Asymmetric tonic neck reflex and symptoms of attention deficit and hyperactivity disorder in children

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One of the particularly important postnatal developmental reflexes that diminish in later stages of development is asymmetric tonic neck reflex (ATNR), which belongs among the so-called primitive reflexes. According to current evidence, certain later developed functions during ontogenesis of the central nervous system tend to replace the primitive reflexes, and their persistence is related to certain specific neuropsychiatric or neurological disorders. According to current knowledge, there is no evidence to which extent persistence of these reflexes may play a role in attention deficit and hyperactivity disorder (ADHD). With respect to these findings, we have tested a hypothesis to which extent persisting primitive reflex ATNR in 60 children in the school age (8–11 years) will be related to symptoms of ADHD and compared the results with 30 children of the same age. Results of this study show that ADHD symptoms are closely linked to persisting ATNR, which indicates that ADHD symptoms may present a compensation of unfinished developmental stages related to diminishing ATNR.

KEYWORDS: ADHD, asymmetric tonic neck reflex, developmental disorders, primitive reflexes

Introduction

According to current evidence, brain functions in their developmental stages are particularly vulnerable to various insults such as brain damages, toxic influences or psychological stress [1–3]. An important postnatal developmental deficit that likely may have various etiological backgrounds is persisting of the so-called primitive reflexes that are in early developmental stages in postnatal periods replaced by higher motor and cognitive functions [4–6]. One of the particularly important primitive reflexes that may pathologically persist in later stages of development is asymmetric tonic neck reflex (ATNR), which typically occurs when turning of the head to one side causes an increase in the ipsilateral and a decrease in the contralateral extensor muscle tone and may be used as a diagnostic instrument to assess spasticity and cognitive functions related to certain specific movements [7,8].

In agreement with this evidence, recent findings also indicate that persisting primitive reflexes are related to certain specific neuropsychiatric or neurological disorders [5,6,9–12], although according to PubMed search in the current scientific literature there is no evidence whether these persisting reflexes play a role in attention deficit and hyperactivity disorder (ADHD), likely they may have some specific relationship to ADHD symptoms. With respect to these missing findings (or at least very rare), we have proposed and tested the hypothesis to which extent symptoms of ADHD will be related to persisting ATNR in children in the school age (8–11 years).

Methods

Participants

Within the framework of ELSPAC (European Longitudinal Study of Parenthood and Childhood) study, data of 60 children (mean age 9.32, age range 8–11, 27 girls and 33 boys) with ADHD diagnosed according to Diagnostic and Statistical Manual of Mental Disorders – fourth edition (DSM-IV) criteria characterizing...
their primitive reflex (ATNR) responses and psychometric measures of ADHD symptoms were collected. Parents of all the participants gave written informed consent, and the ELSPAC study was approved by Masaryk University, Faculty of Medicine Ethical Committee. To compare the results, we have assessed also 30 healthy children of the same age (mean age 9.57, age range 8–11, 14 girls and 16 boys) who had not ADHD or other neuropsychiatric diagnosis.

**Measurement of primitive reflex**

Asymmetric tonic neck reflex usually measured by Schilder test [13,14] presents the tonic reflex response that occurs in newborn babies and normally vanishes around 3 months of age.

Test position: Standing, feet together, with the arms held straight out at shoulder level and height, but with the hands relaxed at wrists.

Test procedure: The tester stands behind the subject and gives the instruction: “When I turn your head. I want you keep your arms straight out in front of you, as they are now. This means your arms remain in the same position, and only your head moves.” Then the tester slowly rotates the subject’s head until the chin is parallel with the shoulder. Pause for 10 seconds. Return the head to the midline. Pause for 10 seconds. Rotate the head to the other side and pause for 10 seconds. Repeat the procedure up to four times.

Observations: Any movement of the hand and arm on the side to which the head is turned, i.e., do the arms automatically follow the movement of head?

Scoring: 0 – no response; 1 – a slight movement of the arms in the direction the face is pointed, a movement of the arms in the direction of head to 45°; 2 – an arm movement to 60° or flexion of the opposite side, a 90° rotation of the arms and/or loss of balance as a result of head rotation [13,14].

**Psychometric measure of ADHD symptoms**

Frequently used measure of ADHD symptoms is Children’s Parent Questionnaire (CPQ) by Conners [15–17]. The CPQ is 93-item scale of symptoms that are most commonly associated with behavioral disorders and related to children and adolescents (aged 3–17), and can measure treatment changes and outcome assessment purposes.

The questionnaire enables to calculate total score, and it has also subscales based on factor structure of the questionnaire – I. conduct problems (items 39, 40, 41, 47, 48, 51, 69); II. anxiety (items 8, 9, 10, 11, 42, 43, 64); III. impulsivity–hyperactivity (items 78, 80, 81, 82, 83, 84, 89, 90); IV. learning problems (items 45, 62, 63, 67); V. psychosomatic difficulties (items 6, 21, 22, 23, 24); VI. perfectionism (items 3, 76, 77, 78); VII. antisocial behavior (items 71, 72, 73, 75); VIII. muscular tension (items 12, 13, 14, 36). The symptoms are rated on a 4-point Likert scale (from 0 to 3) by either one or both parents of the child.

**Statistical analysis**

Statistical evaluation of scores of the measures of ATNR and ADHD symptoms included descriptive statistics, Mann–Whitney tests for independent samples, Spearman correlation coefficients and multiple linear regression analysis. The general purpose of multiple regressions is to analyze the relationship between several independent or predictor variables and a dependent or criterion variable and may be used as either a hypothesis testing or exploratory method.

All the methods of statistical evaluation were performed using the software package Statistica Version 6.

**Results**

Results of the analysis show that the ATNR scores are significantly correlated with ADHD symptoms measured by CPQ total score (r = 0.59, p < 0.01) [Figure 1] and its subscales, i.e., with conduct problems (r = 0.34, p < 0.01); anxiety (r = 0.39, p < 0.01); impulsivity–hyperactivity (r = 0.52, p < 0.01); learning problems (r = 0.35, p < 0.01); perfectionism (r = 0.39, p < 0.01); muscular tension (r = 0.34, p < 0.01) but not with psychosomatic difficulties and antisocial behavior subscales. These correlations indicate that majority of ADHD symptoms are associated with symptoms of persisting ATNR responses. Statistically significant differences for ADHD symptoms and ATNR score between girls and boys were also found (Table 1).

To assess the relations of ADHD psychopathological symptoms with ATNR, multiple linear regression was used to predict ATNR scores from reported symptoms related to conduct problems, anxiety, impulsivity–hyperactivity, learning problems, perfectionism and muscular tension in their specific interactions are linked to ATNR. The result shows that multiple R = 0.64 is statistically significant (p < 0.01; F = 6.43) and describes ATNR scores as a linear function of these ADHD symptoms from which psychosomatic difficulties and antisocial behavior subscales did not enter the equation.

To assess whether ATNR and ADHD symptoms could be associated with any unknown other factors, we have used data from an adequate control group of 30 children at the same age who were assessed for CPQ and ATNR score. The children were without
Table 1. Statistical comparison of ADHD symptoms and ATNR score in ADHD children (n = 60) between girls (N = 27) and boys (N = 33) using Mann–Whitney test.

<table>
<thead>
<tr>
<th></th>
<th>Mean ± SD Girls</th>
<th>Mean ± SD Boys</th>
<th>M–W U</th>
<th>M–W Z</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATNR reflex</td>
<td>1.37 ± 0.83</td>
<td>1.85 ± 0.44</td>
<td>311.50</td>
<td>−1.99</td>
<td>0.04</td>
</tr>
<tr>
<td>CPQ</td>
<td>30.44 ± 14.85</td>
<td>49.39 ± 13.76</td>
<td>149.00</td>
<td>−4.41</td>
<td>0.00001</td>
</tr>
<tr>
<td>I. Conduct problems</td>
<td>1.56 ± 1.71</td>
<td>3.73 ± 2.23</td>
<td>199.50</td>
<td>−3.66</td>
<td>0.0093</td>
</tr>
<tr>
<td>II. Anxiety</td>
<td>2.74 ± 1.97</td>
<td>4.39 ± 2.81</td>
<td>301.00</td>
<td>−2.15</td>
<td>0.03</td>
</tr>
<tr>
<td>III. Impulsivity–hyperactivity</td>
<td>4.41 ± 3.60</td>
<td>6.82 ± 3.42</td>
<td>270.50</td>
<td>−2.60</td>
<td>0.009</td>
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<tr>
<td>IV. Learning problems</td>
<td>1.85 ± 1.43</td>
<td>2.67 ± 1.42</td>
<td>285.50</td>
<td>−2.38</td>
<td>0.01</td>
</tr>
<tr>
<td>V. Psychosomatic</td>
<td>1.44 ± 1.69</td>
<td>1.61 ± 1.51</td>
<td>407.00</td>
<td>−0.57</td>
<td>0.56</td>
</tr>
<tr>
<td>VI. Perfectionism</td>
<td>1.15 ± 1.87</td>
<td>1.73 ± 1.94</td>
<td>354.50</td>
<td>−1.35</td>
<td>0.17</td>
</tr>
<tr>
<td>VII. Antisocial behavior</td>
<td>0.11 ± 0.42</td>
<td>0.09 ± 0.38</td>
<td>439.50</td>
<td>0.09</td>
<td>0.92</td>
</tr>
<tr>
<td>VIII. Muscular tension</td>
<td>0.63 ± 0.88</td>
<td>1.06 ± 1.36</td>
<td>367.00</td>
<td>−1.17</td>
<td>0.24</td>
</tr>
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</table>

ADHD symptoms, and none of this group has manifested ATNR (the score was zero in all cases). On the other hand, in the sample of 60 ADHD children we have found 7 children showing ADHD symptoms who had not ATNR manifestation (ATNR score 0). These children had mild form of ADHD symptoms mean CPQ total score 11.28, SD = 3.98, with the score range 8–19.

Discussion

Results of this study support the hypothesis that symptoms of ADHD are closely linked to persisting primitive reflex ATNR in children in the school age, indicating that ADHD symptoms may present a compensation of unfinished or delayed developmental stages related to diminishing ATNR, which may be particularly influenced by disproportional development. In this context, results of this study, in agreement with several findings, show gender differences in ADHD manifestations that likely are related to delayed brain maturation in boys compared with girls of which underlying mechanisms are currently unknown [18–20].

Because of these unfinished or delayed developmental stages certain motor and cognitive functions have been developed regularly and certain others not, which likely is compensated by persisting more primitive functions. This finding in ADHD patients is in agreement with few reported studies in patients with dyslexia documenting higher level of persisting primitive reflexes [21,22].

As a consequence, these persisting ATNR and likely also other primitive reflexes in ADHD may occur as a response to various stimuli during behavioral and cognitive tasks, which may explain attentional dysregulation and other ADHD symptoms due to a conflict between higher and lower level of cognitive and motor functions during brain processing. In the light of current findings, these data are in agreement with neurological concept proposed by Hughlings Jackson, who suggested that certain later developed functions during ontogenesis of the central nervous system (CNS) tend to replace the older ones when higher stages of development of the CNS has been successfully achieved [23,24]. In the sense of Jacksonian theory, persisting ATNR and other retained primitive reflexes may cause “dissolution” (or disintegration) of mental functions and consciousness that may result in ADHD patients into various symptomatic forms [25,26]. This principle of dissolution is based on inhibition of neural functions or their release from control, which leads to dysregulation of later developed adaptive functions [23]. This concept of dissolution is also in agreement with current clinical evidence indicating that manifestations of retained primitive reflexes as a consequence of frontal lobe damages and cortical disinhibition may occur in various neuropsychiatric syndromes such as schizophrenia, various forms of dementia and others [5,6,9–12].

Figure 1. Dependency graph between ADHD symptoms measured by CPQ total score and ATNR reflex score (r = 0.59, p < 0.01).
Declaration of Interest

The authors report no conflict of interest. The authors alone are responsible for the content and writing of this paper.

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