Exploring My Sleep Debt

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An Example of My Acrobatics Practice with Emily Reuman, Photo by JQ Williams.

I've always been an athlete (at least since I started at age 5), but genetic luck, good health, and a lazy attitude towards self-care allowed me to coast well into my 40's. In recent years I worked professionally with a concierge medical practice analyzing health data, scientific studies, and thought leaders in the field. My focus has been on optimal health metrics for athletes, brain degeneration, food as medicine, and sleep hygiene.

Sleep had never been my concern. I knew I didn't get enough. But I'm in my 50's now, and everything with my health is changing. When I encountered the fitness strap from Whoop, I recognized it as a potentially useful tool to help me learn more about my sleep. Sure enough, it did. I soon discovered I was getting drastically less sleep than I thought I was.

So I've analyzed a couple of years of my health markers from both the strap and other sources. In this examination, I used the following tags: REM, delta wave sleep, sleep debt, resting heart rate, average heart rate, maximum heart rate, heart rate variability, body weight, body fat percentage, and calories burned per day. In addition to this, I used the "Strain" and "Recovery" metric directly from the Whoop system.

My goal is to sleep more and better. I surmised that, to this purpose, using the sleep debt metric, I could create a model where I could use all of the featured data I have collected to predict which feature would lower my sleep debt. It turns out I was correct, or at least I found an excellent correlate to that in REM sleep.

Here's a graph I created of my sleep debt exploration since April 1, 2018. I will return to this after some introductory information.

Fig. 1, Average minutes in REM & slow-wave sleep in conjunction with sleep debt.

Sleep debt (aka sleep deficit) is the cumulative effect of not sleeping enough. Prolonged sleep debt can lead to mental, emotional, and physical fatigue. My biggest concern is that sleep deprivation is considered a leading indicator of brain degeneration. Studies in

both animals and people have begun to show correlations between the amount and quality of sleep and brain health.

Poor sleep is common among those with Alzheimer's and other brain degenerative diseases. It's not clear why this is the case. But recently, researchers at Washington University School of Medicine in St. Louis found that elderly who have less slow-wave sleep have elevated levels of the brain protein tau. Elevated tau is a symptom of Alzheimer's brain degenerative disease. High tau protein levels correlate to brain damage and cognitive decline, and it follows that anything you can do to lessen the overgrowth of the tau protein can potentially be beneficial for your health.

Fig. 2, Top 15 features for predicting improvement in sleep debt.

REM sleep is a phase of sleep that lasts approximately 25% of any sleep period. It is commonly associated with the processing of learning, memory, and emotional state. Excessive strain, alcohol, and medical issues can suppress REM sleep. While there are exceptions due to circumstances of medicines, drink, and illness, a healthy sleep pattern should involve rough parity between time spent in REM and deep sleep. Deep sleep, or

slow-wave sleep, is a phase of sleep most commonly associated with the body recovering from physical exertion during the previous awake period.

I employed a random forest model to run predictions on sleep debt against my data and found that using the metrics I chose; my model will predict 14% better than baseline a reduction in sleep debt daily. Now, this may not seem to be much, but it definitely can help me in my quest to be healthier. I have an average of 82 minutes a sleep debt per night, and if I can improve that 14% of the time, then over any given month, I can expect quite a bit more cumulative sleep.

Fig. 3, ROC curve is rocking out a good number of true positives for the model.

It's essential to note that all of this is a correlation. It seems clear both from the literature and from my analysis that REM sleep plays a big part (it's the top feature importance) in healthy sleep. And while, as shown in the graph above, Fig 2, REM is a leading correlate, this isn't the whole story. All of this points me towards establishing greater REM duration night-over-night as a conscious goal towards better health.

I've focused on sleep hygiene over the last couple of years. It's been a struggle to understand what this means and how to implement a good strategy for improving my sleep habits. Life and living in the city provide ample opportunity for distractions, which get in the way of early-to-bed, early-to-rise. Among the tactics, I have employed to add light-blocking curtains to my bedroom and using blue light glasses an hour before bed. I have been reading, writing, meditating, and stretching before sleep. The hardest part, though, has been the early-to-bed part. It's a constant struggle.

> *If you are on such a path you might find that this report on the 100 top sleepers from the team behind Whoop is helpful.*

On April 21, 2019, I suffered a devastating concussion when a random tricker did a backflip onto my head and shoulder as I walked along, instantly knocking me out. I was prone and unconscious for 45 seconds and was taken to the emergency room to have my brain scanned for injury. Although I did not suffer any bleeding in my brain, the grievous wound affected me greatly for over three months. My life turned upside down. For six weeks, I could barely function and suffered terrible headaches, crying fits, fear of the sound of water, and other symptoms. It was a terrible time. After that, I was injured again in August and finally recovered from all of these accidents in December of 2019.

Figure 1 above is the most exciting graph to come out of my analysis. At the beginning of the time series, I was learning what was integral to sleep hygiene, how to effect change in my life based on this knowledge, and develop strategies to avoid falling back into my old habits. As mentioned above, REM sleep and deep sleep will entrain in rough parity during good health. This graph shows so eloquently my unhealthy sleep patterns giving way to a coherent entrained sleep where the REM and deep sleep minutes per night are rising while the sleep debt per night is falling. This entrained parity between REM and deep sleep feels, to me, like a victory.

Conclusion

There is much to learn. In the future, I'll be further refining this model by adding additional engineered features (such as exploring these numbers by day of the week) as well as simply adding new features such as alcohol consumption (which interferes with REM production).

It has been especially poignant examining this data through the lens of my recent injuries. Getting older and watching the body slow down is heartbreaking. Hopefully, with this additional knowledge and a plan moving forward, I can work back towards more excellent health and the type of intense physical activity that I enjoy so much.

Data Science Concussions Sleep Hygiene Old Age