Quadrant II – Transcript and Related Materials

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Name of the Presenter: Mr. Dipak Bowalkar

Notes

Photic and Non -Photic Zeitgebers

For all the unchecked randomness in this world, there are at least some things you can count on. The sun always rises and it always gets dark, and that's something life – all life – has learned to rely on. Our internal clocks, known as **circadian rhythms**, tend to match up with this established external cycle. In essentially all known forms of life, from the earliest cells and bacteria to plants and mammals, the circadian rhythm is characterized by a period of around 24 hours.

The master mammalian circadian pacemaker is located in the hypothalamus, in a section known as the **suprachiasmatic nucleus (SCN).** Lesser circadian pacemakers with their own 24-hour cycles, sometimes called slave oscillators, have also been located in the eyes, pineal gland, liver, intestines, and other organs, but the SCN is said to synchronize them, employing over 20,000 neurons in the process. The SCN secrete melatonin which regulate wake-sleep cycle of body whereas activation or suppression SCN itself require an external stimulus called "**Zeitgeber**" in German it translate with combination of two wards the Zeit=time Gerber=giver which literally mean time giver or time keeper. **A zeitgeber is any external or environmental cue that entrains or synchronizes an organism's biological rhythms to the Earth's 24-hour light/dark cycle and 12-month cycle.** The most important Zeitgeber which control SCN is amount of Day light or Blue light of Sun which suppresses the activity of SCN and is called as **Photic Zeitgebers**. Where as the other than light stimuli which control SCN are called **Non-Photic Zeitgebers**.

The SCN receives input via three main pathways: the retino-hypothalamic tract, which directly delivers photic (light-derived) information; the geniculo-hypothalamic tract, which indirectly delivers photic information; and the raphe-hypothalamic tract, which uses serotonin to deliver non-photic information to the SCN. The SCN tells the pineal gland to secrete melatonin. Both photic information (like blue light) and non-photic information (like temperature, social cues, food availability, to name a few) act as zeitgebers with the ability to entrain (circadian synchronization in accordance with an outside cue is called **entrainment**) internal clocks.

A] <u>Photic Zeitgebers</u>.

Light is the most important Zeitgeber which influence all rhythms of the body by controlling SCN. The mechanisms of light-effected entrainment are not yet fully known, however numerous studies have demonstrated the effectiveness of light entrainment to the day/night cycle. Studies have shown that:

1. The timing of exposure to light influences entrainment.

In diurnal (day-active) species, exposure to light soon after wakening advances the circadian rhythm, whereas exposure before sleeping delays the rhythm. An advance means that the individual will tend to wake up earlier on the following day(s). A delay, caused by light exposure before sleeping, means that the individual will tend to wake up later on the following day(s).

2. The length of light exposure influences entrainment.

Longer exposures have a greater effect than shorter exposures whereas Consistent light exposure has a greater effect than intermittent exposure of light on circadian rhythm. In rats, constant light eventually disrupts the cycle to the point that memory and stress coping may be impaired.

3. The intensity and the wavelength of light influence entrainment.

Dim light can affect entrainment relative to darkness and Brighter light is more effective than dim light. In humans, a lower intensity short wavelength (blue/violet) light appears to be equally effective as a higher intensity of white light.

<u>B] Non-Photic Zeitgebers</u>

Some of the non-photic zeitgebers affect internal clock and entrain circadian rhythm are:

1. **Feeding**

Just as the sun rises and falls, the availability of food comes in cycles, too. Indeed, research suggests that food availability cycles entrain organisms' circadian rhythms. The classic example is the "early bird" who "gets the worm." How does it "know" to wake up at the hour most advantageous? The bird doesn't actively plan to wake up at a certain time and head out for grub(s). The availability of the food (in this hypothetical case, early morning) conditions the bird's circadian rhythm to prompt an early morning wakeup.

2. **Exercise**

In animals, activity levels affect circadian rhythm. Using body temperature regulation as an indicator of circadian phase shifts. The Exercise or daily activity produces heat and in turn regulate body temperature which essential to be regulate in sleep walk cycle. In diurnal animals the day time is peak for exercise/ daily activity such as feed and foraging and where as in nocturnal animal the exercise will be at night which is essential to maintain high body temperature to keep them awake at night.

Evidence on exercise's circadian effects in humans is less conclusive, but still present. One study identified nightly exercise (three 45-minute bouts of cycling) as an effective phase delayer of melatonin/sleep onset

3. **Social Cycles**

circadian clocks developed primarily in response to the daily cycles of the environment – and, for most organisms, the environment includes not just light, dark, and temperature, but also the rhythms of and interactions with predators, prey, parasites, and community. For example, when two previously isolated deer mice, each with a different circadian rhythm, were placed in a common enclosure, they developed a mutual synchronization of their internal clocks. Honeybees forage in

synchronicity with the rest of their colony, but isolated members tend to drift away from established foraging schedules, suggesting an important role for social entrainment.

4. **Temperature Cycles**

Temperature cycles often correspond with light and dark cycles, but there is evidence that temperature acts independently on certain species' circadian rhythms. The drop in core body temperature during night is also essential for deep sleep along with absence of blue light. Temperature cycles entrain the rhythms of drosophila, the leafcutter bee; and of the circadian-mediated locomotion patterns in certain lizards.

5. **Sound Cues**

It turns out that sound cues play a potentially large role in human (and other species') circadian cycles. To maintain sleep phase of circadian rhythm is essential to maintain lowest sound frequency. In many of experiment showed that high sound frequency is known to disturb sleep cycle in most of the mammals.

6. **Nutrition and Medication**

The effect of nutrition or diet is defiantly known to influence circadian rhythm. Many beverages such as tea, coffee, alcohol, natural and artificial sedatives such as drugs and anti depressant medications are known to stimulate or suppress SCN and intern regulate daily sleeping habits of organism.