Sleep, the clock and mental health

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University of Oxford
Sleep is fundamental
We spend \(\frac{1}{3}\) of our lives asleep

Source: Bureau of Labor Statistics, America Time Use Survey
But sleeping can be costly....
<table>
<thead>
<tr>
<th>Uses lots of energy and resources</th>
<th>Doesn’t use as much energy and allows resources to be replenished</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experience and learn things</td>
<td>Consolidate memories</td>
</tr>
<tr>
<td>Experience feeling and emotions</td>
<td>Processing of emotions</td>
</tr>
</tbody>
</table>
How long we have been awake

What controls when we sleep?

Body clock
The two process model:
the interaction between the clock and sleep need

Borbely Human Neurobiology (1982) 1, 195-204
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Borbely Human Neurobiology (1982) 1, 195-204
What controls when we sleep?

- How long we have been awake
- Social and work commitments
- Body clock
The two process model: the interaction between the clock and sleep need
Body clock
Why do we have biological rhythms?
The body clock gives us:

**Biological rhythms**

Circadian rhythms
Ultradian rhythms
Infradian rhythms
Circannual rhythm

24 hour rhythms
Shorter than 24 hrs
Longer than 24 hrs
Yearly rhythms
What has a biological rhythm:

<table>
<thead>
<tr>
<th></th>
<th>DAY</th>
<th>NIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOOD</td>
<td>HIGH</td>
<td>LOW</td>
</tr>
<tr>
<td>CORE BODY TEMPERATURE</td>
<td>HIGH</td>
<td>LOW</td>
</tr>
<tr>
<td>URINE PRODUCTION</td>
<td>HIGH</td>
<td>LOW</td>
</tr>
<tr>
<td>GROWTH HORMONE</td>
<td>LOW</td>
<td>HIGH</td>
</tr>
<tr>
<td>BLOOD PRESSURE</td>
<td>LOW</td>
<td>HIGH</td>
</tr>
<tr>
<td>ALERTNESS</td>
<td>HIGH</td>
<td>LOW</td>
</tr>
<tr>
<td>MELATONIN</td>
<td>LOW</td>
<td>HIGH</td>
</tr>
<tr>
<td>CORTISOL</td>
<td>HIGH</td>
<td>LOW</td>
</tr>
<tr>
<td>SLEEP</td>
<td>LOW</td>
<td>HIGH</td>
</tr>
</tbody>
</table>
How does the clock keep time?

Light
Not all light is the same

The body clock is maximally sensitive to blue light

Sun light

Screens

Fluorescent lights

Tungsten lights
We don’t all tell the same time...

Morning types

Tend to
• Get up earlier
• Go to bed earlier
• Have better mood in the morning
• Perform better in morning

Evening types

Tend to
• Get up later
• Go to bed later
• Have better mood in the evening
• Perform better in afternoon

...we have different chronotypes
Normal distribution in the general population

Roenneberg et al. Sleep Medicine Reviews (2007) 11, 429-238
Chronotype determined by genetics, age and sex

Body clock

How long we have been awake

Chronotype

Social and work commitments

Sun light
But what happens when we don’t sleep well?

Mental health disorders associated with sleep disruptions

<table>
<thead>
<tr>
<th>Category</th>
<th>Disorders</th>
</tr>
</thead>
<tbody>
<tr>
<td>Affective disorders</td>
<td>Unipolar depression</td>
</tr>
<tr>
<td></td>
<td>Seasonal affective disorder</td>
</tr>
<tr>
<td></td>
<td>Bipolar depression</td>
</tr>
<tr>
<td></td>
<td>Mania</td>
</tr>
<tr>
<td>General Anxiety Disorder</td>
<td>Panic disorder</td>
</tr>
<tr>
<td></td>
<td>Post-traumatic stress disorder</td>
</tr>
<tr>
<td></td>
<td>Obsessive-compulsive disorder</td>
</tr>
<tr>
<td>Developmental disorders</td>
<td>Attention-deficit hyperactive disorder</td>
</tr>
<tr>
<td></td>
<td>Autism</td>
</tr>
<tr>
<td></td>
<td>Fragile X Syndrome</td>
</tr>
<tr>
<td>Eating disorders</td>
<td>Anorexia Nervosa</td>
</tr>
<tr>
<td>Substance abuse</td>
<td>Alcoholism</td>
</tr>
<tr>
<td>Psychotic disorders</td>
<td>Schizophrenia</td>
</tr>
<tr>
<td>Neurodegenerative disorders</td>
<td>Alzheimer’s Disease</td>
</tr>
<tr>
<td></td>
<td>Parkinson’s Disease</td>
</tr>
<tr>
<td></td>
<td>Huntington Disease</td>
</tr>
<tr>
<td></td>
<td>Multiple Sclerosis</td>
</tr>
</tbody>
</table>

What comes first?

Common mechanism - disrupted circadian clock
Sleep disruption is not always a secondary consequence of psychiatric symptoms

Sleep disruption is a risk factor for the onset of many psychiatric symptoms:
• Manic episode (Kaplan et al. 2014)
• First episode of psychosis (Ruhrmann et al., 2010)
• Transition to major depression (Buysse et al., 2008)

And the inception of individual symptoms:
• Paranoia (Freeman et al., 2012)
• Hallucinations (Sheaves et al., under review).

“Still No Sleep” xkcd #776 © xkcd.com by Randall Munroe
Treating sleep could help psychiatric symptoms

Early indications are that improving sleep can improve psychiatric symptoms:

• Psychosis (Myers et al 11)
• Depression (e.g. Manber et al 08, Espie et al 14)
• Anxiety (Espie et al 13)
• Mania (Barbini et al 05)
But there isn’t just one type of sleep problem or one type of mental health symptom
Insomnia, nightmares and chronotype as markers of risk for severe mental illness: results from a student population

Bryony Sheaves, Kate Porcheret, Thanasis Tsanas, Colin Espie, Russell Foster, Daniel Freeman, Paul Harrison, Katharina Wulff and Guy Goodwin
What we did...

Oxford Sleep Survey

Online survey to University students (n=1403)

Grouped students based on symptoms of:
• Depression
• Anxiety
• (Hypo)mania
• Paranoia
• Hallucinations

Characterised sleep:
• Symptoms of Insomnia
• Nightmares – frequency and distress
• Chronotype
Three groups...

<table>
<thead>
<tr>
<th></th>
<th>High risk (N=46)</th>
<th>Medium risk (N=816)</th>
<th>Low risk (N=541)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Median</td>
<td>IQR</td>
<td>Median</td>
</tr>
<tr>
<td>Hallucinations</td>
<td>5</td>
<td>1-10</td>
<td>0</td>
</tr>
<tr>
<td>Paranoia</td>
<td>38</td>
<td>29-46</td>
<td>10</td>
</tr>
<tr>
<td>Anxiety</td>
<td>22</td>
<td>16-26</td>
<td>6</td>
</tr>
<tr>
<td>Depression</td>
<td>28</td>
<td>20-36</td>
<td>12</td>
</tr>
<tr>
<td>(Hypo)mania</td>
<td>10</td>
<td>8-12</td>
<td>6</td>
</tr>
</tbody>
</table>

Minimum possible score on all scales = 0.
Maximum scores for each scale: hallucinations = 45, paranoia = 75, anxiety = 42, depression = 42 and (hypo)mania = 13.
What we found...

**Insomnia (SCI total)**

- High risk: 10
- Medium risk: 20
- Low risk: 25

**Chronotype (MSFsc, local time)**

- High risk: 4.9
- Medium risk: 4.6
- Low risk: 4.3

**Nightmare frequency (per fortnight)**

- High risk: 2
- Medium risk: 1.5
- Low risk: 1

**Nightmare distress (1-7)**

- High risk: 5
- Medium risk: 4
- Low risk: 3
What we can take from this...

Found that people with more symptoms of mental health problems have more sleep disturbances.

Not just one type of symptom associated with one type of sleep disturbance.

**Understand which sleep problems different types of people have will enable better treatments**
However is sleep always the best medicine?
Psychological Effect of an Analogue Traumatic Event Reduced by Sleep Deprivation

Kate Porcheret, PhD1; Emily A. Holmes, PhD2; Guy M. Goodwin, FMedSci2; Russell G. Foster, PhD1; Katharina Wulff, PhD1
1Nuffield Department of Clinical Neurosciences and 2Department of Psychiatry, University of Oxford, Oxford, UK; 3MRC Cognition and Brain Sciences Unit, Cambridge, UK; 4Department of Clinical Neuroscience, Karolinska Institutet, Stockholm, Sweden

Getting a good night's sleep might not be the best way to deal with trauma

Sleep it off? Scientists discover it's not the best idea after a traumatic experience.

THE TIMES

The Oxford Times

No sleep could soothe traumas, according to new study

Sleep deprivation could prevent traumatic memories and flashbacks

Sleep-deprived group experienced around 40 per cent fewer intrusive memories than those who had been able to sleep normally
What are intrusive memories?

Following a trauma people can experience intrusive emotional memories.

Sleep is important for memory consolidation.
What we did...

Healthy students → Trauma film → SLEEP → Intrusive memories

What we found...

People who were **sleep deprived** reported **fewer** intrusive memories of the film
What does this mean? Should I sleep or not after a trauma?

Too early to tell!!

Our preliminary experimental research suggesting not sleeping after a traumatic experience may be beneficial in preventing some intrusive memories.

We still need to know more:
- What happens to other types of memory?
- How long do people have to stay awake for?
- What happens in the real world?
Take home messages

• Sleep is controlled by the sleep homeostat, the body clock and social time

• The body clock is driven by a molecular feedback loop in every cell of the body

• The body clock gives rise to many different biological rhythms that make sure we do the right behaviours and the right time of day

• Sleep disturbance is seen in many mental health conditions

  But...is not just a consequence of these disorders

• Overall sleep is a good thing

  But...in some situations sleep deprivation could be used as a tool to interfere with the normal processing that occurs during sleep with beneficial outcomes.
Thank you for listening!