is in collecting nap data. The findings may inform future studies on sleep patterns in mobile forager societies, give rise to cross-cultural studies on sleep, and provide opportunities to compare adolescent and adult sleep populations in a marginalized community.

Introduction

My research project, centered on the sleep patterns of BaYaka adolescents, is driven by a fascination with the elasticity of sleep and its myriad influencing factors on human health and wellbeing. These young individuals often display sleep characteristics distinct from those of adults, sparking curiosity about the underlying environmental influences, especially in unique small-scale societies.

This interest is rooted in my longstanding engagement with humanitarian issues concerning Indigenous populations. My involvement in Model United Nations since high school has continually prompted me to think about global challenges and the role of research in overcoming species level adversity. The BaYaka adolescent population in Congo, with their unique cultural and environmental context, presents an ideal case study to explore these interests.

This research question intrigues me not only for its scientific significance but also for its potential to contribute to a deeper understanding of Indigenous cultures and their interaction with the natural environment. Ultimately, it represents a synthesis of my academic journey and humanitarian aspirations, and the support of Laidlaw will offer crucial resources for me to pursue a meaningful avenue to contribute to both scientific knowledge and global societal challenges.

Research Objectives & Questions

How do environmental factors affect sleep patterns in the BaYaka adolescent population?

Within this question, our objective is two-fold?

1. What common sleeping patterns can we observe amongst children living in the BaYaka population?
2. Is there a way to quantify naptime by creating a gold standard of naptime usage within our data analysis?

Background

Previous research on the BaYaka population has unveiled sleep deprivation as a prevalent issue (Gettler et al., 2023). More specifically, the findings suggest that BaYaka adults had shorter and lower quality sleep when sleeping in crowded spaces. Total sleep time (TST) and sleep quality were both higher amongst parents with infants at a breastfeeding age, compared to adults who did not have infant children. These contrasts findings in contemporary western society, proving that the current research on sleep is heavily western-biased and does not encompass all cultures for optimal sleep times and conditions to be universally applicable. Additionally, another study on the BaYaka population found that BaYaka women have more fragmented and poorer quality sleep than men, despite going to bed earlier (Killius et al., 2021). Thus, the present study seeks to understand the sleep quality and fragmentation of children, and how it might be different according to numerous environmental and potentially biological factors. This will ultimately stack up against the findings of the adult population, identifying discrepancies in sleep patterns and how sleep efficiency can be improved. In addition to this, the present research also seeks to identify ways to utilize naptime data for an accurate analysis of TST and the of naptime to overall sleep quality, as previous research has not yet been able to validate a gold standard for using nap data in time series analysis.

Methodology

This project at the time of the first Laidlaw summer will have the raw data collected from BaYaka participants in Congo, in two field seasons, with data collection finishing in June 2024. There may be delays in receiving the actigraphy data that needs to be analyzed, since they will be shipped overseas. In the event that there is delay, the current actigraphy data on hand (with n = 54) will be cleaned in analyzed. In addition to this, naptime analysis literature review will be conducted during this period as well.

For data analysis, the age of the adolescents will first be determined using age estimation methods by Diekmann et al. (2021). This is because according to Killius et al. (2021), the BaYaka do not measure their age using years. Additionally, to take weather conditions into consideration when measuring light exposure, humidity, and temperature, the methodology to obtain this data will follow Killius et al. (2021).

Following this, data will have been collected on actigraphy, watches that measure data such as sleep data, physical activity, and light exposure, specifically MotionWatch 8s on adolescents for about five nights. The actigraphy data measures data in one minute epochs, which is the standard duration to record actigraphy data. The actigraph data will be extracted and cleaned onto the MotionWare software, separating the files of each adolescent, thus allowing for sleep data to be manually scored after the algorithm converts the data into sleep and wake cycles. After this, MotionWare will use its algorithm to determine sleep quotas, generating a report of time awake and asleep. Specific factors that will be measured for the purpose of this study are: total sleep time, sleep fragmentation, mobile minutes at night, physical activity, percent moderate to percent vigorous activity data. After this data is generated, it will be copied over to Microsoft Excel and examined in R using statistical analysis.

For the statistical analysis portion, the Bayes level of significance will be used to compare the mean averages of the aforementioned sleep variables between adolescents. This will be done by using the *BayesFactor* R package. Non-Parametric Circadian Rhythm Analysis will be used on

the MotionWare software to calculate circadian rhythms. Additionally, R will be used to test some ecological sleep predictors, more specifically, sleep fragmentation and efficiency. Finally, to compare sleep-wake cycles, functional linear modeling will be utilized. Literature review on naptime analysis will be applied in an updated R code to see how total sleep time differs from that of analysis excluding naps.

Lastly, ChatGPT will be used to help with the literature review of naptime analysis and generate a template code, if possible, for the incorporation of naptime analysis in the current research. Of course, this is contingent on AI being allowed in our research. If it is not, this process will be done manually.

Lab resources will be utilized during the six weeks, including help from lab members familiar with MotionWare. Two PhD students will be working closely, in addition to my supervisor, to track progress and ensure that the data is being cleaned and analyzed correctly. The lab involved in this research is the Sleep and Human Evolution Lab at the University of Toronto Mississauga.

Training/ Certifications Needed

The training that will be required currently is using time-series and linear functional modelling in R, which will be tentatively completed prior to the start of the six dedicated weeks of research. Anticipated time of training can range between one to two weeks, from the beginning of June to mid-June. Training for the MotionWare software was given back in January by lab members, but additional courses and modules pertaining to the usage of MotionWare may be sought during the first week of June. No certifications are really required, as long as the training in the R workshops suffices.

Research Location

All research will be conducted in Canada for the duration of the six weeks.

Research Ethics Board

Ethics approval has been received, as the first phase of this long-term project has been completed (see references for the publications pertaining to the first phase).

- Human Protocol 00040367 - Activity around the clock: The evolution of sleep in the human lineage
- Applicant: Prof David Samson
- Original Approval Date: 2020-12-28
- Current Expiry Date: 2024-12-27

Congo REB.pdf

Note: this version of the REB is not updated. The updated version has myself listed as a Co-Investigator, but that PDF is not available at the moment. I can provide an updated version once it becomes available.

Timeline

Timeline For Laidlaw

	June				July			
Task	*1st week*	*2nd week*	*3rd week*	*4th week*	*1st week*	*2nd week*	*3rd week*	*4th week*
Enroll in R course/workshop								
Enroll in MotionWare course/workshop								
Conduct preliminary literature review on naptime analysis								
Clean the MotionWare data of existing actigraphy (do ~5)								
Show preliminary data cleaning to Erica								
Do remaining MotionWare data already downloaded onto computer								
Extract data from remaining actigraphy from the 2024 field season								
Clean the MotionWare data of from 2024 field season								
Meet with Erica, Leela, and David regarding how we're going to proceed with naptime analysis based on literature review compilation								
Analyze all the cleaned data into existing code								
Modify code to account for naptime analysis								
Review and revise findings with naptime analysis incorporated								
Document findings of data analysis with naptime vs without naptime								

Resources & Support Needed

Specific resources needed will be: RStudio, MotionWare, and MotionWatches primarily. Additionally, mentorship regarding data analysis will be needed, which will be provided by the PhD students in the lab. Also, ChatGPT may need to be utilized for the ease of preliminary literature review research, provided that we are allowed to use AI to aid in the research project.

Potential Impact

Sleep as a universal phenomenon, exhibits variations across different cultures. Drawing on existing sleep studies across various populations worldwide, a one-size-fits-all approach to studying sleep patterns is inadequate. Notably, research on the BaYaka population has unveiled sleep deprivation as a prevalent issue (Gettler et al., 2023). Therefore, the investigation of this research project can examine if the BaYaka people optimally function physiologically, and if not, where those discrepancies lie by examining their sleep patterns. The overall aim is to understand the cross-cultural expression of sleep, which itself is an international concern.

The project pertains to an interdisciplinary focus primarily through the collaboration with my current lab at the University of Toronto, Mississauga Sleep and Human Evolution Lab (SHEL), Notre Dame University and Max Planck Institute for Evolutionary Anthropology. Namely, the collaborators Dr. Lee Gettler and Dr. Adam Boyette have investigated different

aspects of the BaYaka populations, including physiology, health, social learning, and caretaking. This collaboration with its interdisciplinary focus has resulted in peer-reviewed publications and awards such as the SSHRC Doctoral Scholarship, Cambridge International Trust, and funding from the Jacobs Foundation.

Thus, through the employment of a multidisciplinary framework and international collaboration, this project contributes to the interdisciplinary and international discourse on sleep. It steers away from a western viewpoint of sleep and contributes to the underfunded research of marginalized populations, especially indigenous populations. The findings will contribute to a new avenue of sleep analysis: naptime analysis. This will be crucial in determining how TST varies, and whether or not naptime analysis can be efficiently utilized. Future research can examine how current devices measuring sleep data may draw upon naptime data. There are many avenues the research can be taken in the future, such as validation studies of current actigraphy on measuring naptime, the development of a gold standard for naptime analysis, and the comparison of sleep patterns amongst adolescent boys and girls. A cross-cultural analysis in the future may also be beneficial to see if mobile forager societies exhibit similar sleeping patterns, or if the BaYaka people are exclusively unique to the findings.

Budget

Link to Excel Spreadsheet.

References

Gettler, L. T., Samson, D. R., Kilius, E., Sarma, M. S., Miegakanda, V., Lew-Levy, S., & Boyette, A. H. (2023). Hormone physiology and sleep dynamics among BaYaka foragers of the Congo Basin: Gendered associations between nighttime activity, testosterone, and cortisol. Hormones and Behavior, 155, 105422. https://doi.org/10.1016/j.yhbeh.2023.105422.

Gettler, L. T., Samson, D. R., Kilius, E., Sarma, M. S., Ouamba, Y. R., Miegakanda, V., Boyette, A. H., & Lew-Levy, S. (2022). Links between household and family social dynamics with sleep profiles among BaYaka foragers of the Congo Basin. Social Science & Medicine, 311, 115345. https://doi.org/10.1016/j.socscimed.2022.115345.

Kilius, E., Samson, D. R., Lew-Levy, S., et al. (2021). Gender differences in BaYaka forager sleep-wake patterns in forest and village contexts. *Scientific Reports, 11*, 13658. https://doi.org/10.1038/s41598-021-92816-6.