The Golden Tie – Understanding and Supporting Healthy Sleep in FASD

Dr. Ana Hanlon-Dearman
Developmental Pediatrician
Medical Director, Manitoba FASD Centre
Professor Pediatrics and Child Health
University of Manitoba, Canada

University of Manitoba

Manitoba FASD Centre
• Assessment • Education • Training • Research •

SSCY Network
Specialized Services for Children & Youth
Together Is Better

Disclosure

- I have no conflicts of interest to declare

FASD, Sleep and the Whole Body…

“Sleep is…that golden chain that ties health and our bodies together”

(Thomas Dekker, English dramatist, 1572-1632)

Objectives

1. Review insomnia in FASD
2. Relate the biology of sleep disruption in FASD to clinical management
3. Discuss integrative approaches to sleep disruption in FASD

Typical consult

- “Please see this child with FASD and poor sleep. Family is exhausted.”

MANITOBA
FASD CENTRE
• Assessment • Education • Training • Research •

Example

- 3 year old boy with PAE/FASD referred because of frequent night wakenings

- Hx: “restless sleeper since birth”

- SHx: single mother, shift worker (evenings), lives in side by side, neighbours and family provide daycare
- Sees father irregularly on weekend, different schedules at his place

Case

- Sleep: child supposed to go to bed around 10pm when mother comes home from work but often takes 2-3 hours to fall asleep

- Frequently falls asleep on the LR couch in front of the TV “to calm him”; mother later transfers him to his room

- As he falls asleep he often rocks, chews bedclothes
- When he wakens at night he screams +++

- Mother finally allows him to sleep with her saying she’s afraid neighbours will call CFS

- Very aggressive and dysregulated during the day

Growing up….

- Child at 8 years old
  - In school, frequently tired and can’t concentrate
  - Very restless, hyperactive – just started on a stimulant for ADHD
  - Still can’t sleep – rocks himself and chews on his sheets

- Youth now 15 years
  - Tired during the day and has trouble concentrating
  - Up at night, friends, videogames – can’t settle
  - Using marijuana to help him relax and sleep

“Child is not sleeping”

- Sleep is a complex neurodevelopmental and integrative process
  - Memory
  - Cognition
  - Self-regulation

- Range of normal sleep and impairments related to individual biology, genetics, and environment

What is Insomnia?

- DSM-5 and ICSD-3 criteria require:
  - subjective report of a sleep complaint (difficulty initiating or maintaining sleep, or early morning awakening)
  - at least one related daytime impairment (fatigue, attention impairment, mood disturbance, or impaired performance)

- Chronic -- at least 3 times per week over a period of 3 months

Sleep in FASD: Poorly understood

- Sleep difficulties common: 85%
  - In keeping with other children with developmental disabilities (Chen et al. 2012; Robinson-Shelton and Malow 2016)
- Complex:
  - Shorter sleep
  - More frequent night wakenings
  - Elevated parasomnias
  - More frequent sleep anxiety (Wengel et al. 2011; Chen et al. 2012)

Recognizing Fatigue in Children with FASD

- may become more hyperactive
- may become more disorganized
- may become more aggressive
- increased sensory symptoms
- previous behavioural strategies aren't working

MANITOBA FASD CENTRE
• Assessment • Education • Training • Research •

Risk factors for sleeplessness in FASD

- Physical factors – whole body
- Sensory differences
- Behavioral challenges
- Learning difficulties
- Impaired communication

- Parent/family/caregiver behaviors --sleep in family and community context

Contributors to sleep disruption in FASD

(Hanlon-Dearman, Chen, Carmichael-Olsen, 2018)

- Physiologic changes resulting from PAE
  - sleep architecture
  - circadian physiology
  - respiratory control
- Lasting sequelae in health and daytime function
  - affected children
  - chronically sleep disrupted/deprived parents
- Impact on interpersonal relationships restructured by emotional, behavioral, and cognitive perceptions of a “difficult” sleeper

FASD Neurobehaviour & Sleep/Insomnia

- alcohol is a neurobehavioural teratogen
- adaptive dysfunction often severe and out of keeping with cognitive functioning

- PAE damage to global integrative neurological processes
  - reduced inhibitory control
  - impulsivity
  - attention deficits
  - impaired information processing
  - sensory dysregulation
  - problems in regulation of arousal

Sleep dysregulation -- insomnia

MANITOBA FASD CENTRE
• Assessment • Education • Training • Research •

Sleep and Self-Regulation

- Sleep is a self-regulatory process
- Short sleep reduces affective stability and increases emotional reactivity (Anderson 2011, Franzen 2009)
  - Disrupted prefrontal cortical functioning
- Sleep fragmentation associated with higher waking cortisol, increased behavioural reactivity and decreased inhibitory control in toddlers (Scher, 2010)
  - Influence on HPA axis
- Poor sleep has been related to increased impulsivity and aggression (Kamphius, 2014)

Sleep and PAE:
Early neurologic disorganization impacts long term development

Children

- EEG changes in infants with PAE correlated with subsequent motor and cognitive development (Ioffe et al, 1988; Ioffe et al, 1990)

Adults

- "…sleep deprivation, sleep inefficiency, and impaired sleep plasticity may be a continuing, lifelong insult following early EtOH exposure. This link is most pronounced with memory impairment" (Wilson et al, 2016)

MANITOBA
FASD CENTRE
• Assessment • Education • Training • Research •

Does Sleep Matter? (Mindell & Moore, 2018)

- Sleep's impact on next day functioning

- Complex relationship between sleep and development
  - Differential biological reactivity leading to poorer developmental outcomes with poorer sleep, but better outcomes if sleep can be improved

- Are some children less "resilient" to insufficient or disrupted sleep – PAE?

- Best measures of sleep quality may be day-to-day functioning and skill development in family context

MANITOBA
FASD CENTRE
• Assessment • Education • Training • Research •

Supporting sleep impacts everyone

- Social adaptive function (Streissguth et al. 2004)
- Caregiver and family function (Olson et al. 2009*b*)
- Societal costs (Lupton et al. 2004; Riley and McGee 2005; Popova et al. 2012, 2013, 2014*b*, 2015)
- Physical health problems (Popova et al. 2012, 2016)

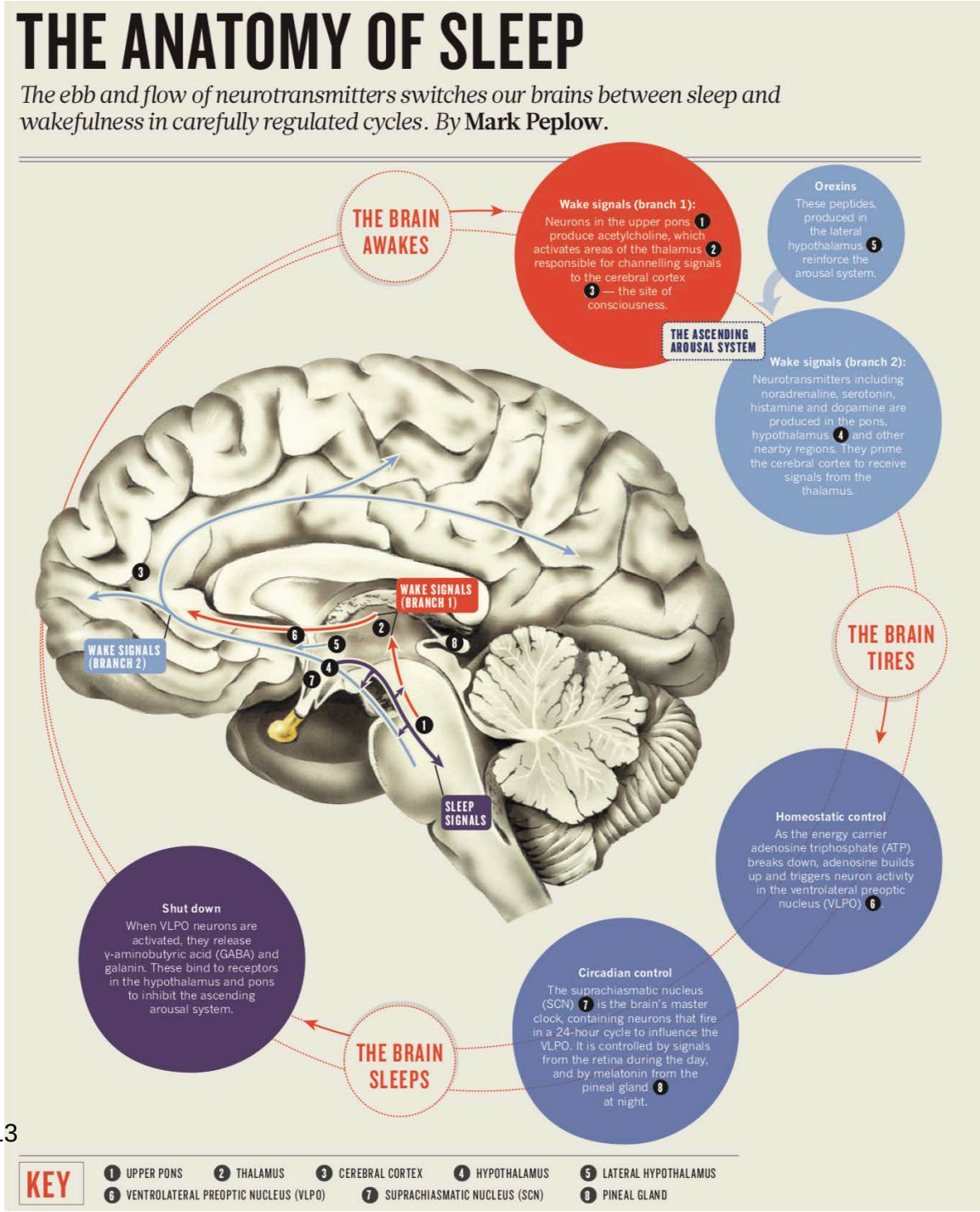
- Opportunities to maximize functioning and reduce morbidity in FASD are critical for affected individuals, their families, and communities

MANITOBA FASD CENTRE
• Assessment • Education • Training • Research •

A Quick Sleep Primer: What Systems are Involved

Sleep is a neurologically mediated system

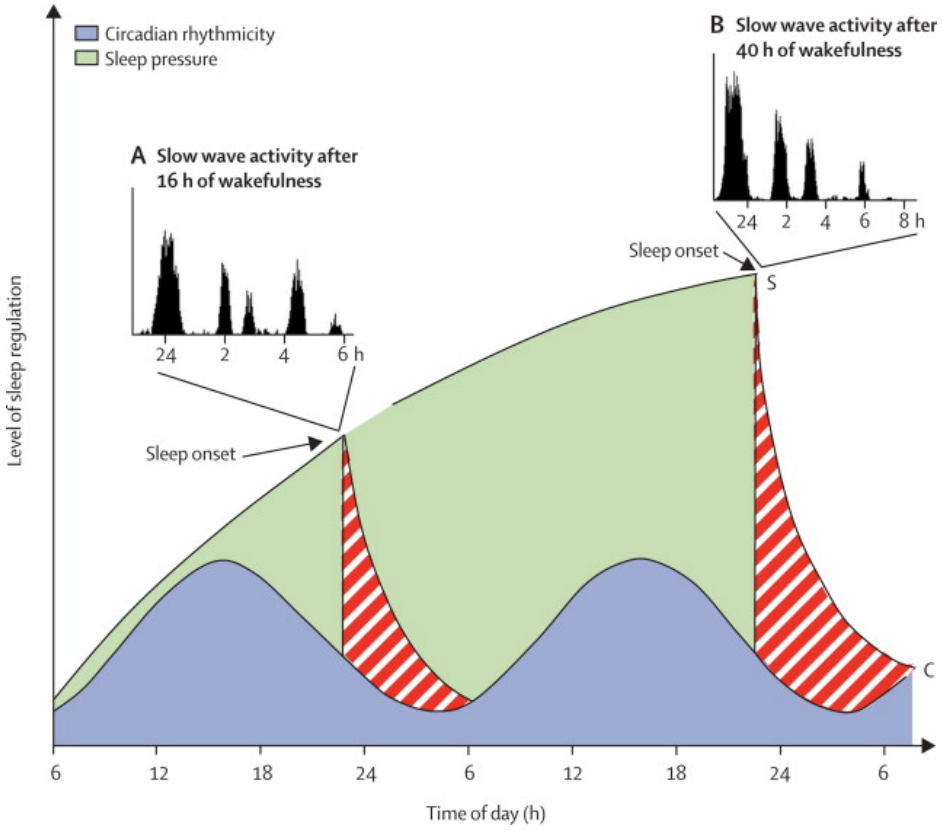
- Neurotransmitter systems
  - Interacting, overlapping across anatomic systems
- Brainstem/cortical systems
  - Pons – thalamus – cortex
  - Variety of brainstem and hypothalamic nuclei – Reticular activating system from which various neurotransmitters project to the cortex
- Cognitive Affective Systems
  - Overactivation of arousal system/emotion regulating system/parts of cognitive system is accompanied by reduced activation of prefrontal cortex and caudate



S2|NATURE|VOL497|23MAY2013

A Quick Sleep Primer: What Systems are Involved

- Sleep Wake Regulating:
  - Homeostatic Drive
  - Circadian Timing
  - Influences of melatonin and adenosine

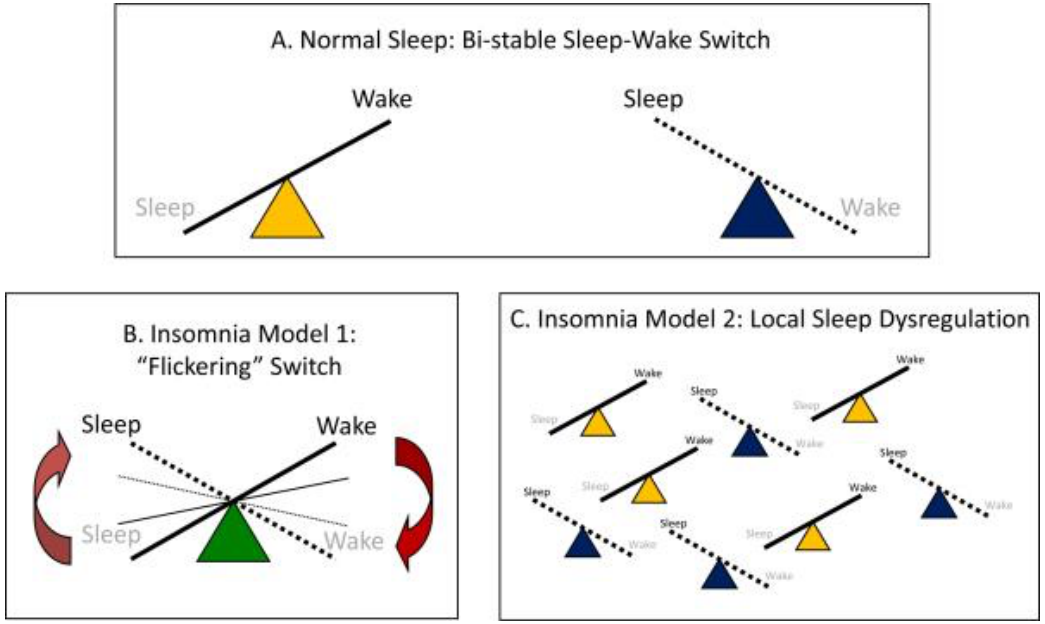


Two Process Model of Sleep Regulation
Riemann, Lancet 2015

MANITOBA FASD CENTRE
• Assessment • Education • Training • Research •

A Quick Sleep Primer: What Systems are Involved

- Sleep Wake Switching
  - “sleep switch”
  - “wake stabilizing”



(Luthi et al, 2016) https://doi.org/10.1016/j.cub.2016.06.059

Final common pathway of insomnia

- Hyperarousal
  - Overactivity of the arousal systems, hypoactivity of the sleep-inducing systems, or both
  - Imbalance of sleep-wake regulation

- All systems interact and overlap (Lancet, 2015)

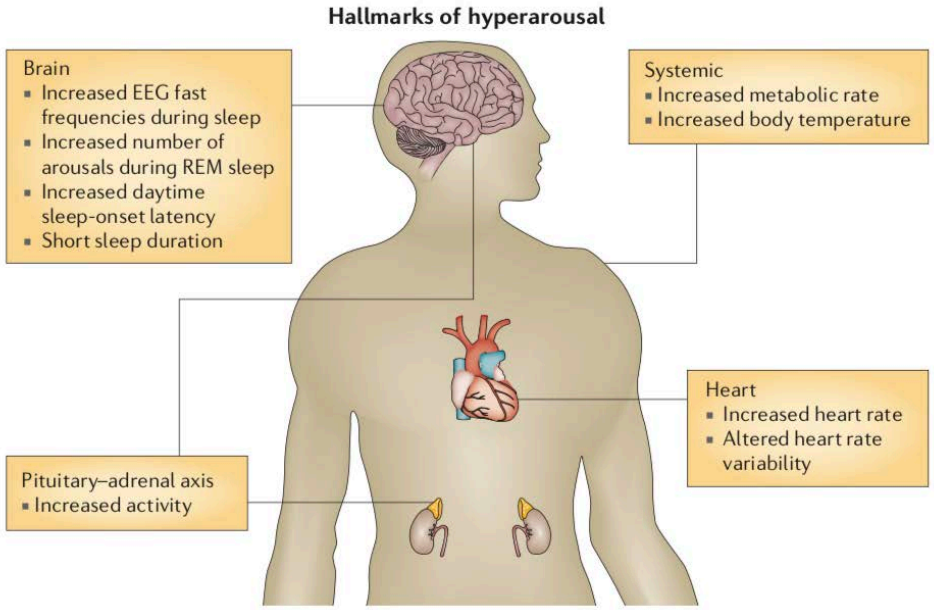


Figure 2 | **Indicators of hyperarousal in insomnia.** Hyperarousal can involve multiple bodily systems and functions, including electrophysiological factors, the autonomic nervous system and endocrine variables. EEG, electroencephalography; REM, rapid eye movement.

(Morin et al, Nature Reviews, 2015)

MANITOBA FASD CENTRE
• Assessment • Education • Training • Research •

Sensory processing

- Sensory systems
  - retinotopic -- visual
  - somatotopic – motor
  - tonotopic – sound
  - odotopic - smell
  - gustatopic – taste

- Development is dependent on early experience/exposures

- In term infants, cortical regions, thalamus, basal ganglia, and brainstem are more often affected by adverse events

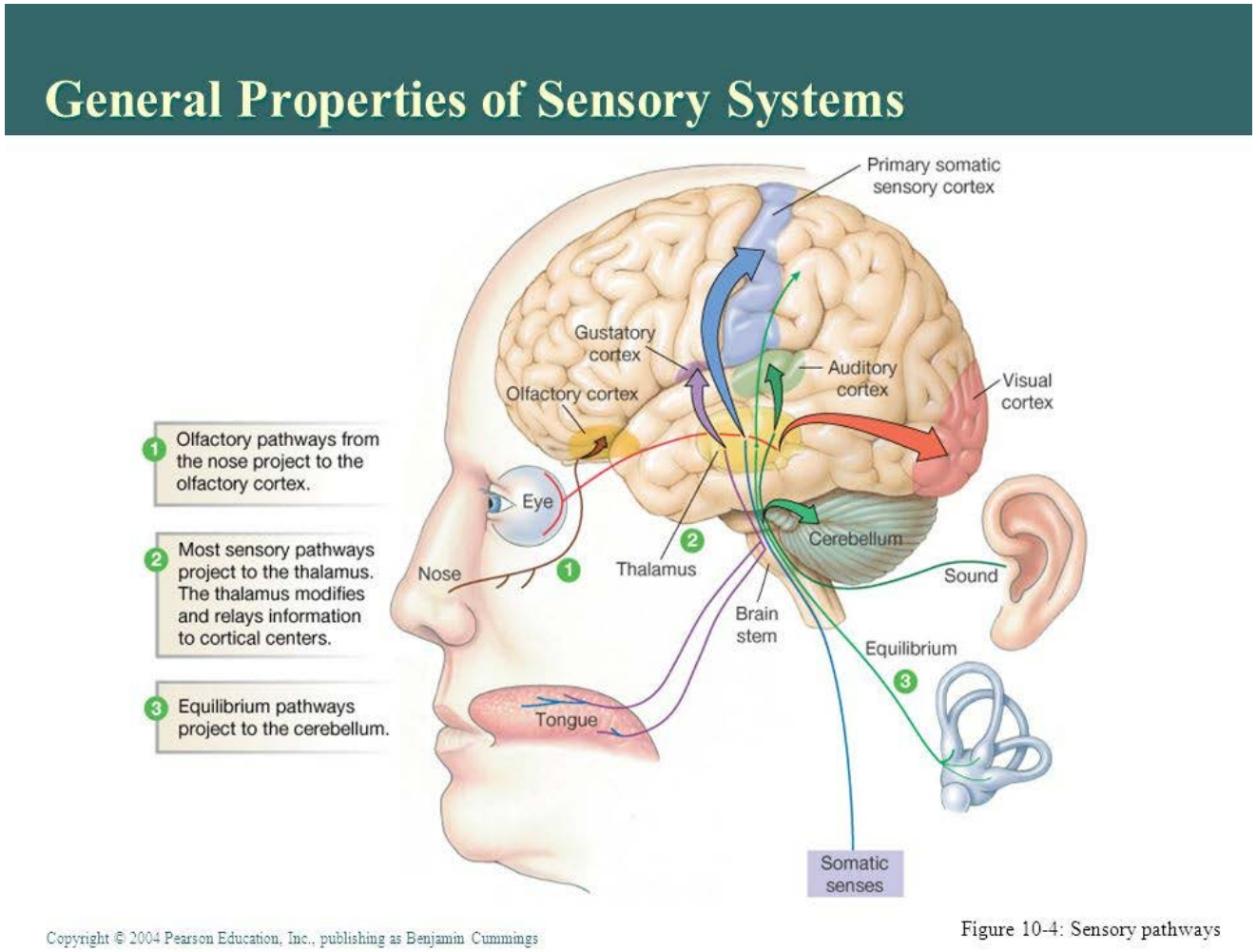
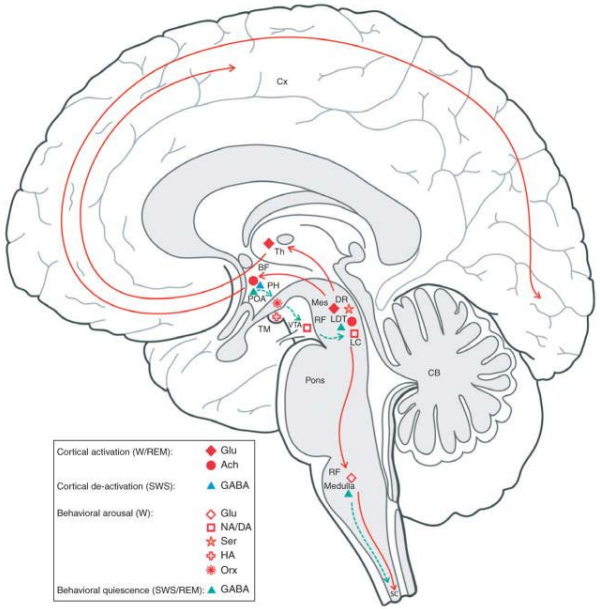


Figure 10-4: Sensory pathways

MANITOBA FASD CENTRE
• Assessment • Education • Training • Research •

Sensory Processing and Sleep



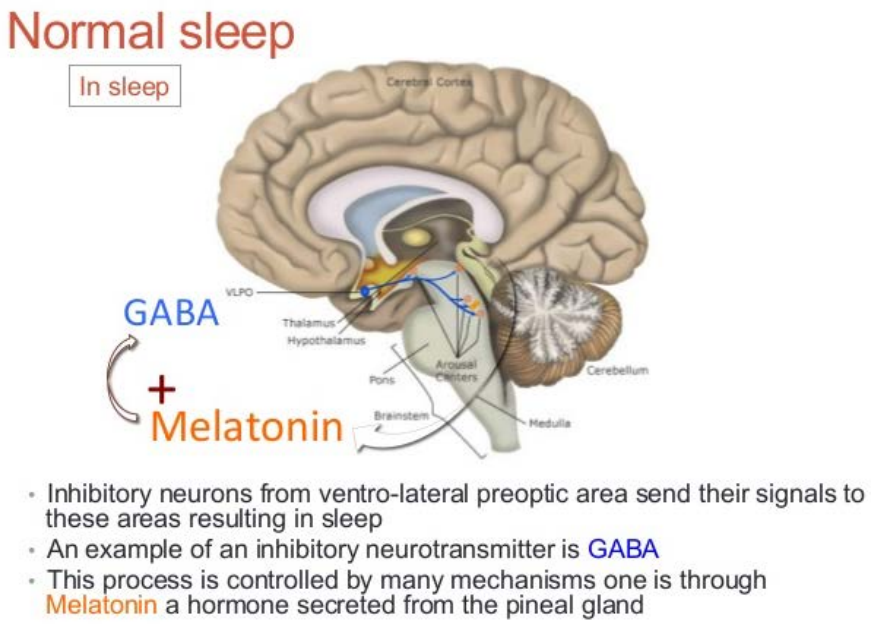
Jones, 2018

- sensory processing is a critical part of sleep induction and maintenance
  - downregulation of the reticular formation (area that regulates alertness) in order to fall asleep
  - filtering of irrelevant sensory information in sleep balanced with maintenance of ability to react to important stimuli (modulation)
  - overlap of CNS centres regulating sleep, attention, and sensory processing

MANITOBA FASD CENTRE
• Assessment • Education • Training • Research •

FASD & Sensory Physiology

- Sensory processing disorders involve primary and higher order cortical regions
  - posterior decrease in white matter microstructural integrity (Owen, 2013)
- Alcohol impacts spatial organization, synchronous functioning, and acuity of these systems (Sadrian, 2013)
- PAE -- atypical sensory responses
  - GABA enhancement (Wu, 2014)
  - disruption of sensory filtering/gating (Skylar, 2014)



Aluwairii, 2014

MANITOBA FASD CENTRE
• Assessment • Education • Training • Research •

Sleep anxiety and sensory processing

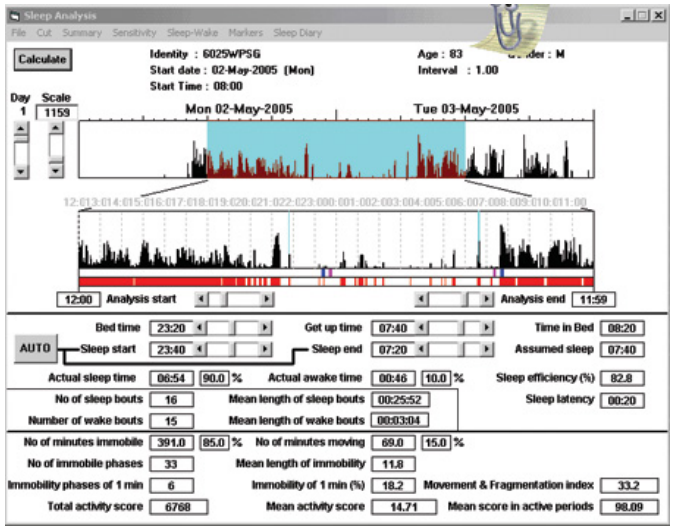
- Alterations in sensory processing associated with increased sleep anxiety and associated arousal sensitivity (Wengel, 2011)

- Biology of anxiety, FASD, and altered stress responsivity (Biggio et al, 2018; Kozanian et al, 2018; Rouzer et al, 2018)
  - impacts of adversity, trauma, poor EF, genetic factors
  - neurobiology of stress/toxic stress – HPA axis, heightened autonomic responsivity, GABA/neurotransmitter modulation

- Increased arousal and increased multisensory sensitivity – may correlate with sleep related anxiety

Understanding Sleep Difficulties in Young Children with PAE/FASD (Wengel et al, 2011)

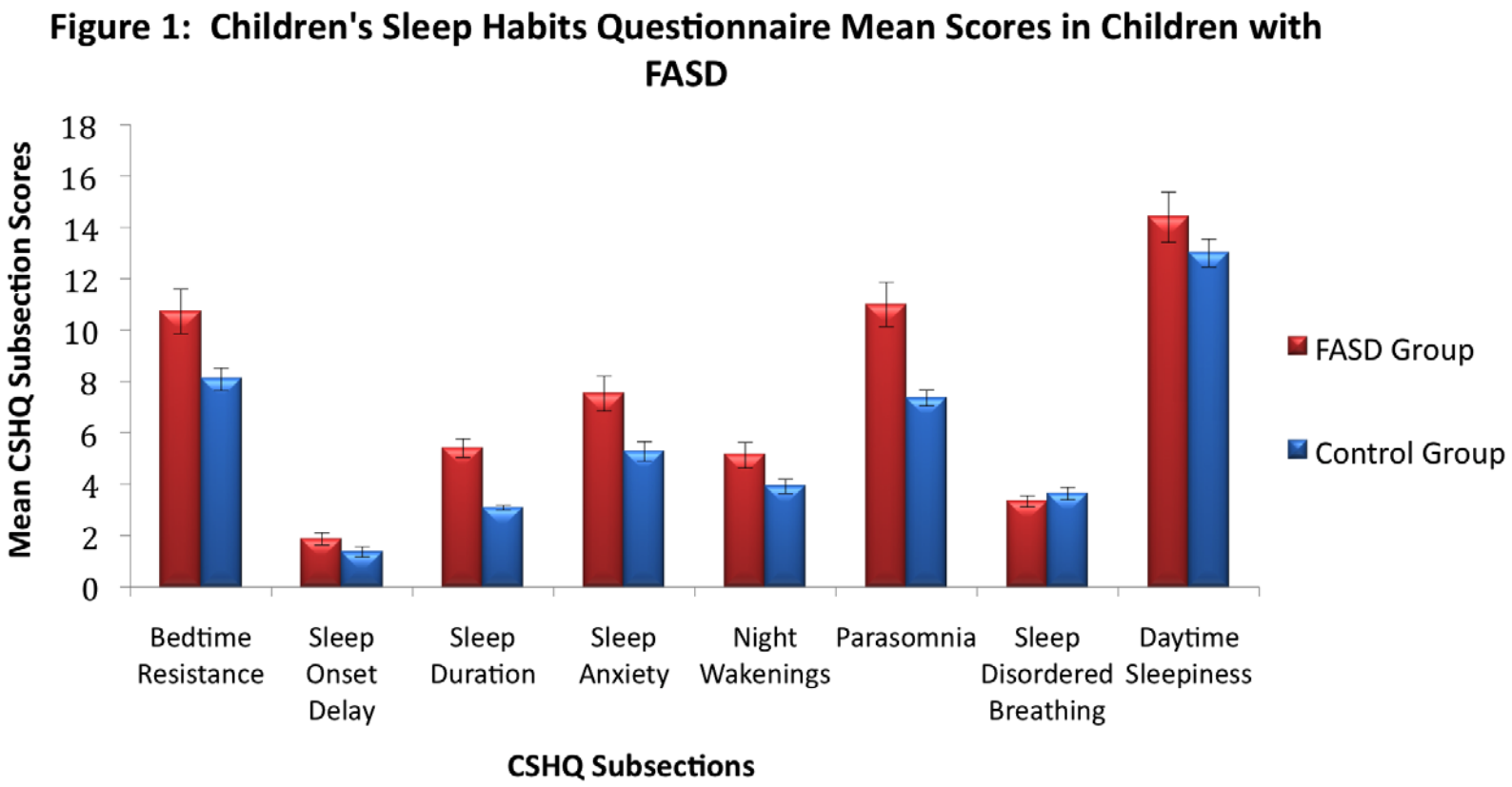
- N=31 (19 FASD, 12 controls)
- Methods:
  - Children's Sleep Habits Questionnaire (CSHQ)
  - Sleep log
  - Sensory Profile
  - Actigraphy



(Source: http://www.minimitter.com/Products/Actiwatch/index.htm)

MANITOBA FASD CENTRE
• Assessment • Education • Training • Research •

Disrupted Sleep in Young Children with FASD



MANITOBA FASD CENTRE
• Assessment • Education • Training • Research •

Wengel, Fjelsted, Hanlon-Dearman, 2011

Significant Correlations Between CSHQ and Sensory Profile

Bedtime Resistance	Fine Motor Perception (r = .573)
Sleep Onset Delay	Behavioural Outcomes of SP (r = .621)
Sleep Duration	Sensory Sensitivity (r = .639)
Night Wakening	SP Affecting Endurance/ Tone (r = .581) Behavioural Outcomes of SP (r = .736) Low Endurance/Tone (r=.581)
Parasomnia	Registration (r = .543) Mod of Visual/Emotional Input (r = .662) Emotional/Social Response to SP (r=.610) Behavioural Outcomes of SP (r = .522)
CSHQ Total	Behavioural Outcomes of SP (r= .613) Sedentary (r = -.543)

Sleep Architecture in FASD

(Chen et al, 2012)

- N=33
- FASD + elevated scores on CSHQ -- offered PSG

- Results:
  - 85% of children with FASD scored above clinical cutoff for sleep disorders on CSHQ, esp. pediatric insomnia
  - PSG (n=5) showed mild sleep disordered breathing and fragmented sleep with elevated non-respiratory arousal indices.

MANITOBA FASD CENTRE

• Assessment • Education • Training • Research •

Sleep and Circadian Rhythm (Goril et al, 2016)

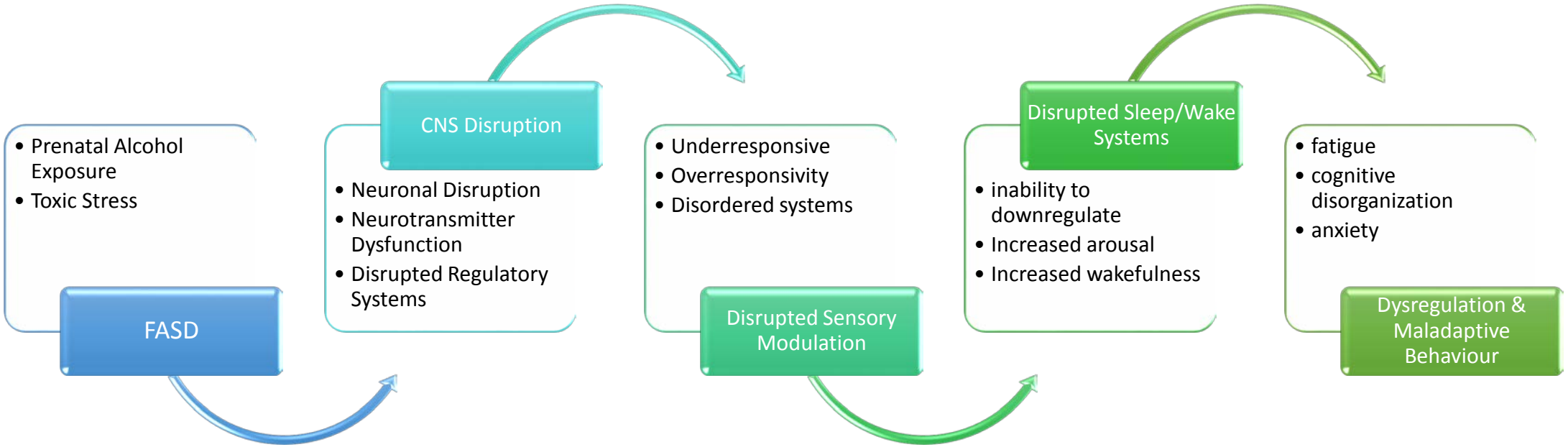
- PSG & DLMO in school age children with FASD (N=36, ages 6-18 years)

- High prevalence of sleep disorders (58%)
  - Parasomnia (27.9%)
  - Insomnia (16.8%)
  - Sleep apnea (5.6%)

- PSG: high rates of sleep fragmentation (19.5%), lower sleep efficiency

- 79% abnormal melatonin profile

Model of PAE, Sensory Dysregulation, Sleep Disorder and Behaviour



MANITOBA FASD CENTRE
• Assessment • Education • Training • Research •

Treating Sleep in FASD

MANITOBA
FASD CENTRE
• Assessment • Education • Training • Research •

Managing complex symptoms

- Goal is to reduce burden of care
- May need to address multiple areas at once

- Special care:
  - Child with history of trauma
  - Child in and out of hospital
  - Child newly adopted

MANITOBA
FASD CENTRE
• Assessment • Education • Training • Research •

General Considerations

- Team approach – child, family, therapists, physicians, other caregivers
- Treat early to avoid secondary behavioural/family consequences
- Comprehensive developmental evaluation to identify strengths, weakness and overall profile
- Manage complex symptoms
  - Mental health & behaviour
- Environmental evaluation
- Sleep hygiene needs to be individualized
- Melatonin; other medications

Sleep Health (adapted from Jan, 2010)

MANITOBA FASD CENTRE
• Assessment • Education • Training • Research •

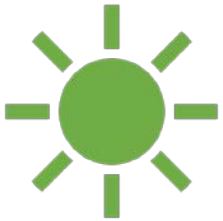
“Biological clock” – 24 hour clock

generated by suprachiasmatic nucleus (SCN) in the hypothalamus

contribution of light receptors found in the retina which have a pathway (the retinohypothalamic tract) leading to the SCN

melatonin – linked to memory and learning

Linked with brain wave activity, hormone production, body temperature, cell regeneration and other biological activities



Regulation of day and night dependent on

internal rhythm

external regulators eg. light, temperature

Circadian Considerations

Circadian Approaches

- "A good night's sleep begins first thing in the morning" (M. Kurchinka)
  - integrated regulation of day and night hours incl. both light and time
  - eg. bed time, wake time, ambient light in morning and at night, regularity of rhythm

- Integration with behavioural and sensory approaches
  - methods for waking in the morning
  - what to serve for breakfast
  - regularly scheduled movement breaks and "heavy work"
  - calming snacks and deep pressure input as tolerated at bedtime

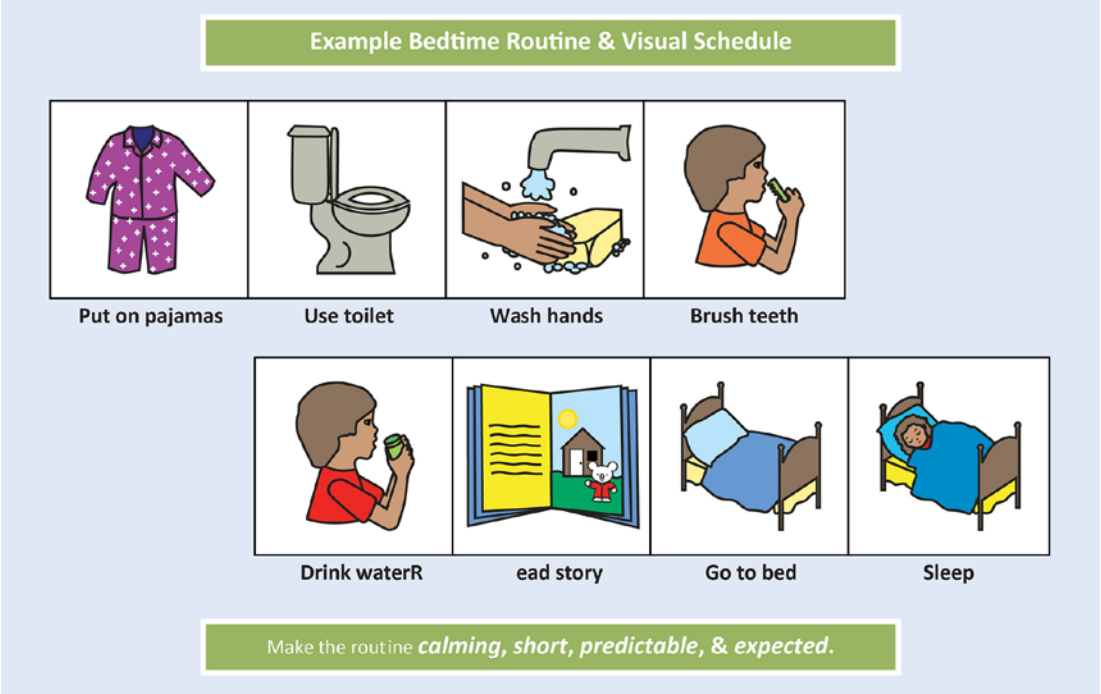
Sleep Hygiene

- Principles based in science and behaviour

- Individualize principles based on needs of child and family depending on:
  - cognitive abilities
  - health issues
  - temperament and behavioural considerations
  - sensory considerations
  - environmental considerations
  - family needs

Sleep Hygiene

- Establish a bedtime routine
- Avoid big meals close to bedtime
- Avoid caffeine
- Comfortably cool bedroom
- Dark bedroom
- Quiet bedroom
- No TV/media in bedroom

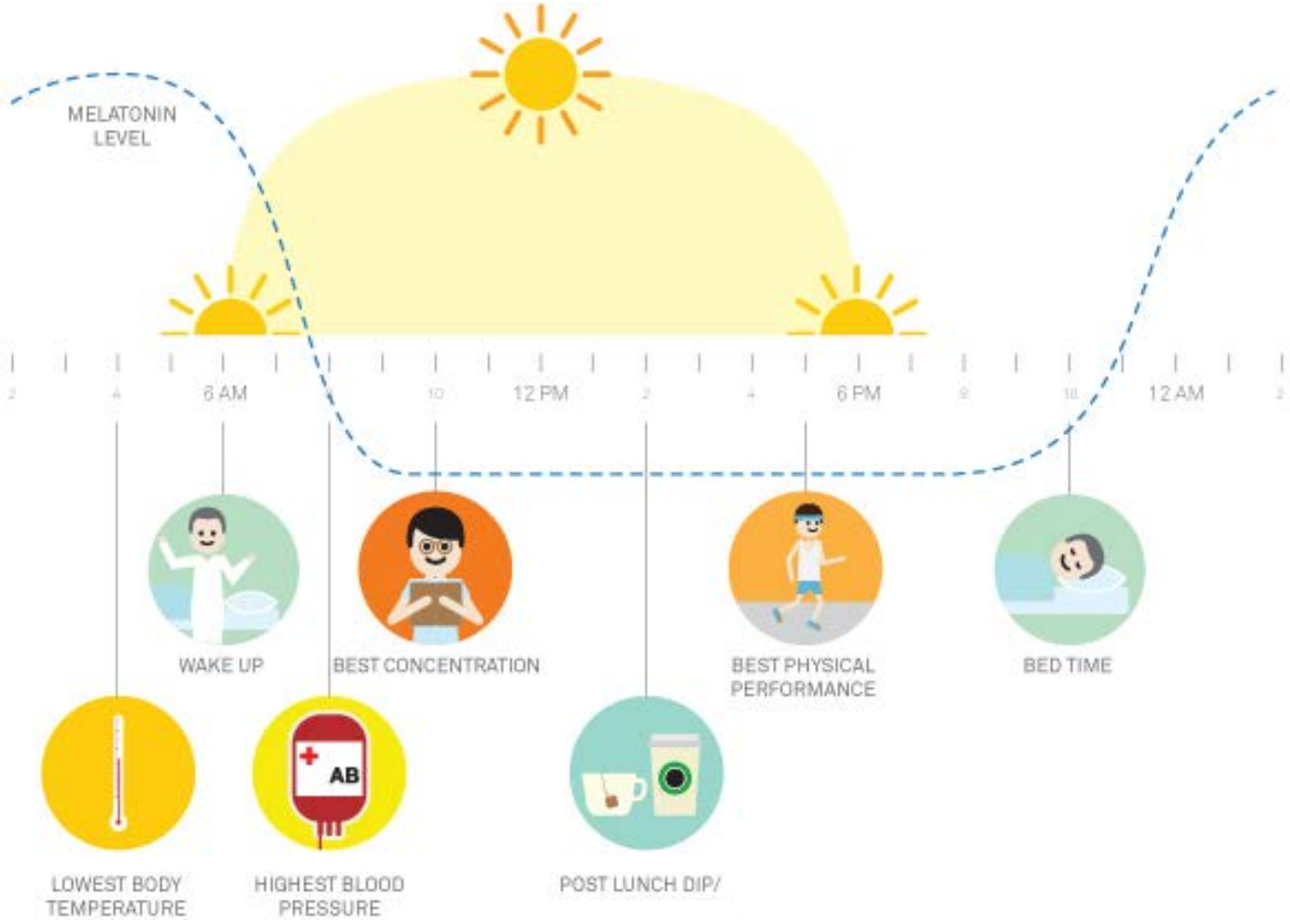


Visual supports from the Autism Speaks ATN/AIR-P Sleep Tool Kit.

MANITOBA FASD CENTRE
• Assessment • Education • Training • Research •

Sleep Hygiene

- Exercise in morning or late afternoon
- Ensure adequate exposure to natural light
- Maintain emotionally stable and positive tone
- Associate bed and bedroom with sleep
- Use of a transition object
- Review medications with physician prn

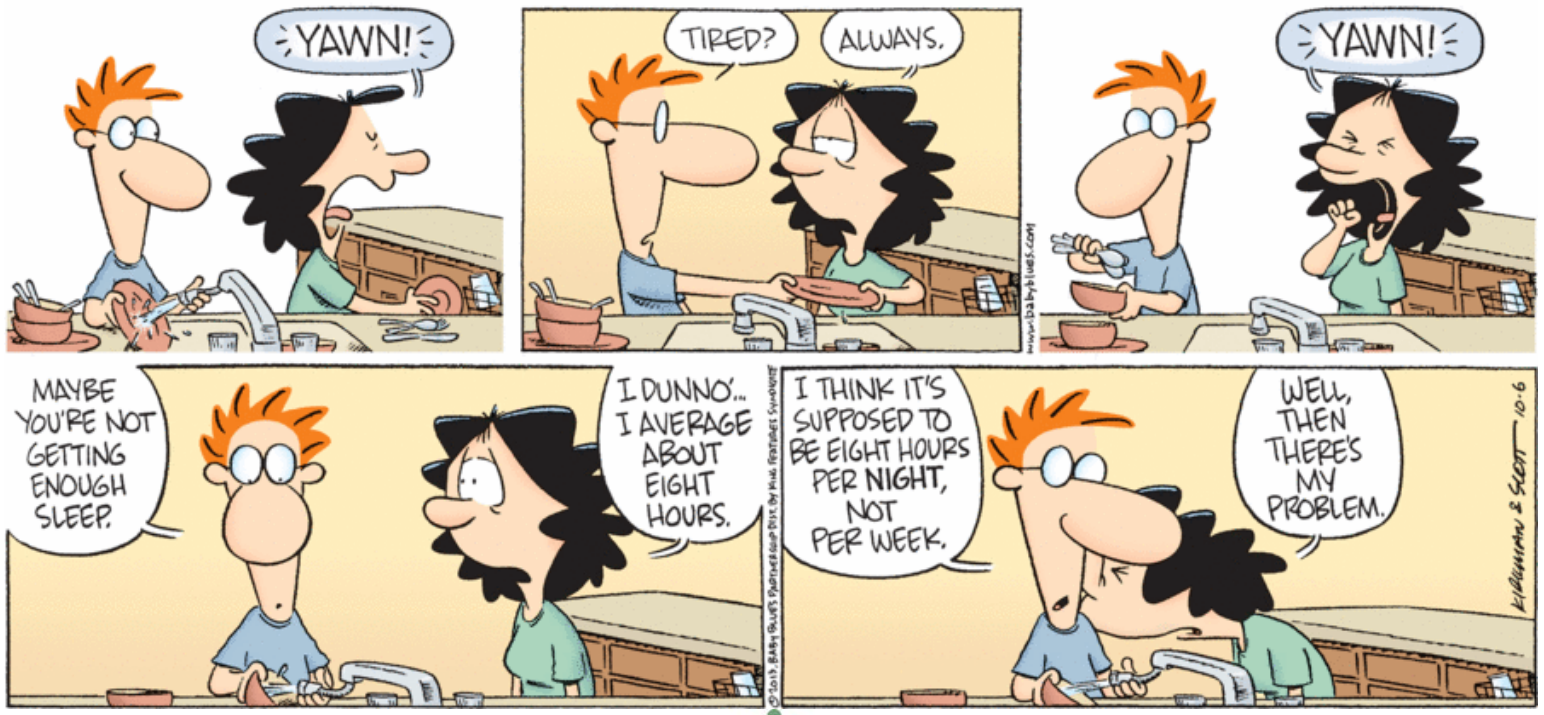


The circadian clock. Illustration by [fuzzyscience]
https://www.pbs.org/newshour/science/science-sleeping-in

MANITOBA FASD CENTRE
• Assessment • Education • Training • Research •

Sleep Support for Parents/Caregivers

- important to address sleep needs of parents



MANITOBA FASD CENTRE
• Assessment • Education • Training • Research •

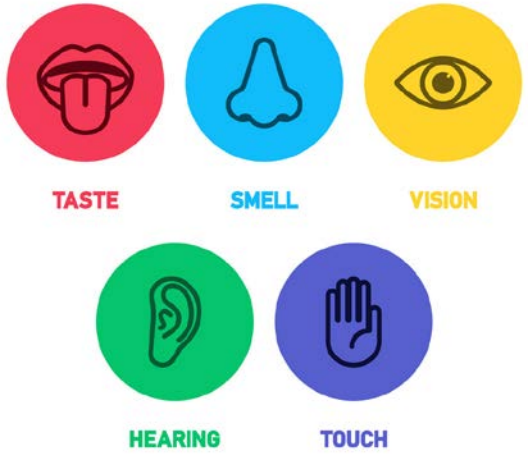
http://babyblues.com/comics/october-6-2013/

Sleep Support for Parents/Caregivers

- important to address emotional and physical needs of parents
- parent sleep patterns are linked to children's patterns – may be in sync or not in sync
- parental TV/screen time should be addressed
- what are parents using to cope – functional, dysfunctional patterns

http://babyblues.com/comics/august-17-2013/

Sensory Strategies -- Environment



- Visual
  - calm and uncluttered bedroom
  - dark and quiet bedroom
  - “nesting” – eg. small tent
- Auditory
  - white noise
  - quiet
- Tactile
  - pajama fabric, tags
  - sheet fabric, pillows
- Proprioceptive
  - deep pressure/massage
  - sleeping bag
  - surrounded by stuffies
- Vestibular
  - slow rhythmic linear rocking
- Olfactory
  - laundry soap
  - toothpaste
  - bath soap, shampoos
  - ambient air

MANITOBA FASD CENTRE
• Assessment • Education • Training • Research •

First Line Approach to Insomnia (adults)

- Cognitive Behavioural Therapy….
  - Available…
  - Appropriate…

- Eg. in hyperarousal syndromes (eg PTSD), combination of pharmacotherapy and CBT may be required (Akinnusi et al 2019)

Box 4 | **Cognitive–behavioural therapies for persistent insomnia**

Sleep restriction (level 1a*)
A method designed to restrict time spent in bed (the sleep window) as close as possible to the actual sleep time, thereby strengthening the homeostatic sleep drive. This sleep window is then gradually increased over a period of a few days or weeks until optimal sleep duration is achieved.

Stimulus control (level 1a)
A set of instructions designed to reinforce the association between the bed and bedroom with sleep and to re-establish a consistent sleep–wake schedule:

- Go to bed only when sleepy
- Get out of bed when unable to sleep
- Use the bed or bedroom for sleep only (no reading or watching television, and so on)
- Arise at the same time every morning
- No napping

Relaxation training (level 1b)
Clinical procedures, for example progressive muscle relaxation, aimed at reducing autonomic arousal, muscle tension and intrusive thoughts that interfere with sleep. Most relaxation procedures require some professional guidance initially and daily practice over a period of a few weeks.

Cognitive therapy (level 2b when used alone)
A psychological approach using Socratic questioning and behavioural experiments to reduce excessive worrying about sleep and reframe unhelpful beliefs about insomnia and its daytime consequences. This therapy usually requires a trained and skilled clinician. Additional cognitive strategies might involve a paradoxical intention technique to alleviate performance anxiety that is associated with the attempt to fall asleep.

Mindfulness-based interventions (level 3b)
The core principle of mindfulness-based interventions is non-judgemental awareness in the present moment. It is derived from meditation, and its most common variant is mindfulness-based stress reduction.

Sleep hygiene education (insufficient evidence)
General guidelines about health practices, including diet, exercise and substance use, and environmental factors, such as light, noise and excessive temperature, that might promote or interfere with sleep. This might also include some basic information about normal sleep and changes in sleep patterns with ageing.

Cognitive–behavioural therapy (level 1b‡)
A multimodal intervention that combines some of the above cognitive and behavioural procedures, such as stimulus control, sleep restriction and relaxation training. Multicomponent behavioural therapy would include more than one behavioural procedure but without a cognitive component.

*Indicates level of evidence (University of Oxford Centre for Evidence-Based Medicine).
‡For cognitive–behavioural therapy with or without relaxation; level 1a for multicomponent behavioural therapy without cognitive therapy. Adapted with permission from REF. 199, Elsevier.

Morin et al, Nature, 2015

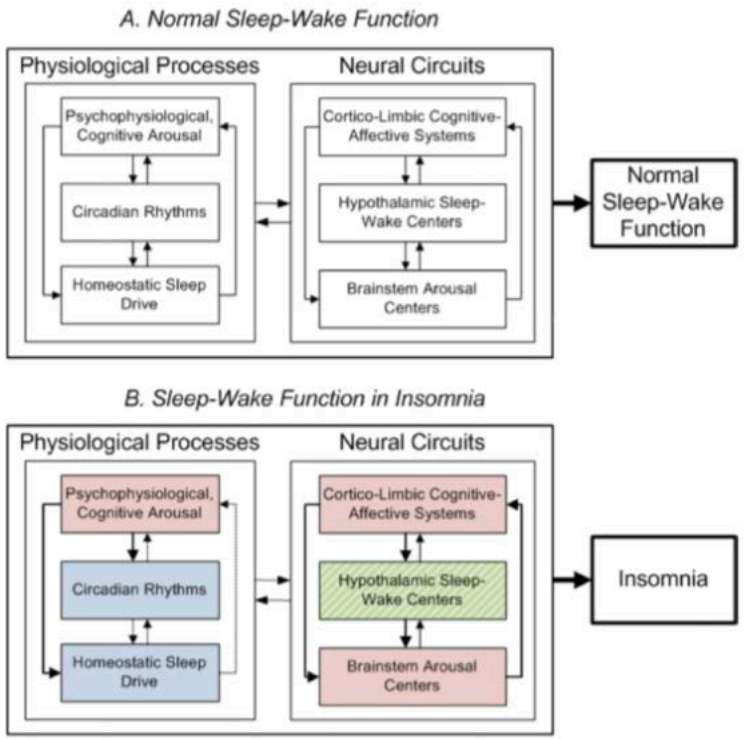
A Clinical/Physiologic Approach to Choosing Medication

- Always in conjunction with sleep hygiene and environmental modification

- Targeted concern approach
  - Difficulty falling asleep
  - Difficulty staying asleep

- Targeted symptom approach
  - Circadian
  - Overactivity, impulsiveness, inattentiveness
  - Anxiety/Mood stabilization
  - Behavioural stabilization
  - RLS

- Targeted mechanism approach?
  - Hyperarousal

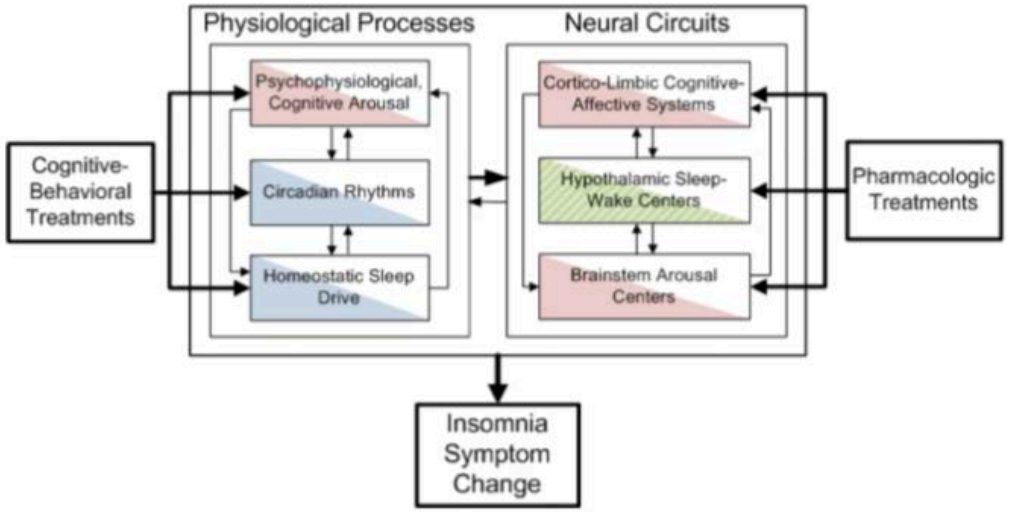


Pink == arousal
Blue == circadian/homeostatic
Green == sleep/wake “switch”

Buyess et al, 2011

MANITOBA FASD CENTRE
• Assessment • Education • Training • Research •

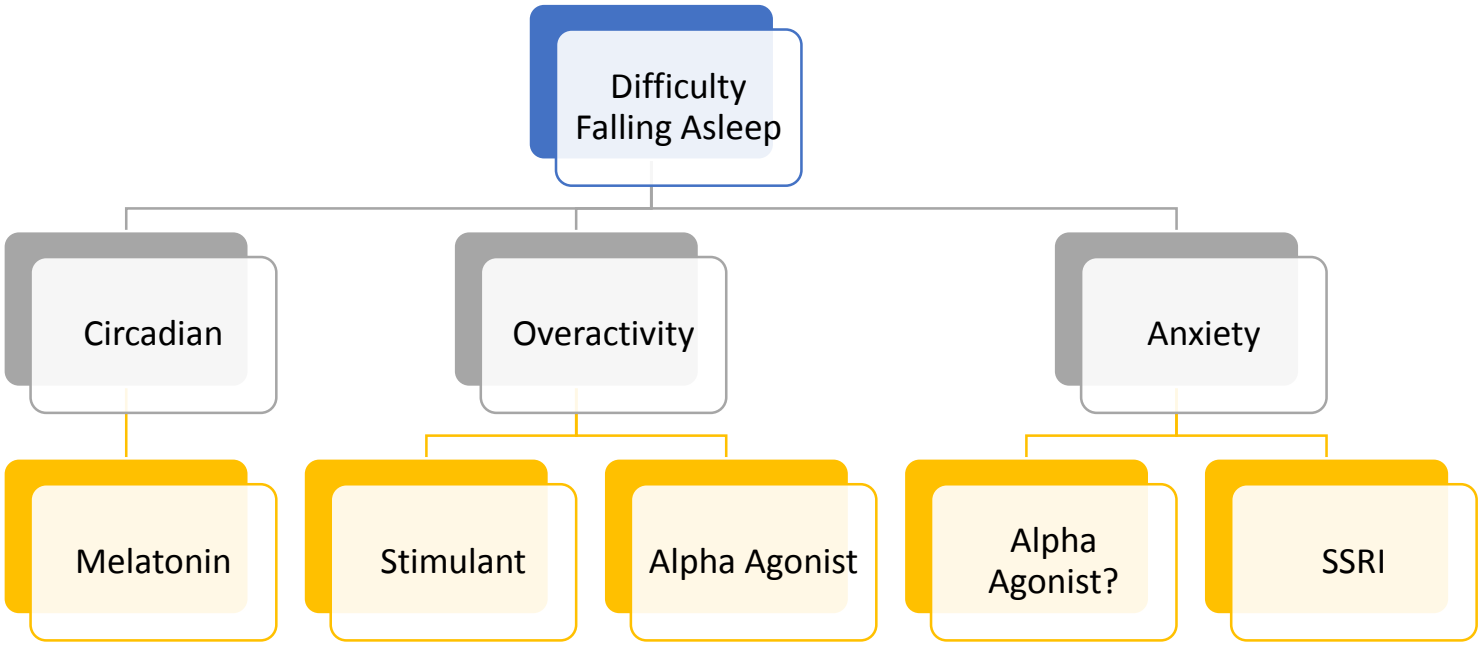
Treatment Approaches and the Biology of Sleep (Buyess et al, 2011)



- Cognitive-behavioral treatments for insomnia may specifically target dysregulated physiologic processes
- Pharmacologic treatment may directly affect neural centers including cognitive-affective circuits and hypothalamic-brainstem arousal centers.

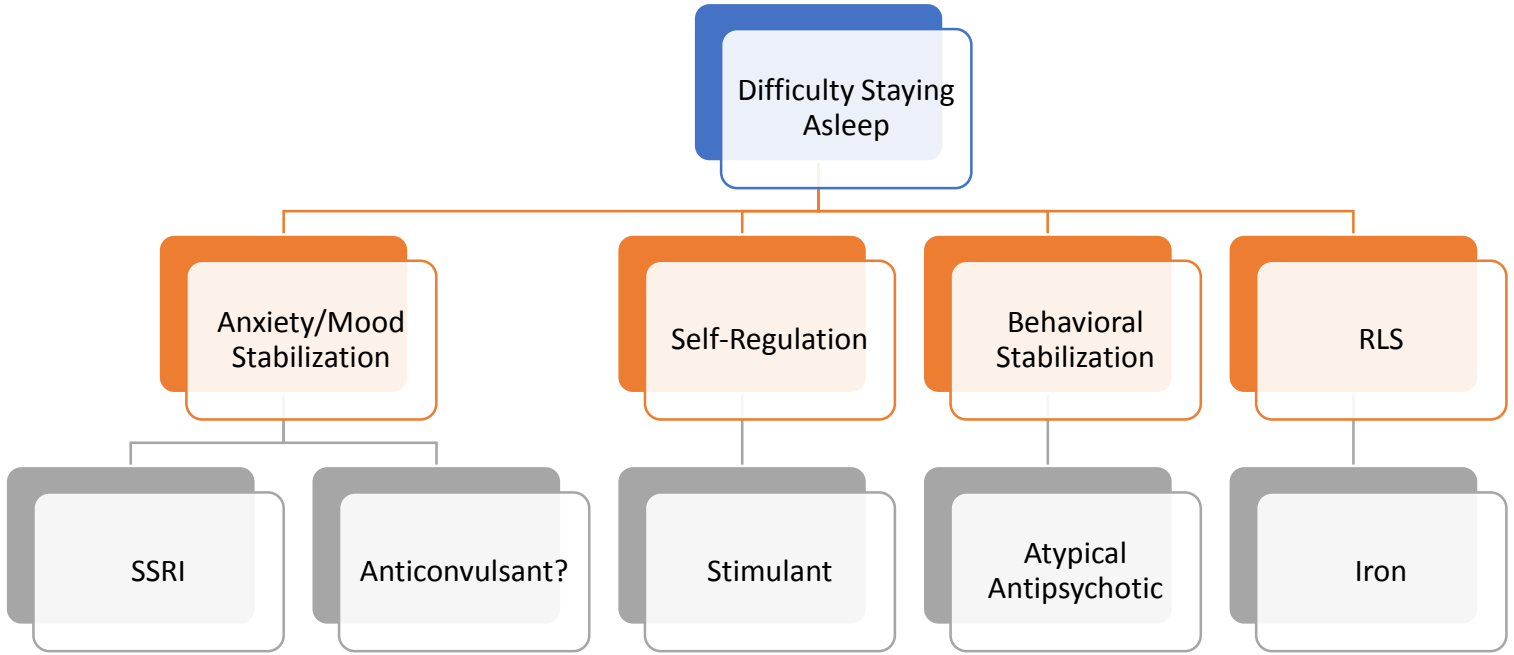
MANITOBA FASD CENTRE
• Assessment • Education • Training • Research •

Medication Approach



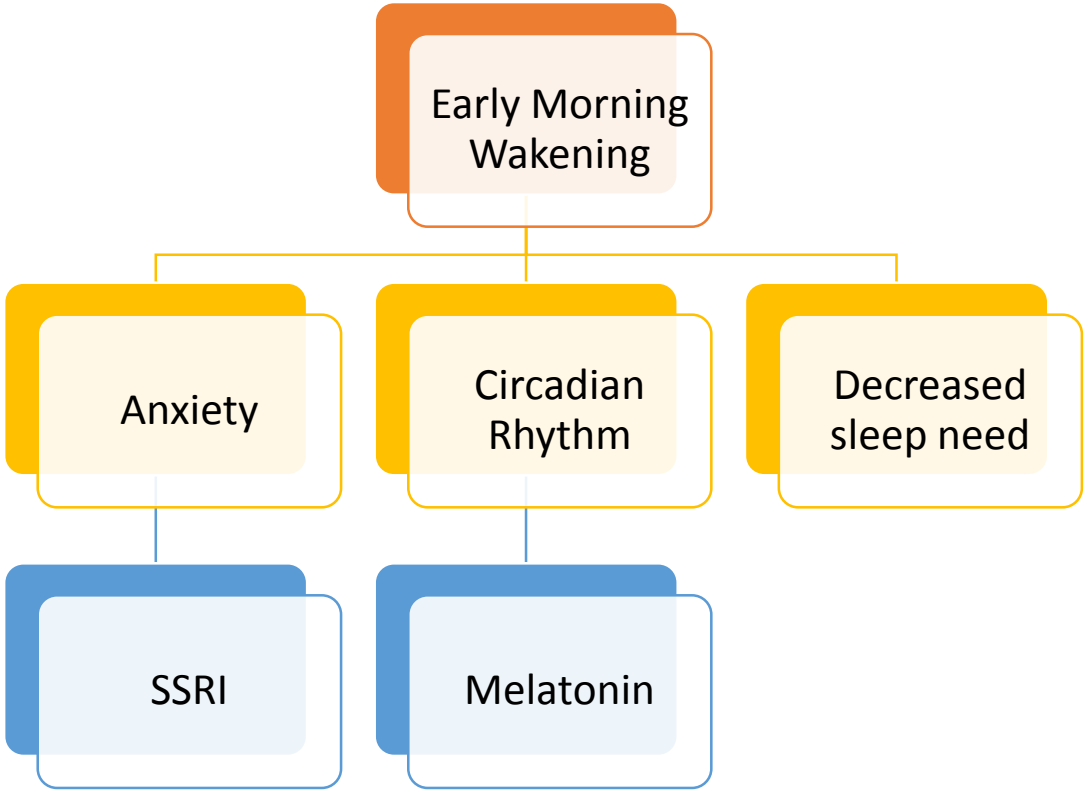
MANITOBA FASD CENTRE
• Assessment • Education • Training • Research •

Medication Approach



MANITOBA FASD CENTRE
• Assessment • Education • Training • Research •

Medication Approach



MANITOBA FASD CENTRE
• Assessment • Education • Training • Research •

Treatment Recommendations

(Hanlon-Dearman, Chen, Carmichael-Olson, 2018)

1. Access early FASD assessment and diagnosis
2. Advocate for healthy families
3. Apply principles of sleep hygiene in a comprehensive sleep management plan
4. Use melatonin or other medications appropriately with input of an experienced clinician
5. Consider sensory needs of the individual with FASD

MANITOBA
FASD CENTRE
• Assessment • Education • Training • Research •

Treatment Recommendations

(Hanlon-Dearman, Chen, Carmichael-Olson, 2018)

6. Screen for mood disorders/disorders of arousal
7. Screen for attachment difficulties
8. Advocate for healthy and safe environments
9. Advocate for appropriate caregiver support

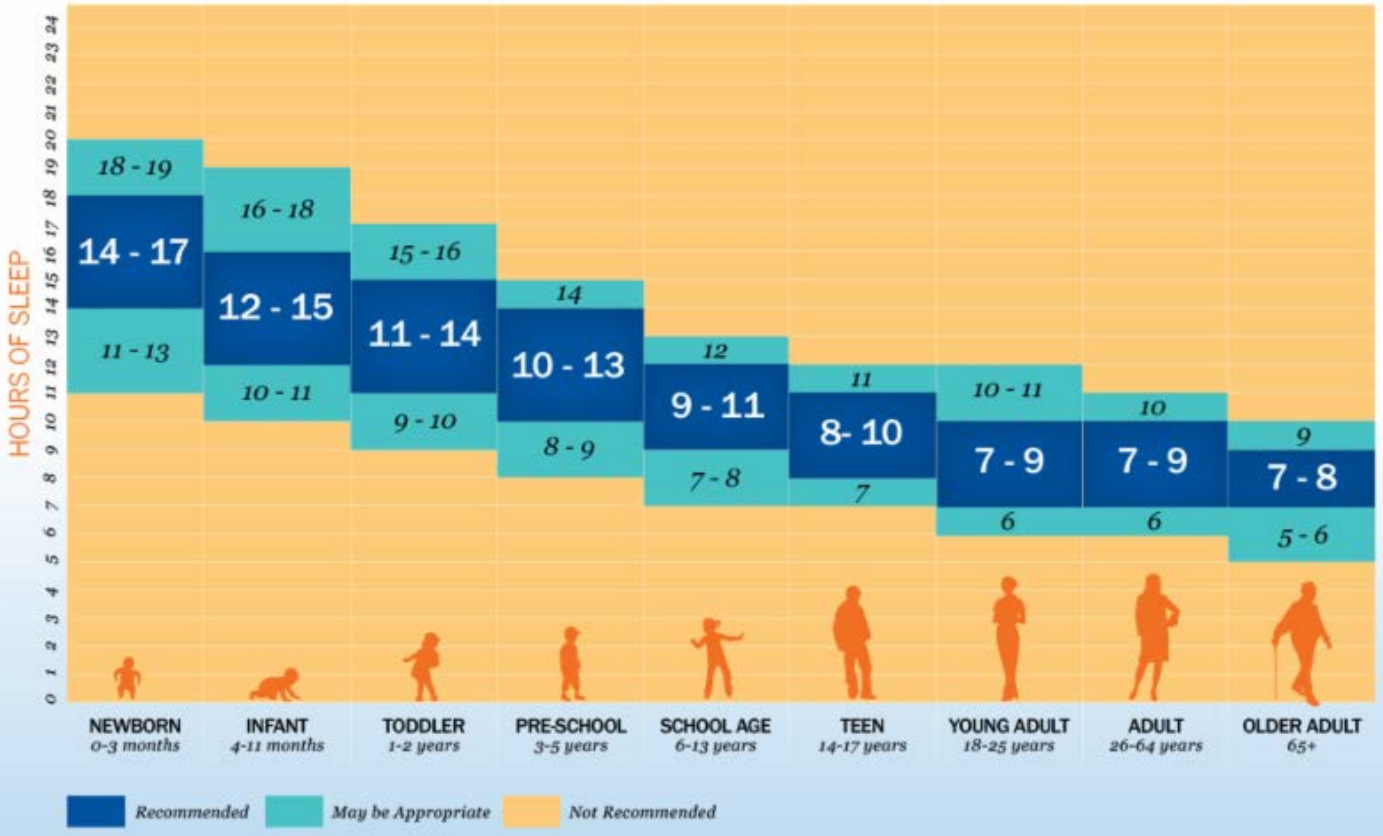
Final thoughts

- Sleep is a integrative process and enhances daily functioning and health
- Sleep disruption is multifactorial and may contribute to many of the challenging behaviours and anxiety seen in FASD
- Awareness and clinical recognition of sleep disorders in individuals with FASD is critical to accessing appropriate treatment
- Sleep health and management when needed should be a priority at all ages

Thank you

NATIONAL SLEEP FOUNDATION

SLEEP DURATION RECOMMENDATIONS



SLEEPFOUNDATION.ORG | SLEEP.ORG

Hirshkowitz M, The National Sleep Foundation's sleep time duration recommendations: methodology and results summary, Sleep Health (2015), http://dx.doi.org/10.1016/j.sleh.2014.12.010

Environmental Biology Relevant to FASD and Sleep

- Stress in prenatal environment influences physiologic organization
  - increased risk of sleep disruption
- Prenatal stress and malnutrition impact circadian rhythm with resulting poor sleep quality
- Maternal prenatal mood disorder may predict poor sleep in toddlers

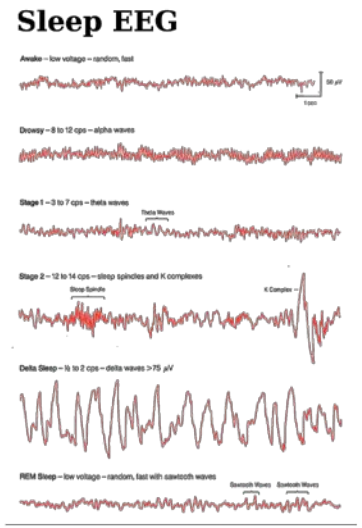
Other Environmental Influences Relevant to FASD and Sleep

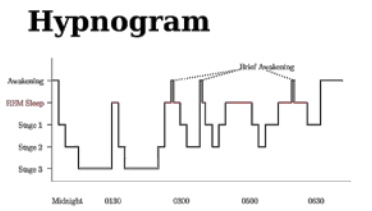
- Increased suseptibility to sleep disruption in high risk populations ie. foster care (Tininenko, 2010)
  - overrepresentation of FASD (Astley, 2002)

- FASD may be complicated by disrupted attachment and family/social disruption

- Resultant disordered sleep hygiene and parental frustration

Sleep and PAE:
Early neurologic disorganization





Sleep Cycles and Age

	Age 20	Age 40	Age 60	Age 70	Age 80
Time to fall asleep	14 minutes	17 minutes	18 minutes	18.5 minutes	19 minutes
Total sleep time	7.5 hours	7 hours	6.2 hours	6 hours	5.8 hours
Time in regular sleep	47%	51%	53%	55%	57%
Time in slow wave sleep	20%	15%	10%	9%	3.5%
Time in REM sleep	22%	21%	20%	19%	17%
Time asleep while in bed	95%	88%	84%	82%	79%

- Early EEGs showed showed disorganized and higher voltage patterns in EEGs of mothers who used EtOH prenatally (Havlicek &Childaeva, 1976; Havlicek et al, 1977; Rosett et al, 1979; Chernick et al, 1983; Ioffe et al, 1988; Ioffe & Chernick, 1990)
- EEG changes prolonged and not related to withdrawal (Ioffe et al, 1984)
- Atypical sleep cycling (Scher et al, 1988)

MANITOBA
FASD CENTRE
• Assessment • Education • Training • Research •

Sleep and PAE: Architecture

Rat models of sleep in FASD (Hilakivi, 1986; Hilakivi et al, 1987; Earnest et al, 2001, Allen et al, 2005):

reduced REM

shortened circadian sleep-wake cycle

abnormal circadian neurotrophin expression in SCN

Impact on circadian rhythmicity may be long term (Allen et al, 2005);

PAE may affect regulatory genes in hypothalamus which may predispose to sleep fragmentation

Rat binge pattern PAE: impaired and fragmented slow wave sleep (Wilson, 2016):

memory impairment

MANITOBA FASD CENTRE

• Assessment • Education • Training • Research •

Measuring Sensory Processing & Self-Regulation in FASD

- Strong correlation between SP and behaviour on CBCL (Franklin, 2008)
  - including anxiety
  - Recent study (Engel-Yeger et al, 2017) uses measures of sensory processing in adults to predict anxiety, sleep efficiency, and daytime function

- Children with FASD show more difficulties with sensory processing and resulting adaptive deficits not uniquely explained by cognitive deficits (Carr, 2010; Wengel et al 2011)