

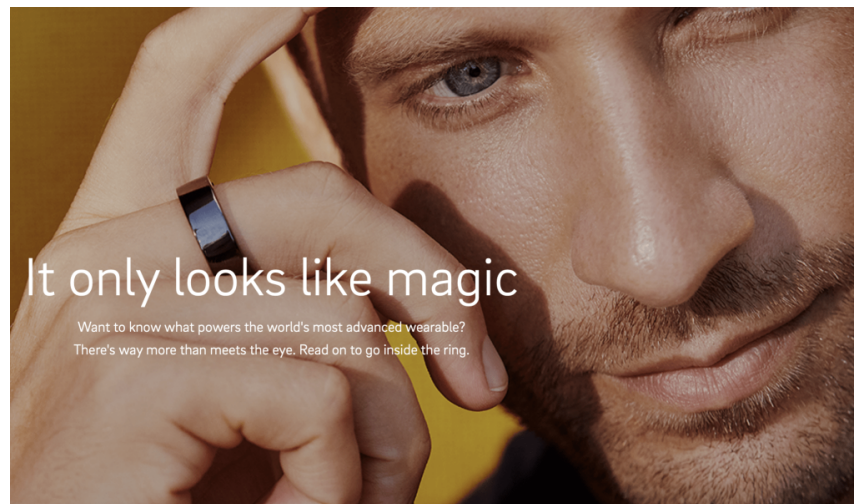
DR. ANTHONY PEARSON

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The Oura Ring For Personal Sleep Analysis: Lots of Hype and Data, Little Science, Utility

or Accuracy

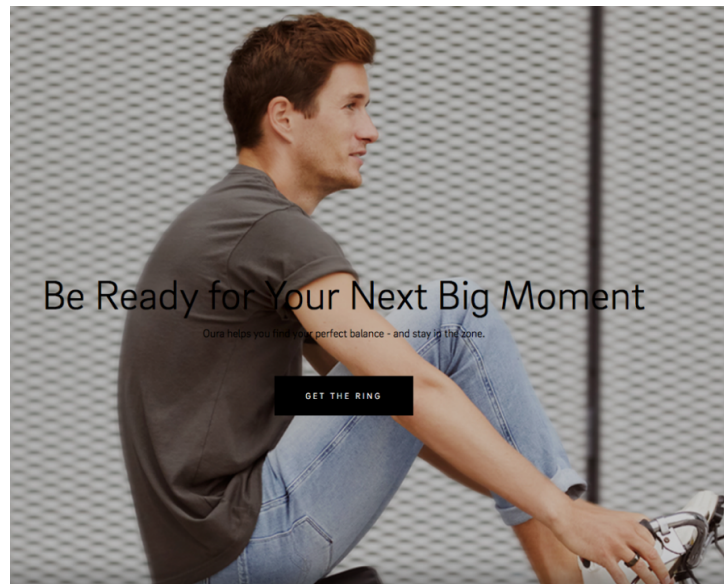
February 9, 2019

Medical/Fitness Devices, sleep

36 Comments

The Oura ring is a novel, multisensory device that claims to be able to distinguish sleep stages, including REM sleep,. I purchased one recently and after several months of evaluation and an extensive look at the data supporting it I have to say I am much more impressed with OURA's hype, marketing and style than any useful or actionable information about sleep that comes from it.

The Oura website is full of pictures of cool people doing cool things wearing their Oura rings-like this guy



It's also chock full of marketing blather which implies that somehow the ring will dramatically improve your sleep and your waking life.

We see every individual as unique: your state of health and wellness today, tomorrow, and days to follow. Getting enough restorative sleep has a profound impact on mental and physical health and performance. Your

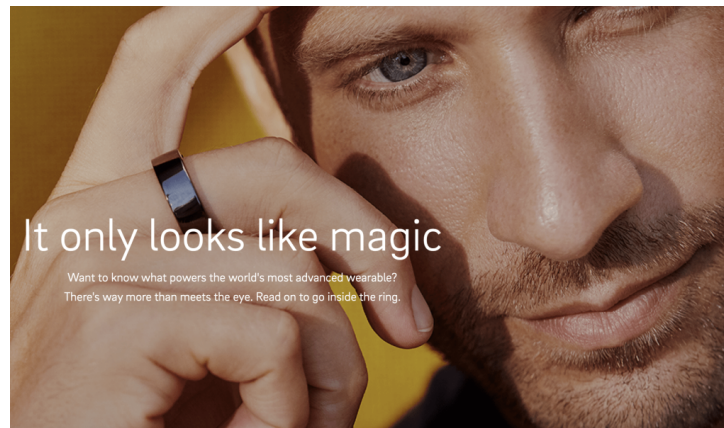
...your personal health...

*daily choices and rhythms
define how well you sleep.*

*With Oura, you learn your
optimal times to move, eat
and take a break to get
that restorative sleep.*

*Giving you actionable
steps to improve your life
opens a totally new
universe of possibilities –
be it for mental, cognitive
or physical performance,
or for beauty, health, and
longevity.*

A quick look at the OURA web site
certainly conveys the sense that this
is the slickest, most cutting edge
personal wearable sleep and activity
tracker one could purchase.



However, despite Oura's tantalizing claims there is only one legitimate scientific comparison of the ring to the gold-standard of sleep evaluation, polysmnography (PSG). This was published in 2017 in Behavior Sleep Medicine and its full contents can be read [here](#).

In addition, there is no published evidence whatsoever that changing one's behaviour based on the various parameters that the ring produces will have any favorable effect on your sleep quality or health in general.

I'll be quoting from that 2017

published paper which I think is a good, unbiased analysis and I'll throw in some of my own observations throughout this piece.

How The Ring Works And What It Claims To Do

A good night's sleep, everyone should know by now is incredibly important to optimal performance the next day. In addition poor sleep quality is linked to a whole host of pathologies (with causality yet to be proven for most.) Thus, I quickly purchased an **OURA**ring after hearing **Peter Attia** rave about his ring.

OURA likes to promote the idea that it has some sort of special way of measuring sleep based on a combination of sensors.

The Oura ring and its proprietary algorithms are a combination of extensive scientific understanding, years of careful research and development work, and top-notch engineering. All insights and guidance you get are based on proven algorithms and verified knowledge. For example, Oura's sleep staging algorithms were the first in the market that have been independently validated. The validation study was made by SRI International.

The OURA website notes that the ring is fitted with the following sensors to collect physiologic signals from your body.

NTC BODY

TEMPERATURE SENSOR

The Oura ring registers your body temperature reading every minute while you sleep. By comparing that value to values from earlier nights, it indicates your body temperature baseline and any variations from it.

INFRARED LEDS

Measuring blood volume pulse directly from the palmar arteries of the finger.

3D ACCELEROMETER AND GYROSCOPE

Detects the amplitude and intensity of your body movement, automatically recognizes that you're active and tracks the time you were inactive during the day.

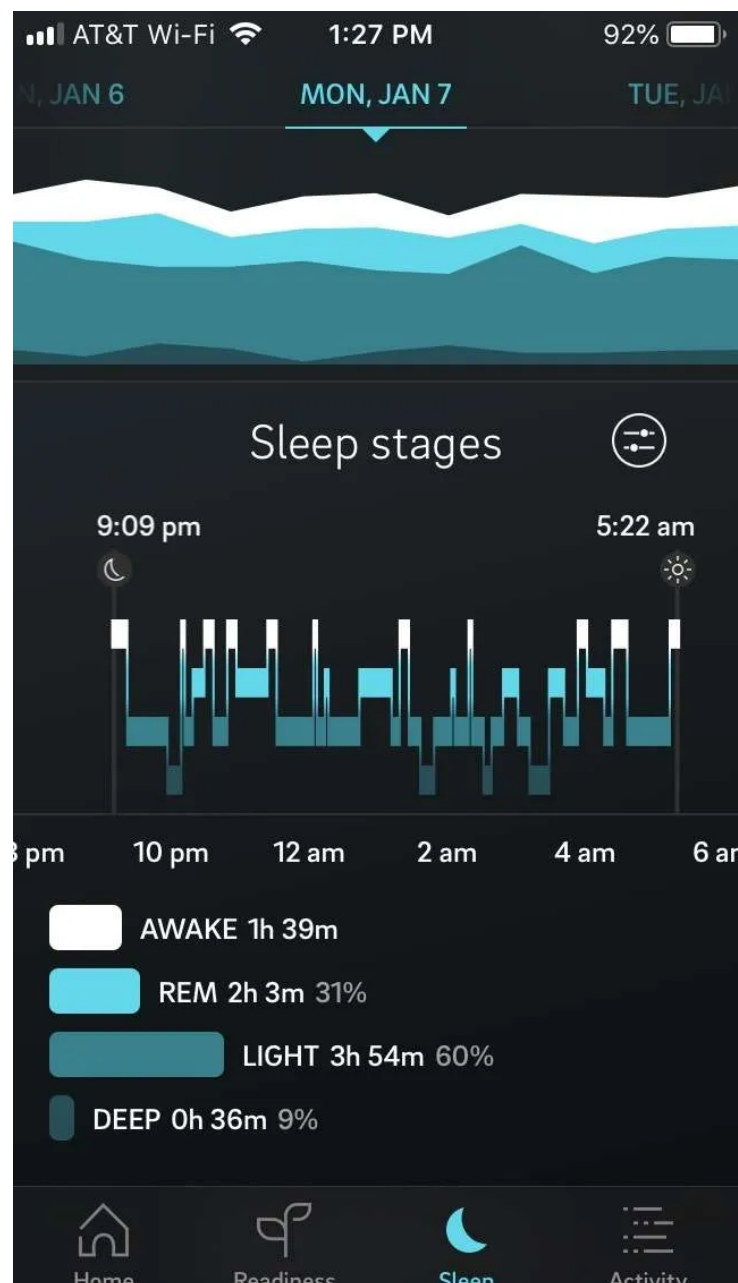
Ouraring (Oulu, Finland) claims to use these physiological signals (a

combination of motion, heart rate, heart rate variability, and pulse wave variability amplitude) in combination with sophisticated machine learning based methods to calculate deep (PSG N3), light (PSG N1+N2) and rapid-eye-movement (REM) sleep in addition to sleep/wake states.

After obtaining a sizing kit from OURA I selected my ring and within a few weeks it was delivered. I downloaded the free OURA iPhone app, charged the ring with the supplied USB charger, slipped it on my left ring finger and eagerly awaited my first night's analysis.

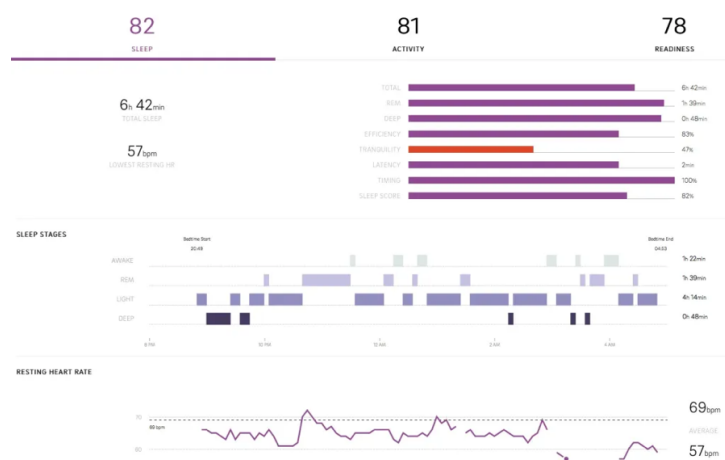


Upon arising in the morning I opened the OURA app and visualized an entrancing display like the one below.



It's a nice graphic summary of the night's sleep with my minutes of REM, light, and deep sleep nicely quantified.

More graphs and more data are available by connecting to Oura's online application which automatically syncs to your smartphone app.



Unfortunately, the app was telling me that I was awake for 109 minutes of the time I was in bed. Which was not correct. I was truly awake only for 10 minutes around 130 AM. This overestimation of my awake time has been a consistent error of the

has seen a consistent error of the ring for my recordings. If the app can't accurately track awake time all of its metrics are going to be inaccurate.

In fact, over several months of using the ring/app I have found little relationship between how I feel after sleeping versus how Oura has rated my sleep. There is even less correlation between the “readiness” score that Oura produces and how I feel during the day. Overall, I have found absolutely no actionable information from my months of using the ring.

One morning Oura gave me a “readiness” score of 68 and told me:

“Don't push it. Your resting heart rate was above average, so you might not be fully recovered”

I felt great throughout the day.
These recommendations in my
experience are almost universally
inaccurate and useless.

Oura also makes recommendations
on when it thinks you should go to
bed. One time it told me I should go
to bed at 7 PM. I have been ignoring
its advice in this area.

Now I am just one individual and it
is entirely possible there is
something unique about my sleep
that invalidates the ring's accuracy.
The ex-eternal fiancée' tells me I'm
a restless sleeper.

In fact, devices that rely on
actigraphy tend to be fairly accurate
at identifying when you are sleeping
but not when you are awake which
is the opposite of what OURA is
doing in my case.

The SRI paper puts it this way

Compared to PSG, actigraphy has high sensitivity (ability to detect sleep) although specificity (ability to detect wakefulness) is lower (Marino et al., 2013; Sadeh, 2011), with a wide range of accuracy, depending on the amount of night-time wakefulness (Paquet, Kawinska, & Carrier, 2007), the algorithms used and the particular population studied (Van de Water, Holmes, & Hurley,

2011). Most importantly, actigraphy relies on a single sensor, an accelerometer, and thus it provides a measure of motion from which it predicts sleep and wake states. However, information about sleep stage composition, fundamental in studying sleep and sleep disorders, is not provided.

The Science Behind Oura's Sleep Analytics: Detecting Sleep Stages

So what does the SRI paper OURA likes to quote as proving its

...to question the accuracy of

accuracy say.

The paper is entitled “The Sleep of the Ring: Comparison of the ŌURASleep TrackerAgainst Polysomnography” and it was written by researchers at SRI international, a research consortium in Menlo Park, California with no ties to OURA.

Another paper which used to be touted on the Oura Ring website (but is no longer referenced on the site) utilized home PSG recordings and was done by an in-house OURA employee.

The SRI researchers studied 41 healthy adolescents and young adults with an average of 17 years and sleep data were recorded using the ŌURA ring and standard PSG on a single laboratory overnight.

Metrics were compared using Bland-Altman plots and epoch-by-epoch (EBE) analysis.

EBE analysis showed that ŌURA accurately detected “light” and “deep” sleep in 65% and 51% of the epochs, respectively. It also accurately detected REM sleep epochs 61% of the time, with an overall overestimation of PSG REM sleep (by about 17 min). When the ŌURA ring misclassified PSG REM sleep, the algorithm classified the epoch as “light sleep” (76%) for the majority of the time.

These data suggest that the Oura Ring is virtually useless in telling you if you are in REM sleep versus deep or light sleep.

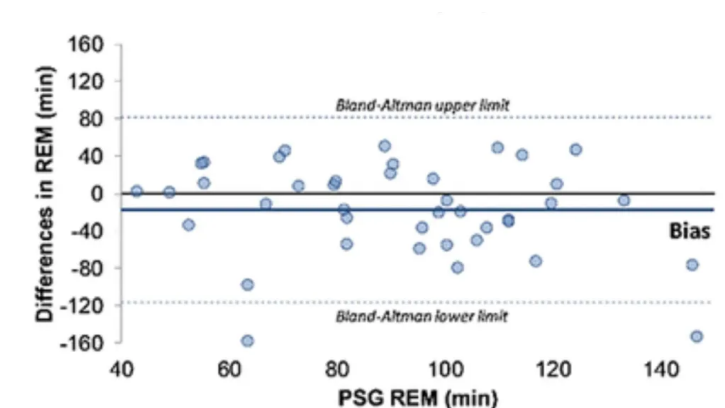
As the authors noted

Distinguishing sleep stages such as REM and N3 with non-EEG based systems has been challenging and is a goal of several commercial sleep-trackers, with mixed success.

Clearly, further work is needed to determine what combination of sensors might be used to optimally

...might be used to potentially develop an algorithm that differentiates sleep stages sufficiently well to detect real differences or changes in healthy and clinical populations.

A look at the Bland-Altman plots really tells you how much variation there was in the PSG estimates of various parameters versus the OURA



The Bland-Altman plots show us how much the PSG time in REM differed from the Oura REM time for each individual subject. You can see

each individual subject. You can see that some individuals had considerable over-estimation of REM time whereas other had considerable overestimation of REM time.

Although OURA REM time was on average only 17 minutes higher than the PSG REM time this was because the marked overestimation of REM time in some (7 subjects over 30 minutes) was balanced by marked underestimation in others (9 subjects with over 40 minutes and one with 160 minutes).

Given that the average REM time was 92 minutes for most subjects there was a significant discrepancy between PSG. and OURA assessments.

OURA: COIN FLIP FOR

DETECTING AWAKE

Oura ring was also pretty useless at identifying when you are awake

Overall, ŌURA had 96% sensitivity (ability to detect sleep), 48% specificity (ability to detect wake), 65% agreement in detecting “light sleep”, 51% agreement in detecting “deep sleep”, and 61% agreement in detecting REM sleep, relative to PSG

Like other sleep sensors utilizing actigraphy, Oura in most individuals can’t accurately differentiate between times when you are lying still but awake and when you are lying still and asleep.

The limitations of wrist actigraphy (see [here](#)) for differentiating sleep from wake are worse in those with insomnia:

With actigraphy, because sleep is inferred from lack of movement, subjects who are awake but lie motionless can be classified incorrectly as being asleep, and thus the technique is biased toward overestimating time to sleep, which may lead to incorrectly minimizing the severity of sleep disturbances. This may present a specific challenge for patients with insomnia, and may partially explain the limited validity of wrist actigraphy for estimating

sleep onset latency..

There are multiple other issues and questions with the usefulness of the data that Oura provides that need clarifying before the ring can be considered useful.

For example the SRI paper found significant differences in results depending on which finger the ring was placed on.

Interestingly, we found that PSG-OURA discrepancies for “light sleep” and REM were greater on the ring finger compared to the other fingers, a result that was independent from the

amount of PSG sleep fragmentation. Assuming that the main parameters that ŌURA uses to determine sleep stages are motion and optical sensor outputs, it is possible that the different blood supply among fingers may partially explain these results. For example, it has been shown that SpO₂ values differ between fingers as well as hands suggesting a finger-dependent difference in accuracy of the pulse oximetry signal (Basaranoglu et al.,

2015). Further studies should confirm and better characterize the dependency of the PSG-OURA discrepancies on the ring position by having the same participants simultaneously wear different rings on different fingers.

The in-house Oura study also noted that results were more accurate on the non-dominant hand finger compared to the dominant hand but the Oura website makes no recommendation on which finger to use.

The other data that Oura compiles (heart rate, heart rate variability,

temperature change, respirations)
are clearly related to sleep cycles
but Oura provides no evidence that
these data or their proprietary
algorithms to give you “readiness”
or sleep quality scores are accurate
or of any value.

Should You Buy An Oura Ring?

If you are hoping to get improved
analysis of your sleep quality I don't
think Oura adds anything to what is
elsewhere available using cheaper
wrist actigraphy devices.

The ring is expensive at 299\$ and
cannot accurately detect sleep
stages.

Although most reviews you will
encounter on the internet are wildly
enthusiastic about Oura, they are

likely biased and they provide no evidence that the unique aspects of the ring sensors provide useful information.

Would I buy it again?

I've misplaced my ring several times and I have to say that this distressed me immensely. Given that I think the sleep analysis is worthless this is hard to explain.

I think my attachment to the ring is due to a number of factors

1. It's stylish and it mimics a wedding ring (which I otherwise would not have.)
2. I'm intrigued by some of the cardiovascular data it produces (night time heart rate and heart rate variability). Although

currently I don't think the data can guide me to healthier behavior, it's possible that there is useful information in there somewhere. I hope to write a post on heart rate variability down the line. I've done research in this area and have some strong opinions on its value.

3. I'm curious to see if the respiratory rate data and the temperature data is of any value whatsoever.
- 4.

So, the ring is best I would say for well-heeled,, self-hacking and self-experimenting techno geeks.

Auroraborously Yours,

-ACP



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Is Butter No Longer Back? Part I

Back in 2014 when I first wrote about butter versus margarine I could not have foreseen that the topics of butter versus seed oils

Should You Take An Antioxidan t (Suppleme nt or Vitamin) To Prevent Or Treat Heart Disease?

The following is an update of a post the skeptical cardiologist wrote 7 years ago. Although nothing