Course Syllabus

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PSY490 Course description

The course will present an analysis of biological rhythms from several perspectives. We will address the diverse roles that timing and timekeeping play in optimizing physiological and behavioral processes, regulating thought and action, and enabling anticipation of future events and conditions. Particular attention will be directed toward the temporal opportunities and constraints that are imposed on human behavior and physiology, including the significant impacts on memory, personality, emotional regulation, and the awareness of time. Weekly topics have been chosen by the instructor and placed in a presentation order whereby later topics may refer to the earlier discussions.

Assignments

1 per week. 2-3 page (double spaced) discussion paper on the topic of the week. 10 papers count toward your final mark, and there are 11 opportunities. The lowest mark out of 11 will be dropped before the final mark is calculated.

a. Treat the discussion question according to your own perspective and interests.

b. There are 11 discussions scheduled. The first meeting does not count.

c. The papers should be concise, focused discussions of an aspect of each topic. The introduction presents the "thesis" of the paper, and you need to back up statements with appropriate citations. Include a list of references (3-4 should be sufficient).

d. Discussion leaders. Each student is asked to lead at least one discussion. This is a partnership with the instructor to generate a lively and "on-topic" discussion amongst all the class members. The student is asked to present their perspective. (This is NOT a lecture). Other students may agree, disagree, or bring a different perspective to each topic. . e.

Marking

10 discussion papers (**60%**). As a discussion leader (see part d), you may substitute one paper for this activity. Participation (**15%**). This is an assessment of your overall participation through the term. This is broken down into 2 parts (attendance 5%, discussion and leadership 10%). Attendance but no contributions to discussion, this is still 5 points. The remaining, 10 points are at the instructor’s discretion. The points are assigned on the basis of reaching a threshold for participation – not on weekly participation. The remaining **25%** is an in-depth paper (12-15 pages, typed, double spaced) on a relevant topic.

Course Summary:

Date	Details	
Tue Sep 20, 2022	Assignment 1. Chronotype	
Tue Sep 27, 2022	Assignment 2. Time memory	
Tue Oct 4, 2022	Assignment 3. Episodic memory	
Tue Oct 11, 2022	Assignment 4. Time perception	
Tue Oct 18, 2022	Assignment 5. Ultradian rhythms and brain communication	
Tue Oct 25, 2022	Assignment 6. Sleep, torpor, hibernation and memory	
Tue Nov 1, 2022	Assignment 7. Mechanisms of change: ontogeny, development, epigenetics, and seasonality	
Tue Nov 15, 2022	Assignment 8. Metabolism, nutrition, food entrainment,	
Tue Nov 22, 2022	Assignment 9. Circadian/sleep disorganization and chronic disease (cardiovascular, obesity), and personality?	
Tue Nov 29, 2022	Assignment 10. Circadian disorganization and neuropsychiatric disorders	
Tue Dec 6, 2022	Assignment 11. Discussion: Ancient and modern roles of biological clocks, their adaptive advantages, and evolutionary origins	
	Assignment 0. Participation	
	Assignment 12. Final paper	d

Course Summary: preferences

Date	Details	1	2	3	4
Tues Sep 13, 2022	Organization - general discussion				
Tues Sep 20, 2022	Assignment 1. Chronotype: Morningness/eveningness, circadian entrainment, and the demands of society				
Tues Sep 27, 2022	Assignment 2. Time Memory				
Tues Oct 4,2022	Assignment 3. Episodic memory				
Tues Oct 11,2022	Assignment 4. Time perception				
Tues Oct 18,2022	Assignment 5. Ultradian rhythms and brain communication				
Tues Oct 25,2022	Assignment 6. Sleep, memory, and hibernation				
Tues Nov 1,2022	Assignment 7. Social Zeitgebers, social isolation, and with special reference to COVID-19				
Tues Nov 8,2022	READING WEEK				
Tues Nov 15, 2022	Assignment 8. Metabolism, nutrition, food entrainment and the non-canonical biological clocks				
Tues Nov 22, 2022	Assignment 9. Circadian disorganization and chronic disease				
Tues Nov 29, 2022	Assignment 10. Circadian rhythms and psychiatric disorders				
Mon Dec 6, 2022	Assignment 11. Discussion: Ancient and modern roles of biological clocks and their evolutionary origins				
Mon Dec 6, 2022	Assignment 12: Final paper				

For this course you will be asked to lead 2 discussions (with a partner, depending on the class size.)
The purpose is not to give a lecture. The instructor will always be a second partner.
Return this form by email as soon as possible. Assignments will be first come, first served for popular topics.
Course marking: 10 weekly essays, @6 pts each -60%: participation, 1.5 pts/wk = 15 pts; final paper 25 pts

Assignment 1. Chronotype: Morningness/eveningness, circadian entrainment, and the demands of society

We introduce the concept of timing as a force of nature as well as a general principle upon which life on Earth arose and evolved. This week we will look at timing in a similar way as a principle that has bound together biological and human social evolution. While there are several examples of timing that are necessary at all levels of organization, one that is most evident for human beings is the temporal program. All humans are aware of some simple facts: we tend to sleep at night and are awake in the daytime, we are better at some things at one time of day than another, and we like to do things more at specific times. This general concept lead to observation lead to the concept of morning and evening types of people (chronotypes), and questionnaires aimed at quantifying the different preferences of individuals have been designed (e.g. the MEQ). Unfortunately, measures of timing preference are not easily transposed into physiological variables. Therefore, other measures based on the timing of sleep have been developed (e.g. the MCTQ).

There are several questions to be addressed. What are the two approaches or the questionnaires actually measuring? What do they have in common, and how are they different? How might the two approaches complement each other? Importantly, what do the results tell us about human chronobiology and the temporal program? According to Levandovsky et al. (2013), the two approaches need to be applied to questions with different expectations. Note that we will talk specifically about COVID-19 experiences later in the term, but it's ok to raise the issues here.

Till_Roenneberg (2003) Life between clocks

Hahn et al.

MEQ scoring.pdf

Munich_ChronoType_Questionnaire[1].doc

Roennberg, T. https://pubmed.ncbi.nlm.nih.gov/26446872/

Goldstein et al. (Synchrony effect) https://pubmed.ncbi.nlm.nih.gov/17268574/

Marta Nováková, Martin Sládek, Alena Sumová

Chronotype instruments review, Levansovski et al., 2013

Impact of COVID-19 self-isolation , Ramanjan Sinha)

Assignment 2. Time Memory

Time memory was first defined in 1929 by Ingeborg Beling referring to the ability of honey bees to return to a source of food at the time of day that it was initially discovered. In addition, after returning to the hive, the forager had apparently communicated with its co-workers, information about the quality, direction, and distance from the hive, as well as the time of day that the food (nectar) had been found. Colin Pittendrigh (paper #1, below) argued that the bees didn't need a special system of time memory because they had fully competent clock. Then next 3 papers describe evidence of the existence of a clock (responsible for "implicit" time memory) that is separate from the circadian molecular clock The Mulder et al paper describes "explicit" time memory. Finally the von Frisch paper (for fun) describes the use of a circadian clock required for orientation and navigation. So, what is the purpose of a second system for remembering the time of day, when we have a competent circadian clock? How does the phenomenon of food entrainment support the existence of time memory? What might be the agents of selection that result in the retention of such a mechanism? Are explicit and implicit mechanisms different, and are they different from the memory systems underlying cognition?

1993 TemporalOrganizationReflectionsofaDarwinianClockWa[retrieved-2015-08-22].pdf

1998_-_Mark_Hurd_-_TheSignificanceofCircadianOrganizationforLongevity[retrieved-2015-05-31] (1).pdf

2013_-_Martin_R_Ralph_-_MemoryforTimeofDayTimeMemoryIsEncodedbyaCircadianO[retrieved-2014-05-29].pdf

Cain et al 2017 Dopamine dependent setting of a circadian oscillator underlying the memory for time of day.pdf

Mulder CK etal Time-place learning.pdf

Karl von Frisch - Nobel Lecture.pdf

Assignment 3. Episodic memory

Episodic memory

This is a broad issue in the context of temporal biology, but it should be clear that however we define episodic memory, we are dealing with events that are experienced at a certain time, at a relative time in our personal history, and for a specific duration.

According to Tulving (2002), episodic memory is the capacity of human beings to remember events (episodes) in their past, and discriminate these memories from the real-time sensation of events. Researchers have debated for a long time whether organisms other than humans have this ability. Various experiments have demonstrated that non-human animals are able to respond to learned cues according to information about the place and time that the condition occurred – so called what-when-where learning. But is this episodic memory? A recent article suggests that the reconstruction of an episodic event involves the brain's system of sensorimotor processing (Purkart et al., 2019). Because an episode occupies a discrete moment in our individual history, to what extent is the memory for time a requirement for episodic memory. And, how might sensorimotor integration play a role in episodic memory?

Purkart R., Versace, R., Vallet, GT. (Links to an external site.)(2019) "Does it improve the mind's eye?": Sensorimotor stimulation in episodic event construction. *Frontiers in Psychology*, 10, 1403. Doi: 10.3389/fpsyg.2019.01403.

Dere E (Links to an external site.)
Kart-Teke E (Links to an external site.)
Huston JP (Links to an external site.)
De Souza Silva MA (Links to an external site.). (2006) The case for episodic memory in animals. Neurosci Biobehav Rev. (Links to an external site.)30(8):1206-1024.
Ralph MR, Sam K, Rawashdeh OA, Cain SW,
Ko CH. (2013) Download Ko CH. (2013)Memory for time of day (time memory) is encoded by a circadian oscillator and is distinct from other context memories. Chronobiol Int. 30(4):540-547.
Endel Tulving (2002) (Links to an external site.)EPISODIC MEMORY: From Mind to Brain Annu. Rev. Psychol. 2002. 53:1–25
http://www.annualreviews.org/doi/pdf/10.1146/annurev.psych.53.100901.135114

Assignment 4. Time perception

The ability to learn and remember how long something takes to get done is something that can be crucial in some situations. However, the perception of the passage of time depends to a large extent on the context in which the timed interval is experienced. Time appears to move faster when you are not paying attention to it. Time perception involves the ability to sense a rate that time is passing, and to recall that sense from memory, so that the amount of Time that has passed can be calculated. Under- or overestimating an interval means that you have perceived Time's value differently. So, how is our perception of Time regulated? And what is the purpose of producing this error? (Is there a purpose)? What happens during episodes of psychosis? For that matter, what happens during an episode (as in episodic memory)? How do attention, rhythmic motor activity, and heart rate alter time perception?

Chronotopic maps in SMA .Protopapa et al. (Links to an external site.)
Disturbed time experience during psychosis. Vogel, DHV et al. (Links to an external site.)
Thoenes and Oberfeld. Meta analysis http://dx.doi.org/10.1016/j.cpr.2017.03.007 (Links to an external site.)

Wittman, M. Modulations of the experience of self and time. http://dx.doi.org/10.1016/j.concog.2015.06.008 (Links to an external site.)
Marchant et al., Neural basis... https://doi.org/10.1146/annurev-neuro-062012-170349 (Links to an external site.)
Passage of time judgements http://dx.doi.org/10.1016/j.concog.2015.06.005 (Links to an external site.)

Rhythmic motor movements and the sense of time http://dx.doi.org/10.1098/rspb.2018.1597

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Assignment 6. Sleep, memory, and hibernation

A long standing debate in physiology has been the role of sleep in hibernation. It's a good question, but it begs the additional query as to the primary role of sleep itself. Among the obvious first questions is whether hibernation is the equivalent of extended sleep, and this is clearly not the case. During extended periods of cold torpor, animals arouse briefly on a regular basis. The brain exhibits electrical activity that had been missing during torpor, and animals spend most of their arousal time in a sleep state. In general, the purpose of hibernation, and cold torpor especially, are discussed in terms of energy conservation during times of harsh environments and lean resources. However, the arousals from torpor also must be necessary, but appear to be contradictory to the need for hibernation in the first place. A focused question is “Why is there spontaneous arousal from torpor”? The two major hypotheses are (1) the need to eliminate toxins accumulated during torpor; and (2) the need to sleep. If so, why are these processes so important? Specifically, why do animals engage predominantly in sleep during these time limited bouts at (almost) euthermic conditions? A interesting hypothesis is the need to maintain synaptic organization in the brain when normal memory mechanisms are shut down. This may allow animals to remember past conditions for months when they have no sensibility and are barely metabolizing.

REFERENCES:

Buck and Barnes, 2000.pdf
Daan et al sleep during hibernation.pdf
Heller and Ruby Sleep and Circadian Rhythms in Mammalian Torpor.pdf
memory during hibernation.pdf
Popov Synaptic changes during hibernation.pdf

Sleep and Circadian Rhythms in Mammalian Torpor.pdf

Assignment 7. Social Zeitgebers, social isolation, and COVID-19

There are several ways to address the general topic of the relevance of social zeitgebers, but the obvious one is the broad issue around social distancing, wearing of masks, and quarantine. To what extent are these factors causing alterations in circadian biology leading to cognitive/emotional disturbance, or are the problems mainly direct? How might these paths be related?

COVID-19 pandemic and lockdown_ cause of sleep disruption, depression, somatic pain, and increased s.pdf
Crowdsourced smartphone data reveal altered sleep_wake pattern in quarantined Chinese during the COV.pdf
SAD overview.pdf
Human seasonal and circadian studies in Antarctica (Halley, 75Â°S).pdf

Chen et al 2020 Light and Hormones in Seasonal Regulation of Reproduction and

Mood.pdf

Assignment 8. Metabolism, nutrition, food entrainment and the non-canonical biological clocks

The three primary functions of living organisms are to grow, to maintain organization, and to reproduce, all of which require metabolism. The circadian regulation of these activities has been recognized for decades. Only recently has the role of the reciprocal regulation of the circadian system by metabolic activity been recognized. Regulation of the mammalian clock by scheduled feeding (nutrition), the impact of circadian disturbance on metabolic health, and the intersection of the molecular clock machinery with critical cell metabolic pathways, attest to the importance and possibly an early evolutionary function of this collaboration. One again we have several potential perspectives from which we can view a topic. Perhaps we can ask a simple question of which may have come first in historic terms, the molecular clock or oscillations in cell metabolism. For that matter, how does a rhythm in the metabolism of individual cells relate to the rhythmic acquisition of food displayed by the organism?

Bidirectional interactions between the circadian and reward systems_ is restricted food access a unique zeitgeber_.pdf
CIRCADIAN CONTROL OF THE NAD+ SALVAGE PATHWAY BY CLOCK-SIRT1.pdf
Neurogenetics of food anticipation.pdf
Feeding signals and brain circuitry.pdf

Peripheral oscillators_ the driving force for food-anticipatory activity.pdf

Assignment 9. Circadian disorganization and chronic disease

The relationships between circadian rhythm dysfunction and deterioration in health have been recognized for decades. However, despite knowledge of these links, there has been little movement toward general acknowledgement that human health is at risk due to the accumulation of human behaviours that disregard the severity of circadian misalignment as a causal factor in chronic diseases such as heart disease, diabetes, obesity, and various mental disorders. So, the evidence has been clear for a long time, but new scientific efforts have brought the issue to the forefront of conversation. My question has two parts: (a) Is this newfound knowledge, based on molecular genetics and cellular chemistry, enough to make a difference in human health, and (b) What will it take to prompt human beings to change their behaviour? Here are some background articles to get started. Notably there were several reviews published this year in Nature Reviews.

1. The arrival of circadian medicine

Nature Reviews Endocrinology **15**, 67–69 (2019) (Links to an external site.)

"Circadian rhythm research is beginning to show how rhythms sustain health. Genome-wide transcriptome, metabolome and proteome studies have improved our understanding of circadian regulation. This knowledge is leveraged for behavioural interventions that optimize daily rhythms, the timing of drug delivery and the targeting of clock components to prevent or treat chronic diseases."

Arrival of circadian medicine Review.pdf
Martino et al Circadian rhythm disorganization produces profound cardiovascular and renal disease in hamster.p
Sleep deprivation and metabolism
Circadian clocks and insulin resistance.pdf
Circadian rhythms and exercise — re-setting the clock in metabolic disease.pdf

Crosstalk between metabolism and circadian clocks.pdf

Assignment 10. Circadian rhythms and neuropsychiatric disorders

Dysfunctional circadian rhythm and sleep often accompany chronic behavioral disorders, although causality remains a question. Given the ubiquitous presence of rhythms in physiology, and the crucial need for sleep in human beings it is not surprising that sleep and rhythmicity are disturbed with chronic disorders of brain function. Schizophrenia (or schizoaffective disorder) is essentially a disorder of thought and action, which presents itself as a complex collection of positive and negative symptoms. These symptoms overlap extensively with other disorders of brain function (e.g. bipolar disorder, ADHD). Not surprisingly these are often misdiagnosed or the diagnosis is ambiguous. In this discussion, we will address the degree to which these disorders are caused by circadian dysregulation/disturbed sleep, or have a different etiology, and may be exacerbated by their own effect on sleep/rhythms. Although the original intent was to discuss schizophrenia, I have attached several articles that involve different disorders as the causality theme is common.

Alzheimer's disease and schizophrenia.pdf
animals models of schizoaffective disorders nihms578993.pdf
Binge eating disorder.
Sleep, CRs, schiz review.pdf
HUNTIN~1.PDF

ADHD Clock genes, aggression.pdf

Assignment 11. Discussion: Ancient and modern roles of biological clocks and their evolutionary origins

Many viewpoints and responses can be expected from the question of, “How did circadian systems arise.” To tailor this discussion, we need to recognize (a) the ubiquity of circadian systems; (b) the complete incongruity of the molecular circadian systems among the major phylogenetic groups; and (c) the presence of circadian oscillators that do not rely on gene activity for their function. That is, Circadian systems can be found throughout phylogeny. So, how old are the different circadian systems? Why has a circadian system been re-invented several times? In the history of life, what factors drove each kingdom to select a different set of building blocks to organize a circadian clock? Looking further into the evolutionary past, what pre-existing blocks were required to produce a circadian system, and what were the original purposes of those blocks? To go back as far as we can, what was the common ancestral clock? And, was there circadian rhythmicity prior to the molecular circadian clock?

Here are some viewpoints:

A brief history of circadian time_ The emergence of redox oscillations as a novel component of biological rhythms.pdf
Evolution of circadian rhythms_ from bacteria to human.pdf
Evolution of temporal order in living organisms.pdf
hoerl and mccormack Thinking in and about time.pdf
O and E clock genes in prokaryotes.pdf
The cyanobacterial clock.ppt

The origin of biological clocks _ Science News.pdf

Assignment 12: Final paper

Papers must include:

a. Title, date, name and a short abstract (5 points)

b. Introduction including description of the subject or question along with information supporting the importance of the subject.(10 points).

c. Logical conclusions that can or have been drawn from the existing information and potential future directions (10 points)

Marking emphasis will be placed on conciseness, a logical presentation, a demonstration that the writer understands the issues, grammatical correctness, and evidence that the topic has been covered sufficiently without unnecessary text. In each of the three items listed (a,b,c), spelling and grammar will count for 10% of the point value.

Topic will not be judged.