Innovating Health

Advances In Personalized Wellness with Daytime Stress & Resilience Features

ŌURA | FOR BUSINESS

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Key Terms

Daytime Stress An estimate of physiological stress and recovery during waking hours.

Resilience An estimate of an individual's ability to withstand physiological stress and to recover from it over time.

Heart Rate Variability (HRV) Variation in the time interval between adjacent heartbeats, evaluated as root mean square of successive differences (RMSSD).

Executive Summary

- With the Daytime Stress and Resilience features, ŌURA has developed cutting-edge stress and resilience tracking, leveraging biometric data collected by Oura Ring.
- Daytime Stress enables individuals to understand and manage their physiological stress in near-real time or track stress over time.
- Individuals with a better understanding of stress can work to become more resilient, bouncing back quickly from stressful events.
- The Resilience feature allows an individual to observe how the body withstands stress and how resilience levels change over time.
- Together, these two features empower Oura members to navigate their stress and resilience, creating a more holistic picture of their health in addition to existing Oura monitoring such as sleep, activity, and heart rate.

Introduction

Oura Ring is a revolutionary smart ring that delivers personalized health data, insights, and daily guidance. With its advanced, research-grade sensors, Oura Ring packs state-of-the-art heart rate (HR), heart rate variability (HRV), blood oxygen, skin temperature, activity, and sleep monitoring technology into a convenient, non-invasive ring — prioritizing both accuracy and comfort without compromise.

Trusted by top-tier research institutions worldwide, Oura Ring has been validated across a range of features including heart rate and heart rate variability, sleep staging, and skin temperature.

The Daytime Stress feature from Oura leverages a proprietary algorithm, grounded in a deep understanding of the physiology of stress. This feature expands the understanding of the human stress response by providing an accurate picture of measurable physiological stress, incorporating biometrics like HRV, HR, and skin temperature.

Utilizing an additional proprietary algorithm based on a comprehensive assessment of recovery and stress through day and nighttime measurements, the Resilience feature enhances the understanding of an individual's stress-recovery equilibrium. When combined with the Daytime Stress feature, Resilience provides insights into one's capacity to rebound from stressors and challenges.

Stress


12:05
ŌURA
TODAY
Daytime stress
Engaged
5m ago
Recent activity has your stress levels in a great place for productivity. Listen to your body. What do you feel like doing?
Heart rate
63 BPM
3min ago
Home
Readiness
Sleep

The State of *Stress*

The prevalence of stress in the post-pandemic world is significant. According to a recent study conducted by the American Psychological Association, in 2023 American adults indicated a median stress rating of 5 out of 10, maintaining consistency with 2022 data. However, 24% of adults expressed a stress level ranging from 8 to 10, reflecting an increase from 19%, the pre-pandemic 2019 level.[4]

Research from Deloitte in 2023 also highlights the prevalence of stress in Millennials and Gen Zs (Millennials born between 1981-1996; Gen Zs from 1997-2012),[5] showing that close to half of Gen Zs (46%) and four in 10 Millennials (39%) report that they feel stressed or anxious all or most of the time.[6] This research also underscores that women may disproportionately experience stress in comparison to men – women report higher levels of stress and anxiety than men in both generations (54% versus 37% in Gen Zs, and 43% versus 35% in Millennials).

As a neuroendocrine response, stress influences homeostasis and adaptive mechanisms including, but not limited to sleep,[7,8,9,10] physical performance,[11,12] emotional regulation,[13] mental health,[14] metabolism,[15] immunoregulation,[16] and even fertility[17]. It should also be noted that circumstances such as poor sleep may cause stress, indicating a feedback loop in human stress physiology.[18,19]

Understanding *Stress and Resilience*

Although the biology of stress is relatively well studied, the exact definition of stress remains obscure and the term may often be used interchangeably with psychological stress.[20]

Oura defines stress as a physiological stress response of the body that may occur in response to physical and/or psychosocial stressors.

Physiological stress is an activation state that helps the human body get through daily challenges and adjust to external and internal changes. To support adaptability, individuals need to understand their personal stress responses and allow the body sufficient time to recover when stress arises.

The neurobiology of psychological and physiological stress reactions includes the sympathetic-adrenal-medullary (SAM) axis and the hypothalamic-pituitary-adrenal (HPA) axis, which orchestrate the release of catecholamines and glucocorticoids, notably cortisol, beginning a cascade of measurable physiological responses in humans.[21]

Many of these measurable changes are regulated by the autonomic nervous system (ANS), which directs the body's involuntary physiological functions. The sympathetic branch of the ANS takes over during a stress response, triggering changes that enable the body to respond, including increased HR,[22] lower HRV,[23] increased breathing rate,[24] and vasoconstriction (narrowing of blood vessels) in peripheral areas of the body.[25,26]

Within human physiology, the stress response constitutes an evolutionarily conserved survival mechanism, orchestrating the mobilization of energy, oxygen, and other physiological and psychological resources.[27,28] In ancestral contexts, the primary objective of the stress response was to prepare an individual for confrontation or evasion in the face of imminent threat. However, in contemporary environments, the nature of stressors has evolved to encompass scenarios such as jetlag, functioning within a team, professional responsibilities, or a chaotic daily commute. Prolonged exposure to stressors can sustain the activation of the sympathetic nervous system, culminating in a state of chronic stress.

Despite its negative connotations, stress exhibits a duality in that it can manifest as a productive force, fostering resilience over the long term.

The key lies in balancing stress exposure with adequate recovery periods and understanding that stress should not and cannot be completely avoided. For example, physical exercise serves as an example of a stressor, which may elicit enduring positive adaptations when complemented by appropriate recovery measures. [29] A physiological stress response may also arise from other rewarding activities or even from sheer excitement.

Further, the concept of hormesis is defined as "a biphasic dose response phenomenon, characterized by a low dose stimulation and a high dose inhibition." [30] Research has demonstrated that diet, exercise, and heat exposure activate a hormetic response.[31,32,33] Hormesis can be applied to resilience in that controlled exposure to challenges enhances adaptive capabilities, preparing individuals for better performance in challenging situations.

Resilience is a subject of ongoing debate among researchers, who question whether it should be conceptualized as a trait, process, or outcome. Some define resilience as the personal qualities that allow individuals to thrive in adversity, emphasizing a constellation of characteristics enabling individuals to adapt to the circumstances they encounter. [34] Conversely, the "process hypothesis" highlights dynamic changes over time, emphasizing positive adaptation within adverse circumstances.[35] Resilience can also be seen as an outcome of post-experienced adversity.[36] Despite these differing perspectives, common elements in resilience studies include baseline or pre-adversity, the adversity itself, post-adversity resilient outcomes, and predictors of resilience outcomes.[37]

In the diverse landscape of human experiences, adversity takes various forms, including social rejection, academic failure, early-life stress, and depression. Resilience, shaped by the specific stressful process, manifests as the ability to either maintain natural functions and elude adversity or positively confront stress and derive benefits from it.

Importantly, resilience lacks a universally accepted definition. It is often broadly defined as a dynamic process involving positive adaptation within the context of significant adversity. From a psychobiological standpoint, it encompasses short- and long-term responses that reduce allostatic load.[38,39] This broader definition differentiates resilience from the concept of resistance. While stress resistance prevents the experience of negative consequences of stressor exposure, stress resilience requires one to go through the negative consequences and demonstrate facilitated recovery.[40]

Measuring *Stress*

In research and clinical settings, common stress monitoring tactics involve both objective and subjective measurements including serum or salivary cortisol levels, breathing frequency, cardiovascular indicators, or administering various assessments such as the Perceived Stress Scale (PSS) questionnaire.[41,42,43,44] These episodic evaluations provide insights into autonomic nervous system dynamics and hormonal flux; however, continuous measurements may offer actionable insights on acute stress in daily life, such as during the workday, before or after exercising, or while socializing.

Throughout the day, physiological functions adjust dynamically to adapt to internal and external stimuli (Table 1). Oura Ring continuously captures these crucial biometric parameters, including photoplethysmography (PPG) based cardiac metrics like HR and HRV, alongside skin temperature, an indicator of vasoconstriction, from negative temperature coefficient (NTC) sensors. These multimodal biosignals, augmented with motion data captured by a 3-dimensional accelerometer, enable the proprietary Daytime Stress algorithm from Oura to construct a precise assessment of daily stress levels.

Table 1. Biometrics of the human autonomic nervous system can be accurately measured by Oura Ring.

Biometric	Human Response	Representation in Oura Ring Data
Heart Rate	The endocrine glands release cortisol, adrenaline, and noradrenaline into the bloodstream, which then bind to receptors in the heart. When stimulated, these receptors increase heart rate. This carries more oxygenated and nutrient-rich blood to vital organs and muscles, preparing the body to confront or escape a stressor.	Higher HR
HRV	When the sympathetic nervous system dominates, parasympathetic vagal activation lowers, and the time between each heartbeat becomes more stable and predictable. When in a state of relaxation, heart rate variability increases.	Lower HRV
Motion	Physical activity can induce stress. Heart rate increases, and demand for oxygen increases, making the body work harder. Additionally, stress hormones (cortisol and adrenaline) can make individuals more physically active. In contrast, relaxed individuals tend to be more stationary.	Increase in movement
Skin Temperature	Stress hormones cause vasoconstriction in the peripherals (including fingers), to focus blood flow to critical organs and muscles needed for the sympathetic nervous system response. The limited blood flow causes the temperature in the fingers to lower.	Lower skin temperature

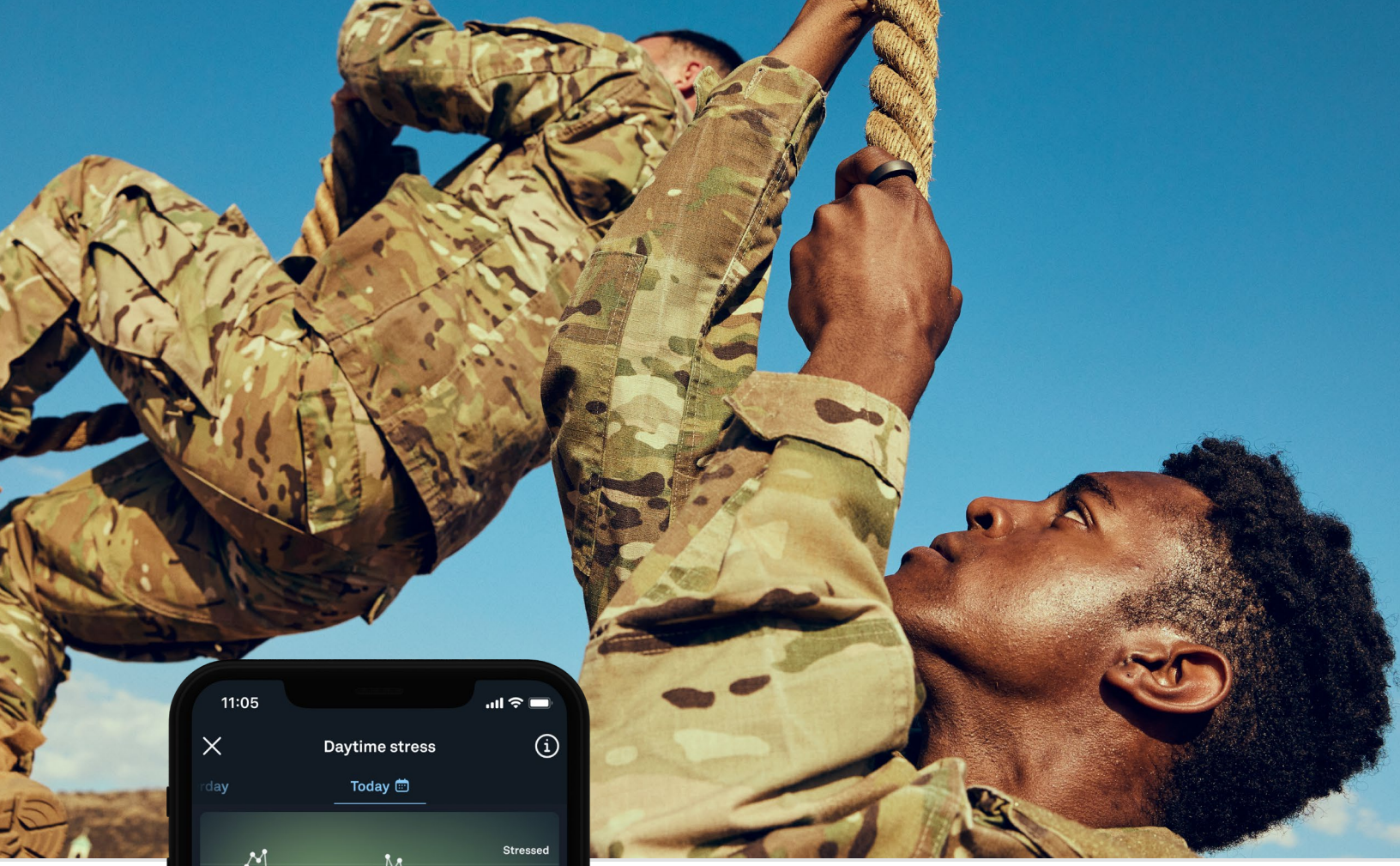
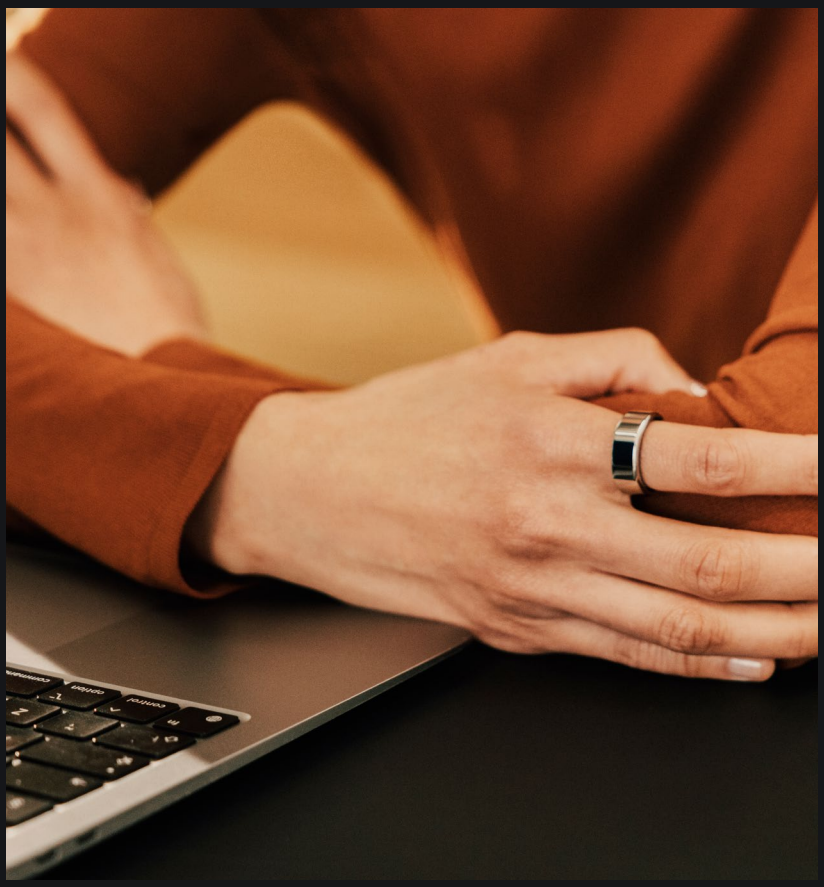


Figure 1. Daytime Stress feature in the Oura App.

Oura's Daytime Stress capabilities extend to quantifying the physiological manifestations associated with the arousal of the sympathetic nervous system (Figure 1). The Daytime Stress graph within the Oura App visually delineates instances when Oura identifies physiological stress, offering a discernible portrayal of an individual's stress levels throughout the day.

Daytime *Stress Algorithm*



Oura's Daytime Stress algorithm (Figure 2) was designed to provide clarity on sources of acute physiological stress and enablers of recovery, both of which vary from individual to individual. By assimilating unique baseline data, the algorithm facilitates an in-depth comprehension of an individual's physiological response to stressors. It serves to guide one's personal pathway toward a balanced life and improved well-being by employing personal data to quantify physiological stress responses and moments of recovery. Notably, the algorithm dynamically adjusts to changes in individual baselines, such as those arising from factors like aging, ensuring a relevant supply of actionable insights.

The Daytime Stress algorithm has been validated against an internal study for algorithmic alignment with subjective estimation.

Baseline Calculation

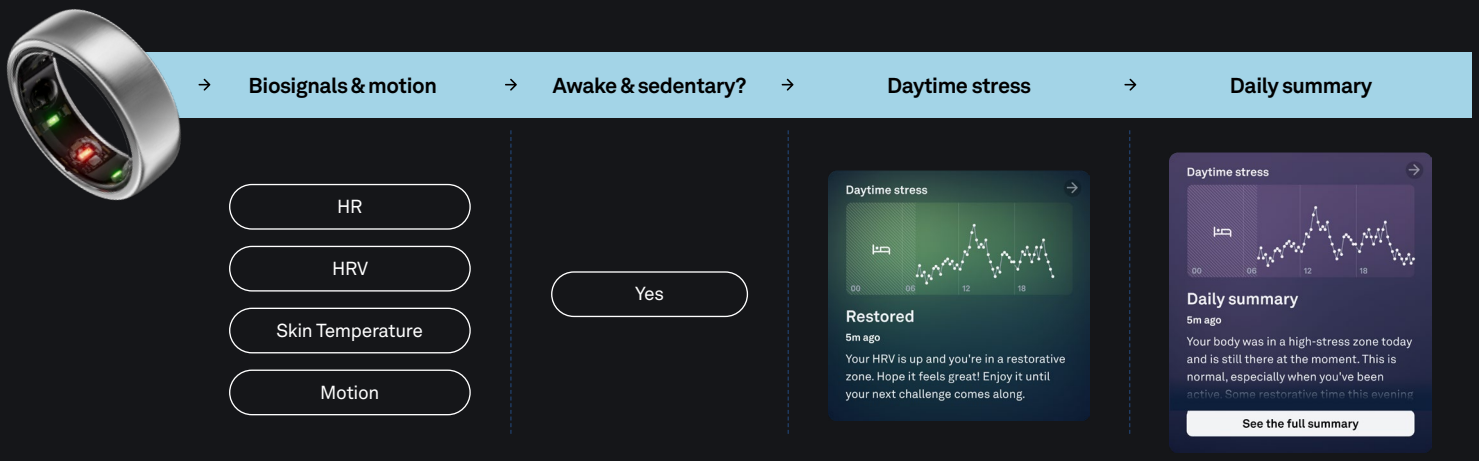


Figure 2. Visual representation of the Daytime Stress feature.

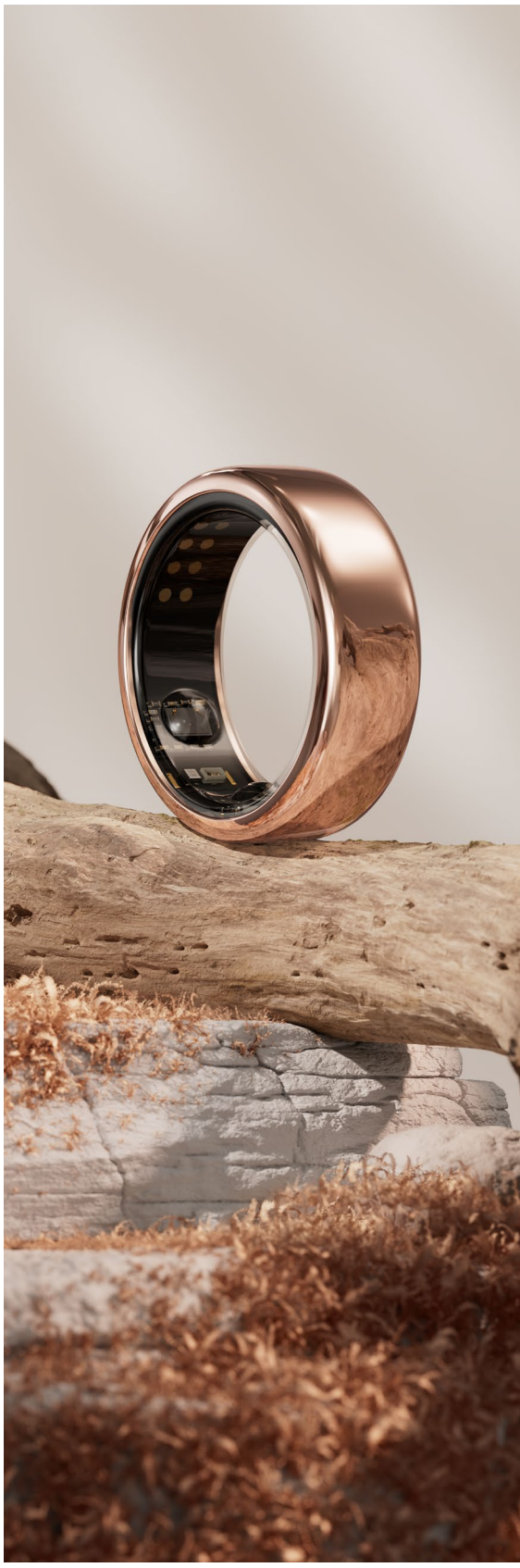
Contributors to Daytime Stress values include HRV, HR, motion data (determined by MET), and skin temperature. An individual's Daytime Stress baseline is based on a minimum of five days and nights of data. The baseline is adjusted with new data each day, allowing the baseline to change and adjust on a rolling basis over time.

Stress values update every 15 minutes during periods when an individual is awake, wearing an Oura Ring, and relatively inactive. The stress values are visualized in-app, in near real-time, similar to the Heart Rate feature within the Oura App.

Daytime Stress is visualized on a time series graph divided into four levels (Figure 3). The momentary stress level is directly defined through the four levels: Stressed, Engaged, Relaxed, and Restored. The more extreme levels, Stressed and Restored, reflect significant deviations from the individual's personal baseline, while the mid-levels, Engaged and Relaxed, are considered neutral or normal (close to an individual's baseline or normal state).

Figure 3. The four stress levels within the Daytime Stress feature. Specific timestamps become visible by tapping an individual point on the graph.

In the evening, individuals see a daily summary and can scroll back to see insights from the previous days. The overall daily categorization is determined based on which level of stress was most prominent, including Normal Day (Engaged or Relaxed), Stressful Day, or Restored Day. At least 25% of the captured stress data must be on the corresponding level(s) to produce the label in question. However, a day successfully balanced between the restored and stressed levels is categorized as normal even if the predetermined threshold is exceeded.



Limitations – Daytime Stress

Daytime Stress sensing is not triggered if:

- The individual is currently active (in motion)
- Measurements overlap with sleep

Occasionally, gaps may occur within the in-app Daytime Stress visualization. This is potentially caused by the following:

- The individual was not wearing an Oura Ring for an extended period of time during the day or night.
- Oura Ring battery was not sufficient to measure biometrics throughout the day or night.
- An individual is wearing an Oura Ring with a poor or loose fit, impacting its ability to accurately capture biometrics.
- An individual experienced cold hands, which can cause signal challenges.

Daytime Stress results may not be valid for users with heart diseases, neurodegenerative diseases, or pacemakers.


12:15
Resilience
Exceptional
Today
Exceptional
Strong
Solid
Adequate
Limited
Thu
Fri
Resilience contributors
Nighttime recovery
Optimal
Good
Moderate
Sleep
Activity
Resilience

Resilience

Understanding Resilience

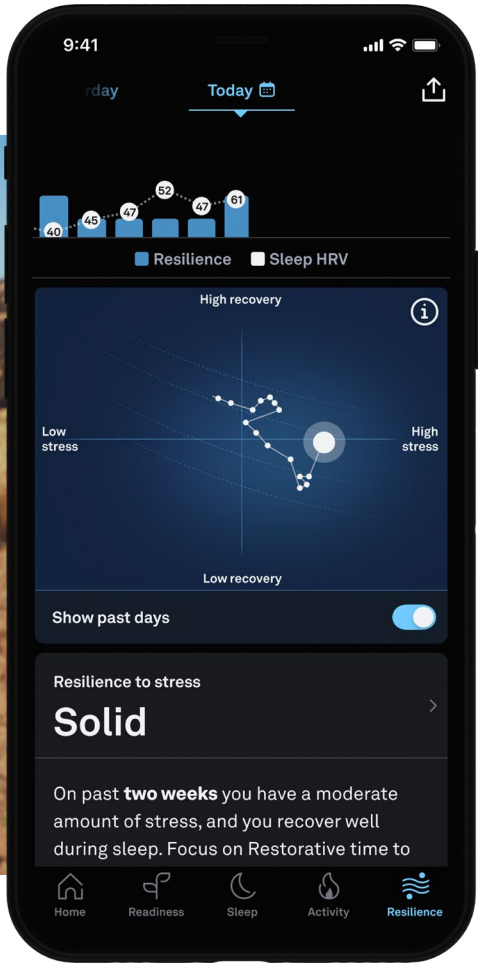
Oura defines resilience as the ability to withstand and recover from physiological stress. Resilience acts as a defense mechanism that safeguards an individual's ability to stay prepared. This does not mean one does not feel or experience stress, but instead, it indicates how one adapts to a stressor and returns to a baseline state. If resilience is robust, individuals can more readily endure, and recover from stress.

A unique experience, resilience transcends mere adaptability. It includes neuroendocrine and autonomic responses to stressors. The concept of resilience is based on maintaining a balance between the amount of stress an individual experiences, and their ability to recover from it throughout the day and night. This equilibrium is crucial in ensuring that stress does not have a long-term negative impact on well-being.

The concept of hormesis shows that some stressors, such as exercise, sauna, or cold therapy, may induce resilience, preparing individuals for future challenges. In research, repeated exposure to stressful events resulted in a blunted physiological stress response.[47,48,49]

The strength of an individual's recovery is a key factor in determining their resilience. A vigorous recovery system enables an individual to quickly bounce back from stressful situations and return to a state of equilibrium.

Measuring Resilience



Resilience is a unique feature, allowing individuals to measure resilience by physiological biometrics, which is unlike traditional resilience assessments.

A variety of instruments have been created by researchers to determine resilience, including the Connor-Davidson Resilience Scale, the Resilience Scale for Adults, and the Brief Resilience Scale, among others.[50,51] These scales require an individual to read, interpret, and truthfully and accurately answer a list of questions. When utilized correctly, these evaluations provide information about resilience and an individual's unique ability to bounce back from stressors. However, these scales are highly subjective, built on self-rated assessments and individual reporting.

When traditional resilience instruments like the scales above are administered, an individual's HR, HRV, skin temperature, stress, recovery, and sleep quality may be unknown, offering a limited portrait of the individual's overall health in the moment and over time. Measuring resilience using biometrics offers additional information about an individual's current resilience, and builds on this by continuously measuring resilience. Trends in resilience can be viewed within the Oura Resilience feature, allowing individuals, leaders, and providers to monitor resilience both historically and progressively.

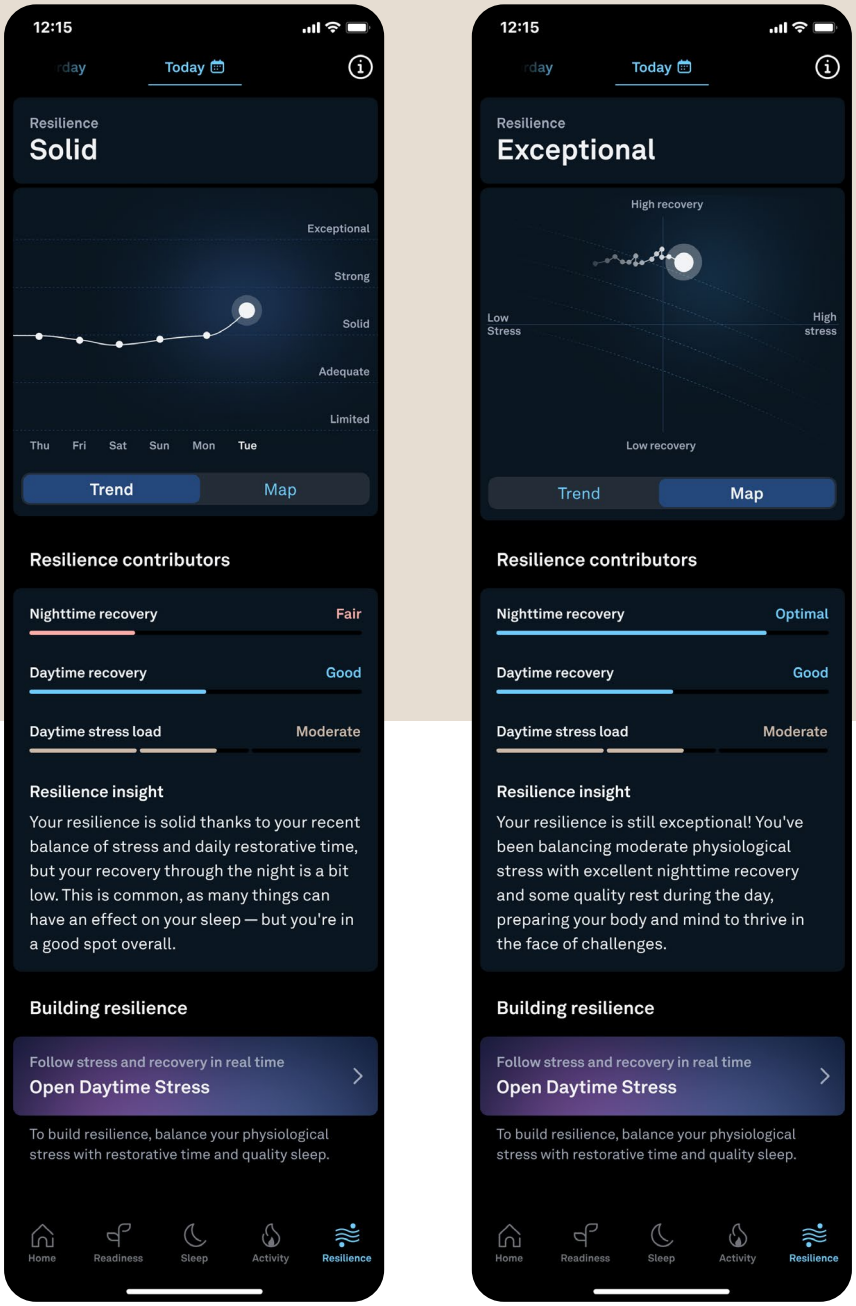


Figure 4. Trajectory maps showing resilience levels in the Oura App.

Resilience is visualized using two options: a time series graph divided into five levels (Figure 4) and a trajectory map showing the combination of stress and recovery. Oura categorizes Resilience into 5 levels: Exceptional, Strong, Solid, Adequate, and Limited. The more extreme levels, Exceptional and Limited, reflect significant deviations from the average while the mid-level, Solid, is considered neutral or average.

Resilience Insights, matching the current resilience level, appear in the Resilience tab view of the Oura App. Inside the Resilience tab, one can also review the current state of resilience level contributors, see suggestions for building resilience, and quickly access real-time daytime stress metrics.

Resilience Algorithm

Baseline Calculation

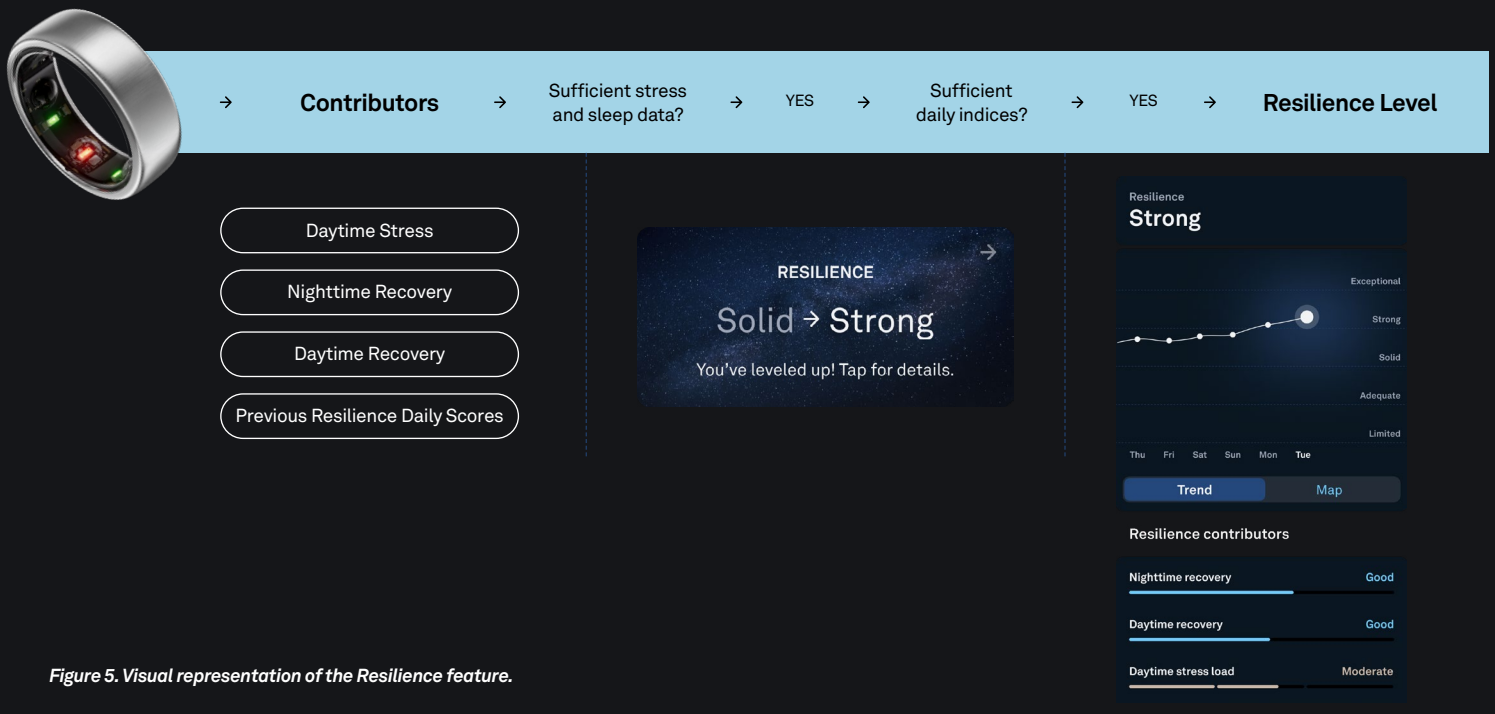


Figure 5. Visual representation of the Resilience feature.

The Resilience algorithm (Figure 5) is designed to evaluate an individual's ability to manage stress and enhance overall well-being by integrating two key components: physiological stress and recovery. The physiological stress component is assessed by tracking the intensity and frequency of Daytime Stress observations. Recovery encompasses both recovery during the day and recovery during sleep. Daytime recovery is monitored by evaluating the frequency and intensity of captured biometrics throughout the day, while the algorithm also considers the importance of nighttime recovery biometrics for overall well-being. The Resilience algorithm analyzes these contributors to recovery during sleep, providing a valuable dimension in understanding an individual's capacity to bounce back from physiological stress.

Together, contributors related to physiological stress and daytime recovery form the foundation of Oura's Resilience feature. These metrics create an assessment of an individual's ability to withstand physiological stress and provide a holistic understanding of an individual's balance between stress and recovery (Table 2).

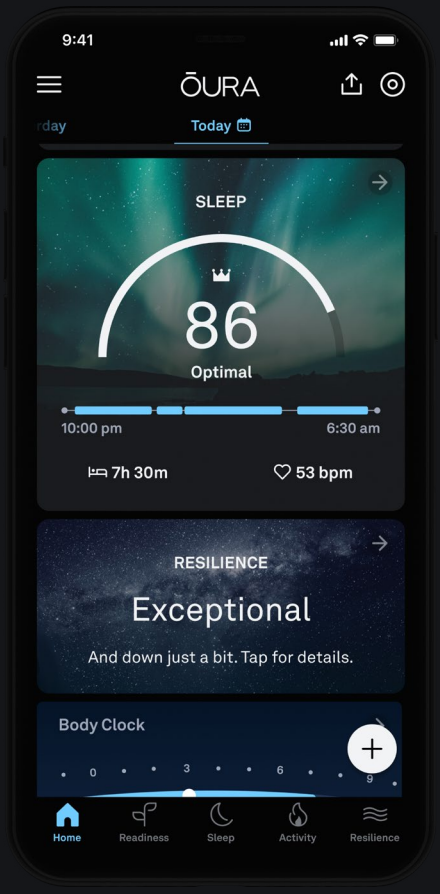


Figure 6. Resilience feature in Oura App.

Resilience Contributor	In the Oura App
Daytime Stress Levels	Daytime Stress
Daytime Recovery	Restorative Stress
Nighttime Recovery	Sleep Score, Resting Heart Rate, HRV Balance, and Recovery Index

Table 2. Resilience contributors are measured by Oura Ring.

The algorithmic determination of an individual's Resilience level is based on a weighted average of the previous 14 days, requiring a minimum of five days of data for each contributor. Additionally, more weight is applied to data from the most recent days. Thus, Resilience is adjusted with new data each day, allowing Resilience and its contributors to change and adjust on a rolling basis, over time (Figure 6).

The Resilience algorithm was validated against an internal study, wherein its alignment was assessed by comparing objective estimations with subjective estimations.

Limitations – Resilience

Resilience model does not generate an output if:

- Daytime Stress data points are unavailable or insufficient.
- Sleep data is unavailable, meaning nighttime recovery cannot be assessed.
- Biometrics from the preceding 14 days and at least 5 Daytime Stress data points, along with the corresponding sleep data, are not available when analyzing data for a particular day, as Resilience functions as a metric over an extended period of time.

Occasionally, gaps may occur within the Resilience visual representations (in-app). This is potentially caused by the following:

- The individual was not wearing an Oura Ring for one or more days or nights.
- Oura Ring battery was not sufficient to measure biometrics throughout the day or night.
- An individual is wearing an Oura Ring with a poor or loose fit, impacting its ability to accurately capture biometrics.
- An individual experienced cold hands, which can cause signal challenges.

Conclusion

Oura Ring, with industry-leading accuracy trusted by over one million members as well as top research institutions globally, is now transforming the understanding of daily stress response and resilience. Utilizing real-time biometric data, Oura is leading the way in understanding the body's stress response and resilience, from high-pressure situations to socializing with friends.

Quantifying and categorizing stress and resilience enables individuals to consider thoughtful choices, such as making changes to daily activities and personal habits, to support overall health. Additionally, gauging stress and resilience within a team, or group, enables organizations to support resilience in dynamic environments by using stress and resilience metrics to adjust workload, responsibilities, or training schedules accordingly.

Oura uses precisely measured biometrics and proprietary, validated algorithms to provide comprehensive stress and resilience insights. This creates visibility into the physical and mental states of individuals. The data can be used to foster a more resilient and responsive group and support strategic planning with real-time insights into stress and resilience states.

Oura is dedicated to advancing solutions in stress, resilience, and critical health areas, underscoring its leadership in health-tech and its pivotal role in supporting the diverse aspects of human wellness.

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Note: Oura Ring is not a medical device and is not intended to diagnose, treat, cure, monitor, or prevent medical conditions or illnesses.