Sleep and early cognitive development in children with Down syndrome

Dr Anna Joyce (née Ashworth), Coventry University
Dr Dagmara Dimitriou, UCL Institute of Education
anna.joyce@coventry.ac.uk
@DrAnnaJoyce
Effects of sleep in typical development

- Cognition
- School preparedness
- Physical development
- Behaviour
Down Syndrome

I have Down syndrome
I am not Down syndrome
I am Nancy

Normal
Obstructed
Sleep and early cognitive development

Aims
• To recruit preschool children with DS and TD children
• To assess sleep characteristics
• To assess early cognitive development
• To determine whether cognitive development is related to sleep
Sleep monitoring

Somnotouch home cardiorespiratory polygraphy
Cognitive Assessment

Mullen Scales of Early Learning
- Gross motor
- Fine motor
- Visual reception
- Receptive language
- Expressive language

Questionnaires
- MacArthur Communicative Development Inventory (MCDI)
- Strengths and Difficulties Questionnaire (SDQ)
- Brief Infant Sleep Questionnaire (BISQ)
- Child Sleep Habits Questionnaire (CSHQ)
## Participants

<table>
<thead>
<tr>
<th></th>
<th>TD</th>
<th>DS</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td>Male/female</td>
<td>13/9</td>
<td>16/6</td>
</tr>
<tr>
<td>Age in months (<em>M (SD)</em>)</td>
<td>39.03 (9.90)</td>
<td>36.57 (9.69)</td>
</tr>
<tr>
<td>Age range</td>
<td>25.79 – 59.53</td>
<td>24.38 – 56.48</td>
</tr>
<tr>
<td>Mental age*</td>
<td>45.03 (11.45)</td>
<td>20.95 (5.49)</td>
</tr>
</tbody>
</table>

* *t (30.16) = 8.89, p < .001*
Developmental trajectories

Significant association between CA and MA with significant delay in onset and trajectory in DS
Developmental trajectories

Children with DS delayed and atypical
Cardiorespiratory polygraphy results

Showing evidence of sleep disordered breathing in DS

<table>
<thead>
<tr>
<th></th>
<th>TD</th>
<th>DS</th>
<th>t</th>
<th>p</th>
<th>r</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Recording duration</strong></td>
<td>8:52 (.40)</td>
<td>9:48 (.26)</td>
<td>-1.18</td>
<td>.25</td>
<td>.19</td>
</tr>
<tr>
<td><strong>Obstructive Apnoea Index</strong></td>
<td>.53 (.26)</td>
<td>.99 (.59)</td>
<td>-1.68</td>
<td>.50</td>
<td>.11</td>
</tr>
<tr>
<td><strong>Apnoea Index</strong></td>
<td>.91 (.29)</td>
<td>1.47 (.61)</td>
<td>-1.79</td>
<td>.43</td>
<td>.13</td>
</tr>
<tr>
<td><strong>Hypopnoea Index</strong></td>
<td>.39 (.11)</td>
<td>2.57 (1.02)</td>
<td>-2.13</td>
<td>.045</td>
<td>.42</td>
</tr>
<tr>
<td><strong>Apnoea/Hypopnoea Index</strong></td>
<td>1.31 (.38)</td>
<td>4.03 (1.40)</td>
<td>-1.87</td>
<td>.07</td>
<td>.36</td>
</tr>
<tr>
<td><strong>3% Desaturation Index</strong></td>
<td>1.64 (.42)</td>
<td>8.06 (2.20)</td>
<td>-2.68</td>
<td>.009</td>
<td>.52</td>
</tr>
<tr>
<td><strong>Baseline SpO₂</strong></td>
<td>98.79 (.20)</td>
<td>97.36 (.35)</td>
<td>3.39</td>
<td>.002</td>
<td>.48</td>
</tr>
<tr>
<td><strong>Minimum SpO₂</strong></td>
<td>90.89 (1.01)</td>
<td>88.36 (.90)</td>
<td>1.87</td>
<td>.07</td>
<td>.29</td>
</tr>
</tbody>
</table>

Significant group differences in **bold**
Association between sleep and cognition

Hierarchical multiple linear regression models

1. Enter
   Chronological age

2. Stepwise
   Sex

3. Stepwise
   Desaturation index
   Apnoea/hypopnoea index
   Apnoea index
   Minimum SpO₂
   Baseline SpO₂
   Total sleep time
Association between sleep and cognition

For TD children

• Shorter sleep duration →
  • Poorer expressive language (MCDI) ($\Delta R^2 = .23$, $p = .03$)
  • More emotional symptoms (SDQ) ($\Delta R^2 = .57$, $p < .001$)
• Increased apnoeas/hypopnoeas associated →
  • Less prosocial behaviour (AI) ($\Delta R^2 = .25$, $p = .02$)
  • Increased conduct problems (AHI) ($\Delta R^2 = .29$, $p = .02$)
  • Increased total problems (AHI) ($\Delta R^2 = .26$, $p = .045$)
Association between sleep and cognition

For children with DS
- Lower minimum \( \text{SpO}_2 \) → fewer conduct problems (SDQ)
  \((\Delta R^2 = .36, p = .02)\)

For TD and DS groups
- Lower minimum \( \text{SpO}_2 \) → Poorer Expressive Language (Mullen)
  - TD: \((\Delta R^2 = .11, p = .02)\)
  - DS: \((\Delta R^2 = .15, p = .03)\)
SDB related to verbal skills and behaviour

Discussion of findings

• Support for previous findings that SDB is related to verbal but not performance skills (Blunden et al., 2005; Bourke et al., 2011)
  • Similar findings in children with DS (Breslin et al. 2014)
• Support for hypothesis that SDB is associated with more problem behaviour in TD children
  • Should mild sleep apnoea be treated?
Sleep duration associated with emotion

Discussion of findings

• Short sleep duration associated with emotional symptoms, including fears, nervousness and unhappiness in TD
  • Cause or consequence? (Dahl, 1996)
  • Childhood sleep problems predictive of adulthood anxiety (Gregory et al., 2005)
Caveats

• Difficulty with tolerance of sleep monitoring equipment
• Problems with motivation and attention to tasks
• IDs are complex disorders with multiple factors that may affect children’s development
• Important to consider individual differences
Comments and questions welcome!

anna.joyce@coventry.ac.uk

@DrAnnaJoyce