

Smell Sensitivity Varies With Circadian Rhythm

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Summary: According to Brown researchers, our sensitivity to smells varies over the course of the day and the patterns rely on our circadian rhythm. Researchers comment the link may contribute to eating habits in teens, potentially elevating obesity risks.

Source: Brown University.

It has always been apparent that some individuals have a better sense of smell than others, but a new study of 37 teens provides the first direct evidence that within each person, smell sensitivity varies over the course of each day. The pattern, according to the data, tracks with the body's internal day-night cycle, or circadian rhythm.

“This finding is very important for olfactory perception science,” said Rachel Herz, lead author of the study in *Chemical Senses* and an adjunct assistant professor of psychiatry and human behavior at the Warren Alpert Medical School of Brown University. “This hadn’t been known before and this is the first clear, direct evidence.”

As one of the five senses, smell is an important ability, Herz noted, not only for experiencing and enjoying the world, but also for receiving information about danger, such as nearby fire or spoiled food, and for basic functions like eating. Changes in the sense during the day can affect all these capabilities.

Indeed Herz, an expert in the sense of smell, made the findings in collaboration with sleep expert Mary Carskadon, a Brown professor of psychiatry and human behavior. Carskadon is conducting a larger study with a hypothesis that circadian timing and sleep habits may affect the

eating habits of teens, potentially contributing to obesity. Smell is associated with food consumption, notes Herz — who has authored the upcoming book “Why You Eat What You Eat” — so the researchers devised an experiment to determine whether smell varies with circadian rhythm.

28-hour ‘days’

To conduct the study, the researchers asked the 21 boys and 16 girls, all between ages 12 and 15, to sleep on a fixed schedule for two weeks before reporting to the Bradley Hospital sleep lab. After an adaptation night in the lab, the teens began a week of 28-hour days where their sleep was shifted four hours later each “night.”

All along, they lived indoors in dim light, socializing and participating in fun activities with each other and staff members. The goal was to separate them temporarily from typical sleep disruptions and from external cues of circadian timing. In this way, Carskadon said, their inherent, internal circadian rhythms could be measured, as could the sensitivity of their sense of smell at all times throughout their rhythms (in addition to other measures, such as food intake).

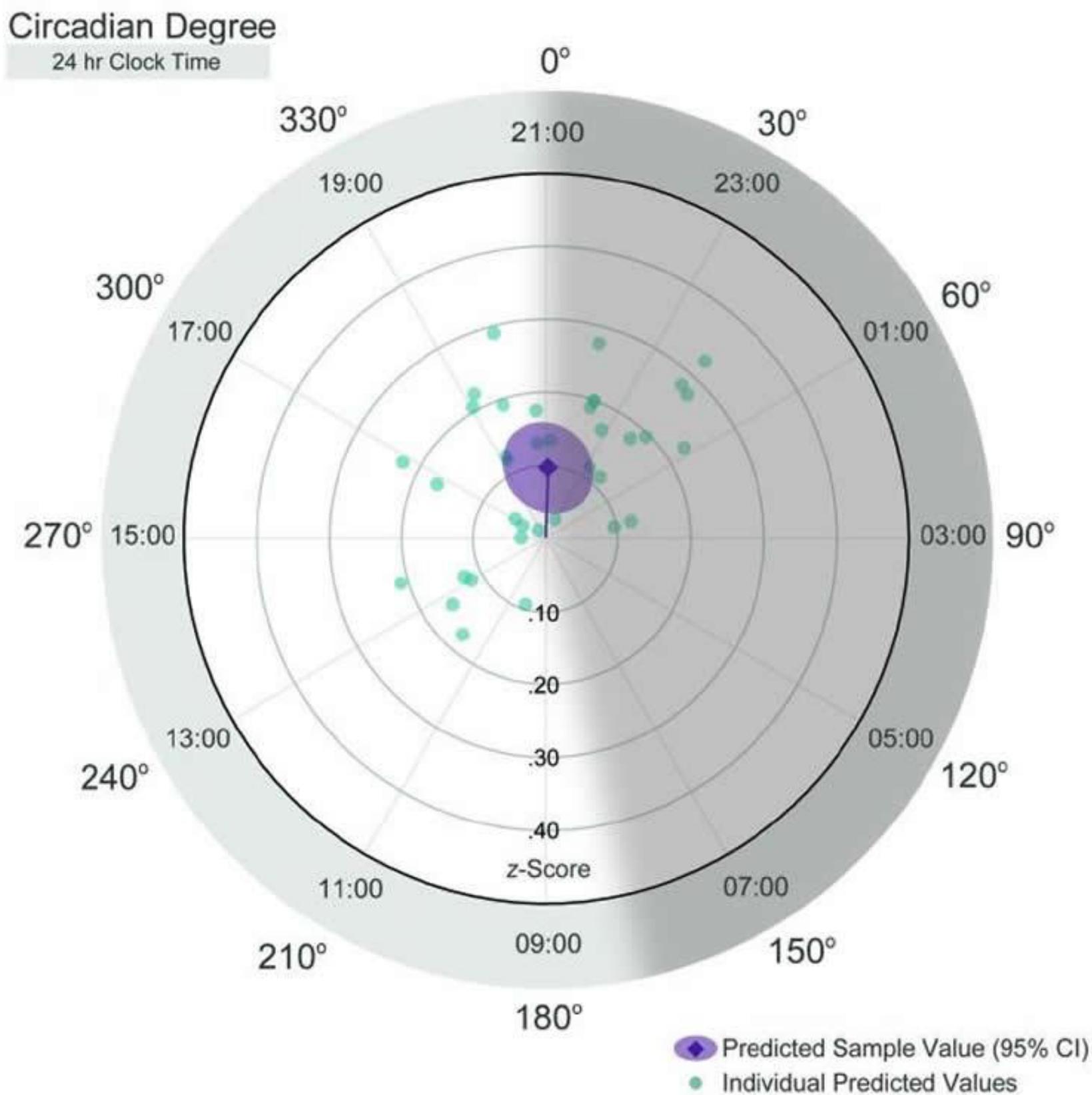
The team measured circadian rhythm by detecting levels of the sleep-cueing hormone melatonin in their saliva. Melatonin secretion begins about an hour before the urge to sleep hits. They assessed smell sensitivity using “Sniffin’ Sticks,” a common test for measuring odor detection thresholds. Each time they used the sticks, the researchers could determine the threshold concentration of the odor that the teens could detect. Smell was assessed every three hours while teens were awake.

The rhythm of smell

Individuals varied substantially in how much their smell sensitivity varied over a circadian cycle and in when it peaked. But there were clear patterns individually and overall. One was that the variance showed a circadian rhythm, and the other was that smell sensitivity was never strongest well into the “biological night,” or the period well after melatonin onset when

people are most likely to be asleep and least likely to be eating. In clock terms, it's from about 3 to 9 a.m.

“So we have 84 tests done on each child, and each one has a circadian phase associated with it,” Carskadon said. “There is a rhythm here, and it's not flat or that you smell the same all the time. Your sense of smell changes in a predictable manner, though it's not the same for every child.”



Around the circadian cycle, either by degrees or time of day, research subjects showed patterns in when their smell sensitivity peaked. Dots show the peak circadian degree, or time equivalent, for each subject. The purple area shows the average. The further dots are from the center, the greater the degree of sensitivity change at the peak. NeuroscienceNews.com image is credited to Herz et. al./Brown University.

Carskadon said the findings should be of note to clinicians and researchers who seek to assess a patient's sense of smell. The study suggests that sensitivity might be inherently higher at an afternoon appointment than in the early morning.

Herz noted that there could be implications for fire safety as well. A decade ago she and Carskadon had found that the sense of smell all but shuts down during sleep. Now there is evidence that the sense of smell is relatively weak during a quarter of the circadian cycle. This emphasizes, Herz said, the value of audible smoke alarms, since smell may be a poor indicator of that danger at least in the early morning hours.

On average, the peak of smell sensitivity was at the beginning of biological night, or about 9 p.m. for the teens.

Herz said she can only speculate about why smell sensitivity might peak, on average, in the late evening. From an evolutionary standpoint, it might be to ensure the greatest sense of satiety during the important end of day meal, it might be a way of increasing mating desire, or perhaps a way of scanning for nearby threats before bedding down for the evening.

For each individual, she said, knowing when during the day smell their sensitivity might peak could be a way of identifying the time when sensory experiences could be most pleasant.

For less ancient health concerns, however, Carskadon says more data from the experiments is coming to help the team determine whether the circadian fluctuations of smell sensitivity helps determine food choices and eating behaviors among teens.

“The sense of smell changes across the 24 hours of the day,” Carskadon said. “We don't know if that difference will affect what or how people eat. There is more to come.”

About this neuroscience research article

The paper's other authors are Eliza Van Reen, David Barker, Cassie

Hilditch and Ashten Bartz.

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Original Research: [Abstract](#) for “The Influence of Circadian Timing on Olfactory Sensitivity” by Rachel S Herz, Eliza Van Reen, David Barker, Cassie J Hilditch, Ashten Bartz, and Mary A Carskadon in *Chemical Sense*. Published online October 17 2017 [doi:10.1093/chemse/bjx067](https://doi.org/10.1093/chemse/bjx067)

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Abstract

The Influence of Circadian Timing on Olfactory Sensitivity

Olfactory sensitivity has traditionally been viewed as a trait that varies according to individual differences but is not expected to change with one’s momentary state. Recent research has begun to challenge this position and time of day has been shown to alter detection levels. Links between obesity and the timing of food intake further raise the issue of whether odor detection may vary as a function of circadian processes. To investigate this question, thirty-seven (21 male) adolescents (M age =13.7 years) took part

in a 28-hr forced-desynchrony (FD) protocol with 17.5 hours awake and 10.5 hours of sleep, for seven FD cycles. Odor threshold was measured using Sniffin' Sticks six times for each FD cycle (total threshold tests = 42). Circadian phase was determined by intrinsic period derived from dim light melatonin onsets. Odor threshold showed a significant effect of circadian phase, with lowest threshold occurring on average slightly after the onset of melatonin production, or about 1.5 \circ (approximately 21:08 hours). Considerable individual variability was observed, however, peak olfactory acuity never occurred between 80.5 \circ - 197.5 \circ (~02:22-10:10 hours). These data are the first to show that odor threshold is differentially and consistently influenced by circadian timing, and is not a stable trait. Potential biological relevance for connections between circadian phase and olfactory sensitivity are discussed.

“The Influence of Circadian Timing on Olfactory Sensitivity” by Rachel S Herz, Eliza Van Reen, David Barker, Cassie J Hilditch, Ashten Bartz, and Mary A Carskadon in *Chemical Sense*. Published online October 17 2017 doi:10.1093/chemse/bjx067

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