

# SHAPE *Shift*

The Shape Intelligence Solution  
Getting Healthy While Creating Your Ideal Shape

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## Chapter 12. Lighting and Shape

*Everything comes in circles—even Professor Moriarty. . . It's all been done before, and will be again.*

Sherlock Holmes

### Opening Dialogue

*Health Scene Investigator: What would happen if you went food shopping on your way to work for the day?*

*Apprentice: Much of the food I purchased would likely spoil.*

*Health Scene Investigator: And what would occur if you consistently dropped your daughter off at school at noon instead of at 8 a.m.?*

*Apprentice: She and I would both get in trouble with the school.*

*Health Scene Investigator: Exactly as I suspected...very important clues.*

*Apprentice: I must be missing something. I don't understand why those questions are important for investigating a health scene.*

*Health Scene Investigator: What you just related to me was that when you do the correct things—buying food and dropping your daughter at school—at the wrong time, it creates a mess; spoiled food and school troubles, specifically. Timing is important in our daily lives; it is no less important for our body. Because of this we want to know what occurs. We also want to know when it occurs. Let me explain.*

### Everything Comes in Circles

In *The Valley of Fear* Holmes tells us that everything comes in circles. We see evidence of this in nature. Cycles of day and night, waxing and waning of the moon, and seasonal changes are examples of things that come full circle at different time scales. Human physiology is intimately connected to these naturalistic cycles. It has a day and a night, a waxing and waning, and different seasons. It is in perpetual motion, constantly changing, but changing in a way that repeats at predictable time intervals. It's all been done before and will be done again. This principle, rhythmic change, can be seen with weight.

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## HSI CLUE

Sleep-wake cycles are one example of a rhythm that repeats every 24 hours. Blood pressure, cholesterol, pulse rate, temperature, pH, metabolism, immune function, bone remodeling, and detoxification are different in the day than the night. Women have robust monthly rhythms and all of us have annual biological rhythms. Shape self-regulation also has a rhythm; it repeats daily, monthly (in menstruating women) and over the course of a year.

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Our weight does not stay constant; it constantly fluctuates. The daily fluctuations in weight were used for humorous purposes in Helen Fielding's book *Bridget Jones's Diary*. Bridget's March 7th diary entry was as follows: "130, 128, or 131 lbs.?? Aargh. How can I have put on 3 lbs. since the middle of the night? I was 130 when I went to bed, 128 at 4 a.m. and 131 when I got up."

While Bridget's weight fluctuations on this night might not be typical, fluctuations of weight within a few pounds over the course of 24 hours are normal. They also follow a repetitive pattern. We generally weigh more at night than during the day. The same rhythm holds for body composition; there are small but detectable and consistent day-night rhythms in muscle tissue, body fat, and water weight. In all of these areas, amounts increase as we move towards and into night and decrease during the day.

In women, if we continued to observe weight over the course of several months, we would detect another rhythm—a menstrual cycle rhythm. Weight increases detectably during the premenstrual phase, reaches a peak during the first half of menstruation, and declines post menstruation.

If we were to stretch our observations out even longer we would detect an annual rhythm. Weight tends to increase as days shorten and decrease as days lengthen. The high point of this annual weight rhythm coincides with the holiday season in the Northern hemisphere. Bridget experienced this seasonal rhythm. On January 1st she weighed 129 lbs.; noting in her diary this was "post-Christmas." Over the course of the year she loses and gains lots of weight, but when the holidays arrive once again, we find her back at her peak weight—a weight of 131 lbs. It's all been done before, and will be again.

There are subtle, yet perceptible, differences that can be detected over the course of a day, a month (in menstruating women), and a year in shape and metabolism. We have a day and a night shape, and a winter and summer shape. These shape differences cycle. They repeat like clockwork, or in the case of yearly changes, like calendar work. Human function is intimately and inextricably entwined with rhythms, layered one on top of another. Figuratively speaking, we are clocks and calendars.

## Human Clocks and Calendars

To fully understand human function it is not sufficient to look at the what. We must also understand the when, the timing or rhythm of things. Almost every important function in our body has at least one rhythm; many have multiple rhythms. The most studied biological rhythms are circadian rhythms—rhythms with a period of about 24 hours. These are not our only rhythms; we also have rhythms that repeat on both shorter and longer time scales. Annual rhythms represent one of these longer biological rhythms.

The hypothalamus—the same part of our brain involved in self-regulation of thirst, appetite, sleep, activity, temperature regulation, sex drives, and shape—is the location of a group of neurons that act as a 24-hour biological clock. Many experts believe that this group of neurons acts somewhat like a master body clock for circadian rhythms. Daily changes in lighting conditions orient this body clock in time.

If our eyes are exposed to correctly timed light and darkness, the master body clock synchronizes our body, and all of its functions, to the sun's schedule. If we are exposed to bright light late at night and darkness in the morning this body clock orients itself differently in time. Changes in lighting are also the critical external signal used by calendar mechanisms, which are at least in part located in our pineal gland.

As discussed in *The Case of Hibernation* (Chapter 11), hibernators use changes in length of days—photoperiod—to anticipate what changes might be needed in physiology and behavior, and to initiate these changes in advance of when they are required. External lighting conditions are used as ways to orient both human body clock and body calendar functions in time, and to shift aspects of our physiology in ways that best match the particular time of the day and year.

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### HSI CLUE

Some people are morning people; others are night people. Many of us fall somewhere in the middle. In one study of persons with bipolar disorder, night people were significantly fatter than day people. What could our preferences for when we are awake and asleep have to do with how fat we are? Night people are also at a higher risk for some diseases, and shifting to a day schedule tends to improve the health of night people. Why?

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Lighting conditions have profound effects on physiology. This can be seen in *The Case of Polycystic Ovarian Syndrome*. Polycystic Ovarian Syndrome (PCOS) is the most common hormonal disorder among women of reproductive age, estimated to affect five to ten percent of women. This syndrome was

unknown prior to 1935. It appears to be a 20th century health issue. PCOS has very strong associations with shape.

Women with PCOS, no matter what their weight, usually have proportionately high amounts of belly fat. Like most complex health problems PCOS is almost certainly a multi-factorial problem, with aspects of diet, lifestyle, and the environment interacting in unique ways with individual genetics to determine whether and how women will experience this syndrome. It is, like many chronic degenerative conditions we face today, complicated. Lighting conditions are one of the complicating factors.

Scientific studies in animals provide direct evidence of the role light and lighting might play in PCOS. Constant lighting will produce polycystic ovaries, as well as signs and symptoms consistent with this syndrome, in several different types of animals. In animals that are very susceptible because of their genetics, as little as 14 hours of continuous lighting a day will trigger this condition. Evidence has also indicated that removing aspects of the calendar tracking ability (pineal gland) makes animals susceptible to polycystic ovaries. Lighting conditions are an environmental tipping point for PCOS in some animals: Whether the same might be true for humans has yet to be investigated.

PCOS is not alone, lighting conditions can influence cancer in animals. In *Cases of the Implanted Cancer* scientists took breast cancer cells and grafted them onto laboratory rats. They divided these rats into two groups. One group was placed in an environment with 12 hours each of light and darkness every day. The other group was placed under continuous light for 24 hours a day. The rats lacked one thing—darkness. The lack of darkness produced by constant light exposure caused the breast cancer cells to grow much faster.

In another similar experiment two groups of rats were exposed to normal lighting conditions during the day; however, one group was exposed to darkness at night and the other group lived in dim light conditions during normal darkness hours. Compared to the constant light in the previous experiment, dim light seems like a relative trifle: It was anything but. Failure to get darkness, even if lights were dimmed at night, resulted in cancer growing at a faster rate and far fewer of the rats surviving cancer.

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## HSI CLUE

Many of us live lives characterized by light pollution. We rarely experience sunrise and sunset, and are inside under artificial lighting during most of our days. Much of the light exposure we do get is poorly timed: We might not get enough bright light in the morning, but get too much at night. Sleep environments might never get completely dark. When it comes to lighting conditions, we have changed our environment, and as a result, it is changing us.

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In these animal studies, and others like them, lighting conditions were a tipping point which made a big difference in whether PCOS occurred, cancer grew, and animals survived or died from cancer. The effects of lighting are not limited to animals. Circumstantial and direct evidence suggests that it influences human health. *The Case of Digestion* is an example.

Two scientific studies on our ability to digest food under different lighting conditions were conducted. In one, volunteers were exposed to either bright or dim light conditions, while the researchers measured the volunteers' ability to digest a meal. The bright lighting conditions had a beneficial effect on digestion. In the other study, volunteers were again exposed to bright or dim light conditions. This time digestion was better with dim light exposure.

Why did the same what—bright and dim light—produce opposite results? The answer is because the when of it changed. In the first study the volunteers were exposed to either bright or dim light from 7 in the morning till 3 in the afternoon. They either were (with bright light) or weren't (with dim light) exposed to naturalistic lighting conditions. In the second study the when was changed. The volunteers were exposed to bright or dim light conditions from 5 at night until bedtime. This time dim light produced the more naturalistic lighting conditions. Bright light was not always helpful for digestion, nor was dim light always harmful. The important variable was whether or not the lighting conditions were evolutionarily appropriate for that time of day. In *The Case of Digestion* it wasn't just what was done that mattered; it was when it was done.

Lighting conditions have been linked to cancer, heart disease, and other chronic health problems. There is abundant direct evidence that lighting affects (1) sleep, (2) mood, (3) circadian rhythms, (4) appetite, and (5) metabolic function. What can we infer from the evidence? The clues tell us one thing unambiguously: The 'what' and the 'when' of lighting conditions are powerful environmental influences on human function and health. Light and darkness might seem trivial: They aren't. We are clocks and calendars. The health and shape outcomes we produce are clock and calendar dependent. It is important that the correct biological events occur; it is equally as important that they occur at the correct time and in the proper sequence. Timing matters and lighting conditions play a disproportionately large role in timing.

## **The Principle of Synchronization**

Scientific studies suggest that the group of neurons in the hypothalamus—light-sensitive circadian pacemaker—is not our only 24-hour clock. Many tissues in the body keep time, including the liver, heart, stomach, and fat cells. They also shift the tasks they do in a time-dependent manner. The liver, as an example, prioritizes certain biological activities in the early morning and others late at night. The same is true of bone remodeling. Processes that remove old bone dominate during dark hours; processes that add new bone dominate during daylight hours. Time dependency occurs with many hormones—cortisol and melatonin serving as examples. Adrenal glands release high amounts of cortisol

between 7 and 9 a.m., and very low amounts during darkness hours. Cortisol's peak punctuates the start of daytime physiology, readying us to face the day. Melatonin is on a roughly opposite schedule, with high amounts released by the pineal gland between 10 p.m. and midnight and little released during daylight hours. It is a darkness hormone, signaling the onset of nighttime physiology. The schedule of both of these hormones is influenced by lighting conditions. These are not isolated examples: They are the tip of the iceberg when it comes to circadian changes in human physiology.

Tissues and systems in the body schedule some tasks at certain times and others at other times. Since our body is a whole system, not separate and independent parts, what one tissue or system does, and when it does it, affects other aspects of the whole. Because of this, it isn't sufficient for the liver to schedule and perform all of its tasks independent of what is occurring elsewhere in the body. Some of what it does might need to be coordinated with bone remodeling. If it isn't, its jobs and bone remodeling both suffer. The same principle applies to timing with respect to cortisol, melatonin, or any other timed function in the body. Healthy function isn't simply a matter of doing the right thing; it is a matter of doing it at the correct time with respect to every other biologically relevant event. This requires coordination; it requires being in sync. And being in sync is a matter of setting all of our different body clocks to the same biological time.

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### HSI CLUE

Synchronization of biology and behavior with the environment allows a living organism to anticipate periodic events, such as the appearance of darkness or winter, and to engage in appropriate changes before the external conditions have shifted. Perhaps nowhere is this as visible as with body fat regulation within migratory animals or animals that engage in hibernation; animals whose survival absolutely requires shifts in their shape in anticipation of periodic environmental changes.

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The importance of timing is apparent in *The Case of the Timed Hormones*. Two groups of female hamsters with a genetic tendency to obesity were placed in constant lighting conditions for ten days and then lived the next ten weeks under short day length conditions—10 hours of light and 14 hours of darkness—while allowed free access to food. This lighting and darkness schedule is sufficient to cause these hamsters to become obese; indicating the power lighting conditions can have over shape. But the scientists took an additional step in this study. During the first ten days both groups received daily injections of two hormones—cortisol and prolactin. One group was injected with prolactin immediately after getting a shot of cortisol; the other group got their prolactin injection 12 hours after the cortisol shots. In this case, the same hormones were given; the only difference was when one was given with respect to the other. What happened?

The group that received the injections of these two hormones timed together remained lean. The other group became, from a hamster perspective, physically and metabolically obese. Under the lighting conditions used in this experiment, altering the timing of one hormone with respect to another produced completely different shape results and the results persisted long after the experiment had ceased.

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## HSI CLUE

The timing of appetite can be a vital clue to rhythm synchronization. When our 24-hour rhythms are in sync, appetite is synchronized to naturalistic light-dark cycles. We wake early in the sun's day and experience significant appetite within 30 to 60 minutes after waking. A robust morning appetite is a clue that our body clock is in sync. Having little to no appetite in the morning, but being hungry late at night, is a clue that rhythms are out of sync.

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Timing of biological events matters in animals; it also matters in humans. But just because timing is important doesn't mean things always stay in sync. The science of biological rhythms refers to a situation where physiological events are mistimed as internal desynchronization. Disruption of tissue timing can occur when food intake, sleep cycles, or timing of light exposure are suddenly altered. Rotating shift work can cause internal desynchronization. Flying across multiple time zones disrupts timing of biological events. Jet lag experienced after these trips is due to the abrupt change away from our normal reference point for time, and the resultant confusion in timing this produces. Shift work and frequent travel are associated with elevated risk for many diseases, presumably, in part, because they disrupt timing—they are a severe form of body clock stress. Shift work also has strong associations with weight gain. *The Case of Intentionally Disrupting Timing* suggests that these links are more than coincidental.

One of the most powerful methods for disrupting the coordination of biological timing is to drastically alter when we eat, sleep, or are exposed to light/darkness. In this case, instead of eating and sleeping at their normal times, the volunteers carried out these activities of daily living twelve hours out of phase. This would be the rough equivalent of traveling across twelve time zones. They maintained this schedule for eight days. At the end of the study period leptin levels had moved in a fattening direction, blood sugar had increased, tissues had become less sensitive to insulin (insulin resistance), and blood pressure had worsened. Signs and symptoms of metabolic obesity developed quickly when body clock orientation in time was abruptly and significantly shifted.

Abruptly altering the timing of our daily activities to a significant degree throws the body into a state, at least temporarily, characterized by internal desynchronization. Shift work, flying across many time zones, or large changes in

when we carry on activities of daily living—sleeping, waking, eating, and exposure to light/darkness—will cause mistiming of biological events.

In the case of shift work, mistiming might last as long as we continue to work these hours. In the case of flying across time zones, aspects of biological timing can still be disrupted weeks after the experience of jet lag has faded. Shift work and long-distance travel are big things; desynchronization can also occur because of many circumstances that occur routinely in the modern world, including bright light exposure at night, or day-to-day inconsistency in sleep-wake times, meal patterns, or lighting conditions. An example is the common occurrence of going to sleep and waking much later on a weekend than on weekdays. This creates a minor form of jet lag.

When we are experiencing any significant degree of internal desynchronization, changes occur in both biology and behavior, which, if sustained, would be fattening. Internal desynchronization has links to many chronic diseases including cancer, diabetes, heart disease, and ulcers. It is also associated with increased risk for obesity. Desynchronization is one side of the rhythm coin; the other side is being in sync. Lighting conditions are the critical time-giving cue that set and synchronize light-sensitive body clocks. Lighting (photoperiod) is also the vital time-giving cue for keeping our body calendar in sync with the seasons. When we eat, which will be discussed in the next chapter, is the time-giving cue for food-sensitive body clocks.

Lighting conditions influence body clocks and calendars. This makes evolutionary sense. Humans evolved in a world where the sun was the dominant time-giving cue for daily and seasonal light-sensitive rhythms. Our physiology is still predisposed to orient itself to the sun's schedule as long as our exposure to light and darkness roughly coincide with a solar day. Like the solar day, our body has a night and day. As darkness becomes dawn, physiology shifts from night to day routines. As day turns to dusk, and dusk to darkness, it is a signal for the reemergence of nighttime physiology. Our body also has seasons. Changes in the length of day (and night) act as a timing cue for our calendar functions. As day length decreases, it is a cue to flip the pages of the calendar from summer to fall to winter, and as days lengthen the calendar flips to spring and back to summer.

Body clocks and calendars are involved in the regulation of appetite, metabolism and shape. Integrating Shape Intelligence with activity, feeding, and sleep-wake cycles makes evolutionary sense. It would have allowed ancient humans to coordinate their daily activities with those of the body in a way that matched the one reliable source of light they had—the sun. It also would allow them to match their physiology with seasonal fluctuations in food availability that occurs, in large part, because of the sun's annual cycle.

In the modern world, where light and food are available around the clock and around the year, this coordination is no longer necessary for survival, but it remains as part of the legacy we inherit from our earlier ancestors. Perhaps because of this, the best health and shape results seem to occur when all of the

different biological events in our body are coordinated with each other and with the sun's schedule. This requires synchronization. And synchronization is, to a significant extent, determined by lighting conditions. The general rule of thumb is that lighting conditions that more closely mimic the light and darkness schedules encountered by pre-industrialized humans—naturalistic lighting—allows for better body clock and calendar function. As lighting conditions diverge further and further from being naturalistic, as they have done in the modern world, shape and health suffer.

## **Body Clocks and Shape**

Body clock orientation in time has a pronounced effect on shape and metabolism. This is evident in *The Case of Clock Mutant Mice*. The Clock gene encodes an essential component needed for the function of the master body clock. Mice that lack this gene have more difficulty orienting to a 24-hour day. They eat large quantities of food and become obese. And they develop signs and symptoms of metabolic obesity—high cholesterol levels, excessive fat in the liver, and insulin resistance. There is a direct relationship with disrupted body clock function and poor shape in these animals. The identification of this link between body clock orientation and shape in animals has resulted in some scientists questioning whether there might be a similar relationship in humans.

In *The Case of Intentionally Disrupting Timing*, scientists were able to move aspects of biology in a fattening direction by doing the equivalent of shifting all activities of daily living normally done during daylight hours to nighttime, and shifting sleep to daytime. The volunteers in this study became extreme night people, and apparently this shift, in when we do things, was fattening. Shift work is a real world example of this type of reorientation in time. Unlike in the study, which only lasted eight days, people who do shift work usually do so for extended periods of time. Studies of shift workers have revealed that they are more likely to be overweight or obese. Rotating shift work is also a risk factor for future weight gain. Shift work is associated with disappointing weight loss results following weight loss surgeries. Shift work appears to be fattening. This type of evidence has led some researchers to suggest that living a nocturnal life, a lifestyle pattern that disconnects us from naturalistic lighting cues, might be a factor involved in body fat accumulation. *The Case of Freshman Weight Gain* provides circumstantial evidence for this hypothesis.

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## **HSI CLUE**

A common complaint of flight attendants, especially during their first six months on the job, is weight gain. Business frequent flyers also commonly complain about weight gain. Conventional wisdom is that they need to do a better job eating and exercising to prevent this worsening of shape. The fault is theirs for failing in some way. But what if body clock stress were the real culprit? How

might this change the way we thought about these complaints and what we did to help?

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An urban myth, of sorts, informs us that during the first year of college, students gain 15 pounds. The newest evidence indicates that college freshman, as a group, do gain weight, just not this much (though many individuals do gain in excess of 15 pounds). Changes in diet, alcohol use, and academic stress are often discussed as possible causes. Perhaps they are. There is another change that accompanies college life that is rarely discussed. Many college students become night people. They go to bed later. They wake later. They get more bright light late at night and less early in the sun's day. More calories tend to be eaten in the evening hours and fewer are eaten early in the day. These might seem like small things, but for body clocks this is a big shift in orientation. Becoming a night person causes us to become desynchronized from the sun's schedule. It reorients body clock rhythms in time, and based upon what science has discovered about biological rhythms, this would be expected to have far from trivial effects of biology and behavior.

We have witnessed many cases of undesired shifts in shape with a move to a nocturnal schedule. We have seen this in college freshman, in shift workers, and in other individuals who become night people. And we have witnessed desired transformations in shape when a person moves from being a night person to becoming a day person. Our investigations into health scenes have resulted in a broader hypothesis than simply a connection between nocturnal living patterns and shape. We believe that chronic rhythm disruption is hidden in the background of the lives of many night people. This rhythm disruption might be the key factor when it comes to weight gain and fat accumulation in shift workers and college freshman. While living a nocturnal life might be one way to inflict rhythm disruption, there are other ways. *The Case of Dr. Mark* illustrates this point.

About a decade ago, because of job demands, Dr. Mark (Percival) spent six weeks flying across the United States and Canada evaluating 35 different medical clinics. He was constantly changing from one time zone to another. Before he began his travels Dr. Greg cautioned him, based upon his understandings of body clock function, that his shape, weight and health might suffer some consequences from the constant rhythm disruption—the body clock stress—this travel schedule would produce. Dr. Mark was unconvinced. He would eat well and exercise. Would this be enough to counter this amount of added body clock stress? We would soon find out. Six weeks later Dr. Mark returned: He was 15 pounds heavier and atypically lethargic, despite having attempted to do all the right things while traveling. Six weeks of this degree of body clock stress proved to be too big of a tipping point for him. His shape, which had been relatively stable for 25 years, shifted.

Dr. Mark's case is not an isolated instance. Body clock stress can be a tipping point for a significant worsening of shape. Whether it is because of frequent traveling across time zones, shift work, moving to a more nocturnal living pattern, or some other lifestyle or environmental factors that throw our body clocks out of sync; rhythm disruption can be an exceedingly powerful shape tipping point. Fortunately, shape changes caused by chronic rhythm disruption can be largely reversed when we get into sync. Dr. Mark was able to shed much of the fat accumulation within several months after getting back in rhythm, so to speak (or as close as he gets with his ongoing travels). One of the ways we get in rhythm is by improving our lighting conditions. The impact this timing cue has on eating patterns and shape is illustrated in the next three cases.

Let's begin with *The Case of Night Eating*. Night eating is a syndrome characterized by low to no appetite in the morning, eating a large amount of total daily food intake after the evening meal, and waking to eat or snack. Night eating is hypothesized to be a causative factor for worsening shape. The evidence for this hypothesis will be discussed in more detail in the next chapter. For now we would like to share a case with you. This case was reported in the medical literature. The person was identified as Ms. B. She was a 51-year-old, overweight, depressed woman. She was also a night eater. Her night eating and depression were worsening despite continued treatment with an antidepressant medication. She was treated with bright light therapy in the morning for 30 minutes a day over a two-week period. Her night eating and her mood improved. One month after ceasing morning bright light therapy her night eating had reappeared, while her mood remained improved. She was given 12 more sessions of morning bright light therapy and this time her night eating completely vanished. Lighting conditions improved her mood and shifted her eating habits.

The second case is the *Case of Phototherapy and Weight*. This is also a case from the medical literature. In this case four overweight women were treated with bright light (phototherapy) between 7 a.m. and 9 a.m. for ten days. After this initial treatment, they continued to have phototherapy twice weekly for another four and one half weeks. Three of the four women spontaneously experienced weight reductions ranging from 3.3 to 5.3 pounds.

The last case is *The Case of Light Therapy and Exercise*. Exercise can improve shape. The evidence for this is overwhelming. Can tinkering with lighting influence the shape results produced by exercising? In an attempt to answer this question scientists assigned 25 overweight or obese individuals to six weeks of moderate exercise. Some of the subjects just exercised. Others exercised and were exposed to bright light every morning. Weight decreased significantly with exercise whether the subjects received bright light treatment or not, but the amount of fat only decreased significantly in the exercising subjects who were exposed to bright light in the morning.

These are isolated cases and small studies. Yet, when they are added to other clues, what argument to the best explanation can we make? We know that biological rhythms are vital for health. We know that lighting conditions, and

other lifestyle and environmental factors can interfere with or improve these rhythms. In some animals, changing lighting conditions affects shape. We know that shift work and other occupations that reorient our body clock in time increase the risk of being obese. The Clock gene directly affects shape in animals. Rhythm disruption can result in changes in biology and behavior that promote fattening. Desynchronized rhythms are a consistent finding in persons with eating disorders and among obese individuals.

We have witnessed shifts in shape for the worse when people chronically disrupt their rhythms, as well as shifts for the better when they get back in sync. The best explanation for these observations is that body clock functions are a vital determinant of our shapes. If this hypothesis is true, lighting conditions, since they are such a vital timing cue for keeping body clocks in sync, should be a tipping point for the better or worse when it comes to shape. In our experience, for some people, they are.

## **The Case of Body Calendars and Shape**

Calendar functions shift the shape of many animals. Hibernating animals and migratory birds are examples. Prior to hibernation or migration, many animals will adjust their natural weight in a way that allows them to be prepared for the upcoming circumstances. By defending more body fat a hibernator will have enough stored energy to survive winter sleep and a migratory bird will have enough energy saved away to make a long flight. In both instances body fat must be accumulated before it is actually needed. To accomplish this task Shape Intelligence must have some way of knowing when to begin advance preparations. Shortening days provide this signal; alerting it to initiate the needed changes in metabolism and fat storage.

Emerging from body calendar research of hibernating and migratory animals has been an appreciation that the natural weight of these animals is continuously readjusted as the photoperiod shifts. A striking example of this seasonality of shape is the golden-mantled ground squirrel. In the wild these animals show a substantial seasonal variation in body fat stores. In labs a similar annual rhythm of fat gain and loss is maintained, occurring even when food is kept constant all year. Evidence like this is inconsistent with a theory that blames shape and weight entirely on caloric intake. Instead it is consistent with a theory that suggests these animals have some form of Shape Intelligence that is constantly adjusting natural weight across the seasons in an effort to produce very specific shape outcomes.

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## **HSI CLUE**

An eight percent increase in meal size has been observed at the time of the full moon relative to the new moon in a study involving nearly seven hundred adults. In both men and women several hormones involved in shape regulation

have lunar rhythms. In women with regular menstruation patterns a marked decrease of waist-to-hip ratio occurs around the time of ovulation. Shape regulation appears to be rhythmically linked to lunar cycles.

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Equally telling is what occurs when food is restricted in golden-mantled ground squirrels. When they are placed on a diet they lose weight. When they are allowed free access to food they regain the weight. We would expect this temporary weight loss outcome and rebound weight gain based on past cases we have discussed. But when they regain the weight they do not return to the weight they were before the diet, they return to a weight that is appropriate for the present point in their annual cycle. If golden-mantled ground squirrels are dieted after the holidays and break the diet in the spring, they don't regain all the fat they lost; they only regain as much fat as they would normally have and need in the spring.

The opposite shape result occurs if golden-mantled ground squirrels are dieted in the late summer and break the diet in the late fall. They regain much more fat than they lost because it is appropriate for them to be fatter going into the winter. The same phenomenon is observed if body fat is removed surgically; the animals replace it, but they do so precisely to match what they would normally need for that season. Whether it is the ground squirrel, other animals that hibernate, or migratory birds, in the animal world natural weight is tightly linked to calendar functions. It should not be a surprise to observe such precision in shape self-regulation in these animals. After all, adjusting body fat stores to match the demands created by the environment is essential for survival.

Even among animals that are not known as hibernators, shape and body composition shift as days lengthen and shorten. Rats are nocturnal animals. Cattle, like humans, are day creatures. Neither is a true hibernator. Yet rats exposed to prolonged periods of long days are heavier and shift fat storage to internal depots—they become fat on the inside. In Holstein cattle short days lead to fattening; long days produce more muscle. In our experience we appear to be more like cattle, with short days—winter in the northern hemisphere—being fattening. This can be detected in *The Case of Holiday Weight Gain*.

We know that humans gain weight seasonally. While reports vary as to the amount of seasonal weight gain, it is clear that most people find it easier to gain weight in the fall and winter. We typically blame this weight gain on the holidays—on what and how much we are eating. This matches our intuitions. It is obvious. But let's ask a question.

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## HSI CLUE

Consistent exposure to bright light during winter months improved mood and vitality of office workers. The benefits were not just observed in workers with

seasonal mood disorders; even “healthy” workers benefited. Lighting conditions have pronounced effects on how we feel and function. We might not be consciously aware of these effects, but light will, nevertheless, be impacting us.

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Food plays a big part in the gatherings over the 4th of July holiday period. Why isn't everyone complaining about weight gain during this summer holiday? Could it be we are falling for an obvious fact; blaming our winter shape results on the wrong thing? Is how much, or what, we are eating the only reason we gain weight over the winter holidays? Or could it be that part of the explanation is that calendar functions are making it easier to gain weight and get fatter when days are shorter? [Note: We have consistently observed that is easier for people to improve their shapes more rapidly (and to a greater degree) in the spring as days are lengthening and much more difficult for them to do so in the fall and early winter as days are shortening.]

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Scientific studies have found that hormones like leptin, testosterone, growth hormone, insulin, DHEA, cortisol, and melatonin, all of which are involved in shape self-regulation, change with the seasons. The same is true for enzymes involved in fat storage and utilization; they shift with the seasons. Many of our body functions, including body temperature, cholesterol, blood pressure, and blood sugar regulation also have seasonal rhythms. Our physiological functions indicate that we are seasonal creatures. *The Case of SAD* illustrates the degree to which many of us are affected by changing calendars.

People with seasonal affective disorder (SAD) almost always have body clocks that are out of sync, with many biological events occurring at the wrong times with respect to each other and to the timing of the outside world. SAD is also a calendar condition; occurring in tandem with shorter days. Scientists have observed that the calendar functions of people with SAD change with the seasons, in a manner parallel to that seen in mammals that hibernate. This has led to a hypothesis that the root of this health problem might well be a problem of evolutionary biology. The bodies of people with SAD might be predisposed to want to hibernate, but modern life prevents these people from following this predisposition.

The most recognized characteristic of SAD is low mood; it is not the only seasonal change these individuals experience. Increases in appetite, shifts in when a person is hungry, carbohydrate cravings, sleepiness, decreased desire for activity, and worsening shape, also commonly occur in combination with winter blues. SAD is more than a mood challenge; it affects many aspects of biology and behavior. How is SAD treated? It can be treated using a specific type of light therapy intended to mimic a naturalistic dawn (dawn simulation). Bright light in the morning, usually delivered using a light box, is a very effective therapy. Vitamin D—the vitamin we make from sunlight hitting our skins—can improve

symptoms. All of these interventions can improve how a person with SAD feels. All three interventions have one thing in common; they are related to lighting.

*The Case of Bulimia* provides another link to clocks and calendars. Body clock issues are commonly encountered in persons with bulimia. There is also a distinct seasonal change in both mood and purging behavior in many affected individuals; with both tending to worsen in the late fall and winter. It has been hypothesized that the reason for this might be a lack of daylight. To test this hypothesis 22 women, with both seasonal worsening of mood and binge/purge symptoms, were treated daily for four weeks with morning bright light for 30 to 60 minutes. Depressive symptoms decreased by more than fifty percent and the frequency of binges by almost fifty percent. Several of the participants ceased binge/purge behavior completely and remained abstinent of binge/purge episodes. Light, an intervention with a known effect on clocks and calendars, shifted biology and behavior.

In the animal world, changes in the length of days triggers changes in shape. In humans, physiology and shapes shift in subtle, yet predictable ways with the changing of day lengths. Lighting conditions influence seasonal mood and eating behaviors in some individuals. People tend to gain several pounds over the winter holidays; pounds they often find difficult to lose. The duration of the photoperiod appears to have a strong impact on shape.

## **The Solution: Naturalistic Lighting**

With lighting conditions (as well as meal timing and sleep-wake schedules) the key things to keep in mind are (1) day-in, day-out consistency, and (2) following naturalistic schedules similar to what pre-industrialized humans experienced.

Early humans evolved in a world where the only two significant sources of light—sun and moon—were naturally occurring and varied in predictable and gradual ways. The body evolved to use changes in naturalistic lighting to prepare itself for the different demands that are caused by days and nights, menstruation in women, and the changing seasons. Our bodies are still designed to respond to these time-giving cues.

Five things are needed to produce the best body clock and calendar results. These are: (1) Bright light early in the morning; (2) Exposure to naturalistic lighting during the day and across the year; (3) Sufficient sunlight on our skin to make enough vitamin D to meet our individual requirements; (4) Dark nights; and (5) Waxing and waning of the moon.

In an ideal world we would experience the lighting equivalent of sleeping under the stars and spending our days outside. We would begin the day with a gradual increase in lighting intensity over a period of one to two hours; waking just after dawn as light intensified enough to rouse us from sleep. Most of the day would be spent out of direct sunlight, but with our eyes able to detect the

naturalistic changes in the sun's intensity as it travels across the sky. At some point during the day, depending upon our skin complexion, season, and latitude, we would get enough direct sunlight on our skin to make the vitamin D we need to be healthy and lean. We would experience sunset and the shift to nighttime physiology this transition initiates. Night would have a lighting intensity similar to what would be caused by stars. We would be exposed to the waxing and waning of the moon. Our schedules, and hence our exposure to light, would be characterized by day-to-day consistency. We would rise and sleep at about the same time each day over the course of a few weeks, but our sleep-wake schedule would adjust itself gradually as the length of the sun's day changed, causing us to sleep for a bit longer during the long nights of winter than we do during the short nights of summer. This is what our body was designed for: Most of us don't live this life.

Lighting conditions affect all of us, but some of us are more susceptible to its effects than others. Fluorescent lights—one type of artificial lighting—cause measurable stress responses in some people; yet not in others. Some of us will need several hours of naturalistic light during the day to sleep well at night or lift our moods. Others might only need 30 minutes. Some of us will be severely affected by seasonal changes; others of us will manage short days much more readily. No matter where we might be on the continuum of susceptibility to lighting conditions, improvement in this area can be a tipping point for better health. If you are like some people we have worked with, it might even improve your shape.

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### **HSI CLUE**

Clues to light and darkness issues include: (1) Little or no appetite for breakfast, (2) Late night hunger, (3) Food binges, (4) Cravings for carbohydrates, (5) Sleep issues, (6) Mood problems, (7) Trouble getting going in the morning, and (8) Chronic digestive issues.

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While there are many things one can do to improve lighting conditions, the two most important are getting (1) bright light early in the morning, and (2) more hours of complete darkness at night.

Early morning naturalistic light positively influences all biological rhythms that are synchronized by light. It is a make or break time for body clocks. And it can be a huge tipping point for improving how we function, especially in the winter months.

There are three options for improving morning light quality. The first, and preferred option is to get outside for 30 to 60 minutes between 7 and 9 a.m. daily. If the above is not feasible, use of a light box—a device that emits high intensity light—between 7 and 9 a.m. is an option. The third option is to use what you already have available to make your morning environment as bright as possible:

Open drapes; turn on all available lights; sit near windows, and put the TV on. Thirty minutes represents the minimum, in terms of how much time to be exposed to bright light in the morning. One hour is a better target amount, but if more time is available there is no need to limit morning bright light to only an hour.

Whichever option is chosen, the when of morning light exposure matters—the time of exposure is important, as is day-to-day consistency. We want to make sure that our first bright light exposure occurs shortly after waking, preferably before 8 in the morning. Strong pulses of light early in the sun's day will reset our biological rhythms and synchronize them to the sun's cycles. If we wait till later, and don't get our first exposure to bright light until after 9 a.m., it tends to push most people's body clocks towards a nocturnal schedule, making them night people. Later and later exposure tends to shift body clock to more and more of a late night orientation. Day-to-day consistency of timing is also important. If one day, morning bright light occurs at 7 a.m., and the next day it occurs at 9 a.m., this is, from a body clock perspective, akin to flying across two time zones. Rather than synchronizing our body clock, inconsistency can cause something researchers call social jet lag.

In addition to morning bright light, it is important to periodically punctuate our days with exposure to naturalistic light. This allows our eyes to send a signal to the light-sensitive parts of our brain that lighting conditions are continuously changing. It also tends to orient us more firmly to the sun's schedule. This can be accomplished, at least to a degree, by sitting close by a window and using it as our principle source of illumination during the day. It can also be accomplished by going outside for at least five minutes every one to two hours during the day.

Actual darkness—lack of light—is a requirement for optimal body clock performance. The human body is evolutionarily adapted for daytime light and nighttime darkness. We need both. Without periods of darkness, light ceases to be a meaningful time giving cue; losing its ability to synchronize the body clock. Bright light in the morning shifts the body into daytime physiology. Darkness produces the shift to nighttime physiology. Without it the body remains in a sort of limbo between night and day physiologies, unable to completely shift gears into nighttime mode until the environment is dark. Once we have shifted to night physiology, we remain in it as long as darkness remains uninterrupted by light. The earlier in the evening the shift to nighttime physiology occurs, and the more uninterrupted time we spend in darkness, the more likely the body is to complete all of its important nighttime duties. If we don't spend sufficient time in nighttime physiology, some things can't get done, and health suffers.

While bright light in the morning is an important time giving cue, the same what—bright light—can be very disrupted if the when occurs at night. Much of this disruptive effect can be eliminated if we are more careful with the wavelengths—colors—of light we expose ourselves to at night. Light is made up of many colors. We can see them in a rainbow or with a prism, both causing light to

refract in ways that reveal its hidden colors. Most people are aware of the health risks associated with one of these colors—ultraviolet (UV) light. Too much UV light exposure will cause sunburns and is associated with skin cancer. Far fewer people are aware that other colors of light have biological effects.

Of all of the colors of the rainbow, the blue light wavelength has the strongest impact on light-sensitive rhythms. It appears to be the most important wavelength to get exposure to in the morning; it is also the most disruptive wavelength if exposure occurs at night. In an ideal world we would get sufficient blue light exposure in the early mornings to set our body clocks, we would get much less as dusk approached, and we would get none for the several hours prior to bedtime. The first part of this is accomplished by morning exposure to bright light; the latter part only occurs if our evening, late night, and sleep environments are blue light friendly (as low in blue light as is possible).

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### **HSI CLUE**

Constant light (or darkness) isn't good for body clock accuracy. The reason for this is complex but basically boils down to one principle: Constant lighting conditions are devoid of time- giving cues. They don't send a signal our eyes can detect and respond to. This is why naturalistic lighting, including its opposite, darkness, is so vital for body clock health. Contrast, rhythmic change in illumination, is required for time keeping.

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The goal is to minimize blue light exposure at night, especially in the hours immediately prior to bedtime. Since incandescent sources of lights (including candles and fireplaces) emit proportionately lower amounts of blue light, they are the preferred sources to use for nighttime illumination. Using only enough of these light sources to create a dim environment is preferable to using more of them, or brighter versions of them, to create a brighter nighttime environment.

Since televisions and computer monitors emit significant amounts of blue light, the ideal solution would be to avoid these at night. This is not a realistic solution for many people. An alternative, and highly effective strategy, is blue light blocking. Orange lenses or tinting block blue light. An orange tinted light bulb will emit less blue light than a regular light bulb. Sunglasses with orange lenses will screen out blue light wavelengths. Polaroid lenses will usually also block out a significant amount of blue light. Special antiglare screens for blocking blue light emissions from TVs and computer monitors are available. Wearing orange-tinted sunglasses, or so-called blue blockers, is a low cost and easy step. We strongly recommend this solution for people who spend any significant amount of time watching TV or using a computer during night hours.

The other important area to focus attention on is the sleep environment. An ideal sleep environment is cave-like. Simple steps to make the sleep

environment darker include (1) having drapes/curtains that are dark enough to block outside sources of light pollution, (2) removing electronic devices which produce illumination (3) getting rid of night lights, (4) moving the head of your bed to the darkest corner of the room, and (5) wearing a mask over the eyes during sleep if there is still ambient light.

For people who wake at night to go to the bathroom, or for some other reason, switching on a light can counter many of the benefits of other positive steps taken to improve nighttime lighting. If you are likely to switch on any lights after lights out, please replace these with bulbs that don't emit any blue light. Red or orange-tinted light bulbs are typically blue light safe.

There are many small steps we can take to improve our individual lighting conditions. We can make a decision to be outside close to sunrise or sunset. We might use breaks at work or school as opportunities to go outside, even if for only a few minutes, to orient light-sensitive body clock to the sun's constantly changing intensity. We might make our sleep environment more cave-like, or our home blue light friendly at night. A small step can be as simple as buying some blue light blocking glasses and committing to using these while watching TV or using a computer any time after 8 at night. There is no shortage of opportunities for improving the quality of light and darkness in our individual environments. The only limits are on our individual willingness and creativity.

## **Closing Dialogue**

*Health Scene Investigator: What have you learned?*

*Apprentice: I learned that a person could be doing the right things for their shape and health, but if they did them at the wrong times, they would have a shape and health mess on their hands.*

*Health Scene Investigator (laughing): Well said.*

*Apprentice: I also must admit that I have quite a few lighting issues to address myself. I can make improvements in many areas.*

*Health Scene Investigator: Most of us can. But it is not where we are that matters so much as which direction we are heading. With light and lighting even a few small changes in our environment and habits can get us moving in the right direction. But lighting conditions are not alone. One other factor is also critical for body clock function. Let us turn our attention to this other time-giver—when we eat.*