AN EXAMINATION OF THE NATURE OF SLEEP FRAGMENTATION IN CHILDREN WITH UPPER AIRWAY OBSTRUCTION

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Bachelor of Science, Bachelor of Science (Honours)

A thesis submitted for the degree of Doctor of Philosophy in Physiology by a mixed portfolio of publications, submitted manuscripts, manuscripts and traditional chapters

Discipline of Physiology
Faculty of Health Sciences
University of Adelaide
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i.  **Abstract**

An examination of the nature of sleep fragmentation in children with upper airway obstruction.

**Introduction** – Sleep related upper airway obstruction (UAO) in children disrupts breathing in sleep, resulting in sleep fragmentation and subsequent neurocognitive and behavioural deficits. Unfortunately the nature of this fragmentation in children is poorly understood and a universally accepted, clinically valid, measure of sleep fragmentation has been elusive. This limits our ability to accurately determine and measure the consequences of sleep fragmentation on a child’s development due to UAO, as well as the success of any treatment administered.

**General Aims** - The aim of the current study was to (i) examine the nature of sleep fragmentation in children with upper airway obstruction and (ii) to develop a new sleep fragmentation index for use in paediatric clinical populations with upper airway obstruction. When this study began no such index existed that was widely accepted and utilized. A range of sleep fragmentation measures already trialed in children with upper airway obstruction were reviewed to identify problems and limitations with current and previous methods of measuring sleep fragmentation in these children. An attempt was also made to identify other possible additional factors that mediate sleep fragmentation so as to develop a workable and generally applicable sleep fragmentation index for children with upper airway obstruction.

**Methods** – We performed a series of analyses on sleep and neurocognitive data from children with upper airway obstruction to identify and quantify neural activity associated with sleep fragmentation. We then used these measures and other mediating factors to create a composite measure of sleep fragmentation in children.

**Results** – We found that children with upper airway obstruction had characteristically altered neural activity as measured by electroencephalogram (e.g. changes in sleep spindle density,
decreased alpha and sigma power around spontaneous arousals from sleep). They also had an altered movement distribution in sleep (increased exponential distribution coefficient when sleep runs between movements are modeled on a survival curve), when compared to normal controls. The studies also demonstrated the potential ability of a composite measure of such sleep fragmentation markers and mediating vulnerability factors to more accurately and usefully quantify the negative impacts of upper airway obstruction.

**Conclusions** - Sleep fragmentation is a significant consequence of UAO in children, however the current measure of UAO severity is insufficient for determining the overall impact on a child’s development. As this study demonstrates, the impact of sleep fragmentation is dependent on a complicated set of variables including: age, health factors (e.g. BMI), exposure time, disease severity (e.g. AHI), genetics, trait-like factors, social factors (e.g. SES) and family history. The arousals, or disruptions to sleep, are also altered in children with UAO compared to normal controls. We therefore propose a composite measure of these important factors as a more accurate tool for determining the impact of sleep fragmentation and overall severity of UAO in children.
This work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. I give consent to this copy of my thesis when deposited in the University Library, being made available for loan and photocopying, subject to the provisions of the Copyright Act 1968. The author acknowledges that copyright of published works contained within this thesis (as listed below) resides with the copyright holders of those works.


Scott Coussens

Date 29th January 2014
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iv. Publications


v. *Style and Referencing Format of Jointly Authored Papers, Documents and Unpublished Manuscripts*

The manuscript style and referencing format for chapters 1, 2, 3, 5, 7 and 8 are that prescribed by the journal *Sleep Medicine*.

The manuscript style and referencing format for Chapters 4 and 6 are that prescribed by the journal *Sleep*. 
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<tr>
<td>α</td>
<td>Alpha Wave Form In EEG (~ 9 – 12 Hz)</td>
</tr>
<tr>
<td>ACPT</td>
<td>Auditory Continuous Performance Test</td>
</tr>
<tr>
<td>Adolescents</td>
<td>12-18 Years Old</td>
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<tr>
<td>AHI</td>
<td>Apnoea-Hypopnea Index</td>
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<td>ANOVA</td>
<td>One Way Analysis Of Variance</td>
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<td>Total Arousal Index</td>
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<td>BMI</td>
<td>Body Mass Index</td>
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<td>DS</td>
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<tr>
<td>DTVMI</td>
<td>The Developmental Test Of Visual-Motor Integration</td>
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<td>ESS</td>
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<td>nCPAP</td>
<td>Nasal Continuous Positive Airway Pressure</td>
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<tr>
<td>NEPSY</td>
<td>Neuropsychological Developmental Assessment (Korkman 2001)</td>
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<td>NIPPV</td>
<td>Nocturnal Non-Invasive Positive Pressure Ventilation</td>
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<td>NN</td>
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<tr>
<td>SBP</td>
<td>Systolic Blood Pressure</td>
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<td>SPT</td>
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<td>TWT</td>
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