Chapter 3: Sleep
Learning activity suggested answers

Learning Activity 3.1 (p. 133)

1 What is sleep?
Description should refer to sleep as a regularly occurring altered state of consciousness primarily characterised by a loss of awareness.

2 Why is sleep considered to be an altered state of consciousness?
Explanation should refer to differences in awareness and physiological responses.

3 What is polysomnography?
Description should refer to polysomnography as an intensive study of a sleeping person involving simultaneous monitoring and recording of various physiological responses during the course of their sleep.

4 Explain what a self-report is and how it may be used to study sleep, with reference to a specific self-report method.
Self-report description may include:
- a participant’s information about mental processes such as thoughts and feelings associated with different stages of sleep
- a participant’s information about mental processes such as thoughts and feelings associated with different types of sleep, e.g. NREM and REM

Explanation of use may refer to:
- diagnosing and assisting people with sleep problems and disorders, e.g. - -reports are commonly used in supporting diagnosis and the nature, severity and causes.

Common type of self-report:
- sleep diary e.g. - participant records across 24 hours a checklist of behaviours that may include: lie down, get up, nap, sleep, wake at night, ingest caffeine, medicine, alcohol and when they exercise.

5 Construct a table that summarises the recording devices that may be used in a sleep study.
Headings should include Name of device, What it is and What it measures in relation to sleep.

<table>
<thead>
<tr>
<th>Name of Device</th>
<th>What it is</th>
<th>What it measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electroencephalograph (EEG)</td>
<td>detects, amplifies and records the electrical activity spontaneously generated by the brain</td>
<td>changes in electrical activity shown as distinctive brainwaves on a graph, with the frequency and amplitude of each kind of brainwave associated with a</td>
</tr>
<tr>
<td>Instrument</td>
<td>Function</td>
<td>Purpose</td>
</tr>
<tr>
<td>------------------------------------</td>
<td>----------------------------------------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Electromyograph (EMG)</td>
<td>detects, amplifies and records the activity of muscles</td>
<td>different stage (NREM 1–4), and different type (NREM or REM) of sleep</td>
</tr>
<tr>
<td></td>
<td></td>
<td>changes in muscle activity (movement) and muscle tone (tension) throughout the sleep cycle</td>
</tr>
<tr>
<td>Electro-oculogram (EOG)</td>
<td>detects, amplifies and records electrical activity in eye muscles that control eye movements</td>
<td>changes in eye movements during different stages and types of sleep (e.g. REM and NREM sleep periods)</td>
</tr>
<tr>
<td>Thermometer</td>
<td>measures temperature</td>
<td>changes in core body temperature (degrees Celsius) throughout the sleep cycle</td>
</tr>
<tr>
<td>Electrocardiogram (ECG/EKG)</td>
<td>detects, amplifies and records heart rate</td>
<td>changes in heart rate (beats per minute) throughout the sleep cycle</td>
</tr>
<tr>
<td>Video monitoring</td>
<td>video camera(s) record the sleeping person (often using infrared technology and software packages for image enhancement)</td>
<td>externally observable physiological responses and changes in types and patterns of sleep and dreaming</td>
</tr>
<tr>
<td>Self-reports</td>
<td>sleep diaries (sleep logs) and questionnaire responses (completed by a sleeper)</td>
<td>various behaviours of interest during the sleep–waking cycle, e.g. amount of sleep, number, time and length of awakenings during sleep, naps, caffeine intake, exercise, meals consumed and use of medication</td>
</tr>
</tbody>
</table>

6 Suggest two potential limitations of:
   a research studies undertaken in a sleep laboratory
   Limitations may include:
   • Disrupted sleep pattern as a result of being in an unfamiliar situation – sleep pattern is not reflective of a pattern at home
   • If participants are continually woken up during observation, this will also impact on their sleep pattern
   • Being observed affects behaviour, likewise being wired up to machines may inhibit relaxation and sleep as participant may find this intrusive
   b self-report methods for sleep research.
   Limitations may include:
   • subjective nature of data
Learning Activity 3.2 (p. 143)

1. Copy and complete the table below to summarise the main distinguishing characteristics of NREM and REM sleep periods.

<table>
<thead>
<tr>
<th>Type of sleep</th>
<th>EEG records</th>
<th>EOG records</th>
<th>EMG records</th>
<th>Other physiological responses</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>NREM stage 1</td>
<td>• alpha and theta waves (with a decrease in alpha and appearance of theta)</td>
<td>• some eye movement</td>
<td>• some activity</td>
<td>• heart rate slower</td>
<td>5–10 min.</td>
</tr>
<tr>
<td>NREM stage 2</td>
<td>• mostly theta waves</td>
<td>• limited eye movement</td>
<td>• little muscle tension/movement</td>
<td>• breathing becomes more regular</td>
<td>10–20 min.</td>
</tr>
<tr>
<td>NREM stage 3</td>
<td>• theta and delta waves</td>
<td>• little muscle tension/movement</td>
<td>heart rate, body temperature continue to drop, and breathing rate continues to be slow and steady</td>
<td>about 30 min. first cycle, then less</td>
<td></td>
</tr>
<tr>
<td>NREM</td>
<td>• delta waves</td>
<td>• limited eye movement</td>
<td>• muscles completely</td>
<td>like NREM</td>
<td>about 20 min. first cycle, then</td>
</tr>
</tbody>
</table>
### Table: Characteristics of NREM and REM Sleep Stages

<table>
<thead>
<tr>
<th>Stage 4</th>
<th>REM</th>
</tr>
</thead>
<tbody>
<tr>
<td>movement</td>
<td>• beta waves (irregular)</td>
</tr>
<tr>
<td>• barely any movement (slower and larger than stage 3)</td>
<td>• rapid eye ball movement (beneath closed eyelids)</td>
</tr>
<tr>
<td>• lack of muscle tension/tonic movement</td>
<td>• heart rate faster and more irregular</td>
</tr>
<tr>
<td>• most skeletal muscles are limp</td>
<td>• blood pressure rises</td>
</tr>
<tr>
<td>• occasional twitches</td>
<td>• breathing quicker and more irregular</td>
</tr>
</tbody>
</table>

### Questions

2. Briefly describe the pattern and proportions of NREM and REM sleep in a typical night’s sleep for an adult.

- Pattern: cycles of NREM sleep, with each cycle progressing from stage 1 through to 4 then back to 1 (e.g. 1, 2, 3, 4 then 3, 2, 1), usually followed by a REM sleep period (which completes the cycle). NREM stage 3 and 4 may not be experienced in the latter half of the cycle. Note that stage 1 may or may not be included after the first occurrence, depending on whether this ‘drifting into sleep’ period is viewed as a sleep stage per se.

- Proportions: in a typical night’s sleep for an adult, 4–5 cycles of NREM/REM sleep, comprising about 80% NREM and 20% REM, with the NREM cycle shortening and the REM period lengthening as the night progresses. REM period early in the night may last only a few minutes, but REM period later in the night may last up to an hour or so.

3. Why are NREM stages 3 and 4 referred to as slow wave sleep?

Explanation should refer to appearance of slower frequency delta waves in these stages (i.e. fewer waves of a longer wavelength per unit of time).

4. Why is REM sleep sometimes referred to as paradoxical sleep?

Explanation should refer to the contradictory measures, i.e. internally, the brain and body are active, while, externally, the body appears calm and inactive.

### Learning Activity 3.3 (p. 144)

- Participant 1: NREM stage 2
- Participant 2: REM sleep
- Participant 3: NREM stage 4

### Learning Activity 3.4 (p. 144)
See Learning Activity 3.2, Question 1.

In addition:

<table>
<thead>
<tr>
<th>Type of sleep</th>
<th>Subjective experiences</th>
<th>Ease of waking</th>
<th>Responsiveness to external stimuli</th>
</tr>
</thead>
<tbody>
<tr>
<td>NREM stage 1</td>
<td>- drift into and out of a true sleep state</td>
<td>- easily disturbed</td>
<td>- gradually lose awareness of self and surroundings</td>
</tr>
<tr>
<td></td>
<td>- do not perceive that sleep has occurred</td>
<td></td>
<td>- may still be aware of faint sounds in our environment</td>
</tr>
<tr>
<td>NREM stage 2</td>
<td>- light stage of sleep</td>
<td>- less easily disturbed than in stage 1</td>
<td>- can still be easily aroused</td>
</tr>
<tr>
<td></td>
<td>- often report ‘just dozing and thinking’</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NREM stage 3</td>
<td>- beginning of moderately deep sleep</td>
<td>- difficult to arouse</td>
<td>- less and less responsive to the outside world</td>
</tr>
<tr>
<td></td>
<td>- often groggy and disoriented when awoken</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NREM stage 4</td>
<td>- deep sleep</td>
<td>- difficult to wake; may take up to 10 minutes to orient when woken</td>
<td>- not responsive at all</td>
</tr>
<tr>
<td></td>
<td>- sleep inertia, a poor memory of sleep events post-awakening</td>
<td></td>
<td></td>
</tr>
<tr>
<td>REM</td>
<td>- light and deep sleep properties</td>
<td>- difficult to wake</td>
<td>- EEG reveals a busy brain, but REM is deep sleep</td>
</tr>
<tr>
<td></td>
<td>- most dreaming occurs (80% woken from REM sleep report dreaming)</td>
<td></td>
<td>- not responsive at all</td>
</tr>
</tbody>
</table>

**Learning Activity 3.5 (p. 152)**

1. Briefly describe two general trends in the pattern and proportions of NREM and REM sleep across the lifespan.
   - Main pattern: total sleep time decreases as we age.
   - Proportions of NREM and REM sleep: REM decreases as we age, proportion of NREM increases as we age.
2 Compare and contrast sleep–wake patterns of children, adolescents and adults with reference to two distinguishing features of each lifespan stage.

- children: about 12–13 hours total sleep time, 25–30% REM
- adolescents: about 9 hours total sleep time, 20% REM
- adults (late adulthood): about 6-7 hours total sleep time, 33% REM

3

a Explain the meaning of the term sleep–wake cycle shift.
Explanation should refer to a shift of the body clock, forward or backward in time, affecting an individual’s normal/regular sleep onset time and biologically required waking time.

b Briefly describe the sleep–wake cycle shift occurring during adolescence.
Description should refer to a shift of the body clock forward by about one to two hours, resulting in the delayed onset of sleep by one or two hours (but not necessarily a reduction in the normally required duration of the entire sleep cycle).

c What are three potential consequences of this shift?
Consequences may include:
- nightly sleep loss if required to awaken earlier than would occur naturally (which can accumulate as a sleep debt that needs to be made up)
- difficulty waking up (e.g. to go to school or work)
- erratic sleep patterns
- sleep deprivation
- lethargy
- impaired cognitive functioning during waking hours
- negative moods
- self-control (difficulties controlling behaviour)
- low grades and poor school performance.

d To what extent may it be possible to readjust or compensate for this shift? Explain your answer.
Explanation should refer to readjustment or compensation as possible, refer to biological, psychological and social factors, and demonstrate understanding that repayment of accumulated sleep debt can shift the sleep period further forward.

4 Explain the meaning of the following terms:

a delayed onset of sleep: sleep cycle onset occurring at a later time than normal/usual

b sleep debt: sleep that is owed and needs to be made up/accumulated sleep loss that needs to be recovered.

Learning Activity 3.6 (p. 152)
1. Compare and contrast the typical sleep patterns of young adults and elderly people shown in figure 3.18 on page 145.

<table>
<thead>
<tr>
<th>Sleep pattern</th>
<th>Young adults</th>
<th>Elderly people</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleep onset</td>
<td>relatively shorter (10–15 min.)</td>
<td>relatively longer (20–25 min.)</td>
</tr>
<tr>
<td>REM episodes</td>
<td>start with a shorter initial episode (about 10 min.) and lengthen as sleep progresses to about the half-way mark of the sleep period, then of about the same duration (about 30 min.); overall more REM sleep</td>
<td>start with a longer initial episode (about 20 min.) and tend to be of the same duration as sleep progresses; overall less REM sleep</td>
</tr>
<tr>
<td>NREM stages 1 and 2 episodes</td>
<td>initially of relatively shorter duration and lengthen as sleep progresses; more regular and sustained episodes</td>
<td>initially of relatively longer duration then shorter, particularly stage 1; less regular pattern, particularly stage 1</td>
</tr>
<tr>
<td>Awakenings</td>
<td>few (2) and regular</td>
<td>frequent (9) and irregular</td>
</tr>
</tbody>
</table>

2. Suggest a possible limitation of the data.

   Limitation of data may refer to:
   - single case studies
   - lack of demographic data, e.g. specific ages
   - lack of information on participant sleep problems/disorders (particularly the elderly person).

3. Write a conclusion on the typical sleep pattern of young adults and elderly persons based on the data.

   Conclusion should be based on responses to Question 1 and accurate. Example: Young adults experience a more regular sleep cycle involving longer periods of slow wave sleep and REM sleep and fewer awakenings than elderly persons.

**Learning Activity 3.7 (p. 152)**

Media response

Read ‘Back to school to sleep’ on pages 148–149 and answer the following questions.

1. On what grounds does Mellor argue the case that high schools should offer ‘sleep hygiene education’ to students?

   Research findings on adolescent sleep patterns indicating sleep deprivation and associated adverse effects due such as problems with behaviour, academic ability, motivation and concentration. He suggested a connection between poor sleep patterns and mental health problems such as depression, stress and anxiety but did not imply a cause-and-effect relationship between these factors.
To what extent is the article’s explanation of adolescent sleep deprivation and description of its effects consistent with this text’s information in terms of biological, psychological and social factors? Which points may be understated or overstated in the article?

- Article does not explore biological factors adequately, despite mentioning that adolescents have a susceptibility in being negatively affected by sleep deprivation. Article does not illustrate that this may be part of their developmental biology.
- Article explores the social factor of electronic media impacting on sleep behavior (text messaging and social media) and the psychological relationship between sleep deprivation and its effect on behavior and mental health of adolescents.

Some psychologists propose a later start to the school day as a solution for secondary students who are ‘missing vital shuteye’. Is this likely to be a more effective solution to the problem of adolescent sleep deprivation than sleep hygiene education?

Students may explore some of the following reasons:

- Starting school at a later time will affect school timetables and teaching hours, school bus and other transportation issues including coordinating the day for all members of the teen’s family.
- has been shown that allowing a ‘sleep in’ contributes to later and later bedtimes causing further problems with a sleep-wake cycle.
- A ‘sleep hygiene’ program emphasising education may promote change in behaviour through understanding the necessity of sleep, how to promote good sleeping patterns, how to recognise problems in sleeping and guide how to work towards solving sleep problems.

Write a letter to the editor in which you discuss the potential benefits of the two solutions and their possible limitations. Express your opinion on what should be done.

Ensure student responses are based upon and focus on relevant and accurate psychological information, all of which may be derived from the text.

**Learning Activity 3.9 (p. 159)**

1. **a** What does the term sleep deprivation refer to?

   Explanation of sleep deprivation should refer to sleep loss-going without sleep, either partially or totally.

   **b** How are partial and total sleep deprivation defined?

   - partial sleep deprivation: having less sleep than what is normally required
   - total sleep deprivation: not having any sleep at all

2. Describe three relevant ethical guidelines that psychologists must follow when conducting research on sleep deprivation with human participants.

   Relevant ethical guidelines include:

   - informed consent
   - safeguarding against physical and/or psychological harm
• withdrawal rights
• professional responsibility, e.g. termination of research if required.

Ensure descriptions/explanations are relevant to sleep deprivation research.

3 Prepare a table in which you summarise common psychological and physiological effects on people of partial and total sleep deprivation.

<table>
<thead>
<tr>
<th>Effects</th>
<th>Partial sleep deprivation</th>
<th>Total sleep deprivation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Psychological Cognitive Effects</td>
<td>Effects tend to be relatively minor, short-lasting and temporary, e.g.</td>
<td>Effects may be more severe but also tend to be short-lasting and temporary. Some of the more significant side effects may include:</td>
</tr>
<tr>
<td></td>
<td>• lapses in attention</td>
<td>• deterioration in cognitive functioning, e.g. difficulty thinking clearly and remembering</td>
</tr>
<tr>
<td></td>
<td>• inability to maintain prolonged concentration</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• deterioration in cognitive functioning</td>
<td></td>
</tr>
<tr>
<td>Psychological Affective Effects</td>
<td>• low motivation</td>
<td>• depression</td>
</tr>
<tr>
<td></td>
<td>• irritability</td>
<td></td>
</tr>
<tr>
<td>Psychological Behavioural Effects</td>
<td>• impaired motor skills</td>
<td>• hallucinations</td>
</tr>
<tr>
<td></td>
<td>• slower reaction times</td>
<td>• delusions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• paranoia</td>
</tr>
<tr>
<td>Physiological</td>
<td>Effects tend to be relatively minor, short-lasting and temporary, e.g.</td>
<td>Effects may be more severe but also tend to be short-lasting and temporary. Some of the more significant side effects (depending on the individual and their waking activities) may include:</td>
</tr>
<tr>
<td></td>
<td>• tiredness</td>
<td>• sleepiness</td>
</tr>
<tr>
<td></td>
<td>• lack of energy</td>
<td>• fatigue</td>
</tr>
<tr>
<td></td>
<td>• headaches</td>
<td>• hand tremors</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• drooping eyelids</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• difficulty focusing the eyes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• lack of energy and strength</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• slurred speech</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• increased sensitivity to pain</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Continuous waking period of five consecutive days and nights:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• slower heart and respiratory system</td>
</tr>
</tbody>
</table>

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VCE Psychology Units 3 & 4
ISBN 978 1 4202 3217 2 | Digital teacher: 978 1 4202 3242 4
• body temperature drops
• some biochemical changes including impaired functioning of immune system and impaired production of certain hormones by the endocrine system

4 How quickly and how well do people usually recover from the side effects of
   a partial sleep deprivation?
   quick recovery when the accrued sleep debt is repaid (but entire sleep debt does not have to be repaid)
   b total sleep deprivation?
   effects tend to disappear after uninterrupted sleep (but entire sleep debt does not have to be repaid)

5 What key factor(s) influence(s) recovery from sleep deprivation?
Factors influencing recovery include:
• recovery of some of the lost sleep, preferably through uninterrupted sleep (but no need to fully compensate for all lost sleep)
• resynchronisation/resetting of the biological clock/sleep–wake cycle.

6 What is a microsleep and when is it more likely to occur?
• Description of microsleep should refer to a very short period of drowsiness or sleeping that occurs while the person is apparently awake.
• Occurrence: after three or four sleepless days people automatically drift into periods of microsleep.

Learning Activity 3.10 (p. 160)

1 Sara’s job requires attributes such as focused attention, prolonged concentration, quick reaction time, problem-solving and logical/rational thinking.
Example of relevant research and application:
• Quigley and others (2000) found a decline in ability to perform cognitive tasks (e.g. assessing critical aspects of an emergency).
• Siegal (2000) found slower reaction times on motor tasks (e.g. responding to an emergency), irrational and illogical tendency in thoughts (e.g. think that a swimmer is waving when they’re actually in trouble) and difficulties in making decisions and solving problems that require creative thinking (e.g. poor solutions to everyday problems).

2 Adam’s job involves more automatic processing and rote skills (e.g. the computer decides if the ticket is a winner and assigns payout) but his role also requires customer management skills. Repetitive nature of work may make loss of motivation a factor adversely influencing performance.
Example of relevant research and application:
Koslowsky & Babkoff (1992) found that when deprived of sleep, participants made significantly more errors than when they had not been deprived of sleep on simple, monotonous repetitive tasks such as identifying bleeps and flashing lights on a radar screen. (e.g. Adam may misinterpret a winning ticket amount or forget to scan a ticket).

Note that all three research studies can be applied to both Sara and Adam.

Learning Activity 3.13 (p. 164)

1.

a. Briefly describe the purpose of sleep in terms of restorative theories.
   - Purpose of sleep in terms of restorative theories should refer to sleep providing ‘time out’ to assist/enable recovery from depleting activities during waking time that use up the body’s physical and mental resources.

b. Outline the differing restorative effects of NREM and REM sleep.
   - NREM sleep: restoring and repairing the body, e.g. tissue growth and repair throughout the lifespan.
   - REM sleep: physiological maintenance and restoration of the brain (e.g. revitalisation/preservation of unused neuronal circuits through activation), assistance with consolidation and memory of newly learned information by strengthening neuronal/synaptic connections, brain growth in infancy.

c. Explain the meaning of REM rebound and why it occurs.
   - Explanation of REM rebound should refer to catching up on REM sleep immediately following a period of lost REM sleep by spending more time than usual in REM sleep when next asleep.
   - Why it occurs is unclear: there may be a biological need, possibly for restorative purposes.

d. Outline empirical research in support of restorative theories.
   - NREM restorative findings include:
     - Siegal (2003) and Douglas (2002) found that growth hormone is secreted at a much higher rate when asleep than when awake.
     - Shapiro & others (1981) tested the effects of strenuous physical exercise over a long time period and its effect on sleep. When athletes were allowed to sleep for as long as they needed to, the runners slept significantly deeper and longer in the two nights following the 92 kilometre race.
     - Everson (1993) experimented with rats and found that prolonged sleep deprivation resulted in breakdown of various bodily tissues and death within three weeks.
   - REM restorative findings include:
     - Hockenbury & Hockenbury (2006) reported on the greater amount of REM sleep in the developing fetus and in infancy than during childhood, suggesting that it
may play an important part in the peak period of brain development in the early stages of the lifespan.

- Kavanau (2000) did animal studies with rats and found that memory consolidation of newly learned information may occur during REM sleep through strengthening of neural connections that form during the learning process.
- Karni & others (1994) found improved performance in human participants when REM sleep occurred after learning a particular motor task.
- Walker and others (2002) found that learned motor skills improve significantly when a period of REM sleep follows initial practice.

2

a Briefly describe the purpose of sleep in terms of survival theories.
- Purpose of sleep in terms of survival theories should refer to sleep enhancing survival by protecting an organism through making it inactive during the part of the day when it is most risky or dangerous to move about.

b Outline empirical research in support of survival theories.
- Little empirical research evidence; primarily animal studies of different species.

3 Which theoretical perspective do you believe better explains the purpose of sleep? Give a reason for your answer.

Students’ answers will vary but should maintain that neither theory by itself provides an entirely satisfactory explanation. Lack of empirical evidence for survival theory does not necessarily negate usefulness.