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PRIMITIVE REFLEXES AND ATTENTION-DEFICIT/HYPERACTIVITY DISORDER: DEVELOPMENTAL ORIGINS OF CLASSROOM DYSFUNCTION

Myra Taylor
Stephen Houghton
and
Elaine Chapman
The University of Western Australia

The present research studied the symptomatologic overlap of AD/HD behaviours and retention of four primitive reflexes (Moro, Tonic Labyrinthine Reflex [TLR], Asymmetrical Tonic Neck Reflex [ATNR], Symmetrical Tonic Neck Reflex [STNR]) in 109 boys aged 7-10 years. Of these, 54 were diagnosed with AD/HD, 34 manifested sub-syndromal coordination, learning, emotional and/or behavioural symptoms of AD/HD, and 21 had no (or near to no) symptoms of AD/HD. Measures of AD/HD symptomatology and of the boys' academic performance were also obtained using the Conners' rating scale and the WRAT-3, respectively. Results indicated that, in general, boys diagnosed with AD/HD had significantly higher levels of reflex retention than non-diagnosed boys. Results also indicated both direct and indirect relationships between retention of the Moro, ATNR, STNR and TLR reflexes with AD/HD symptomatology and mathematics achievement. The pattern of relationships between these variables was also consistent with the notion of the Moro acting as a gateway *for the inhibition of the other three reflexes.*

AD/HD is the current diagnostic label for one of the most prevalent neuro-developmental disorders of childhood (American Psychiatric Association, 2000) that comprises difficulties with sustained attention, distractibility, impulse control, and hyperactivity (Barkley, 1997a; Houghton et al., 1999; Schachar, Mota, Logan, Tannock, & Klim, 2000). Although most individuals with AD/HD have symptoms of both hyperactivity/impulsivity and inattention, there are some individuals in whom one or the other pattern is predominant. Thus, the subtypes of AD/HD are *AD/HD Predominantly*

Hyperactive-Impulsive Type (AD/HD-HI), *AD/HD Predominantly Inattentive Type* (AD/HD-PI), and *AD/HD Combined Type* (AD/HD-CT). Although there is some debate over the demarcation of subtypes, recent findings converge on the distinction between AD/HD-PI and AD/HD-CO (Barkley, 1997a; Houghton et al., 1999). For example, Houghton et al. (1999) demonstrated that tests of executive function, identified in an extensive review by Pennington and Ozonoff (1996) as differentiating between children with and without AD/HD, only did so on the basis of the AD/HD-CO subtype and matched non-AD/HD controls. For children diagnosed as AD/HD-PI no significant differences were evident, suggesting in line with Barkley's (1997a) Unifying Theory of AD/HD that, in reality, two qualitatively different disorders may actually exist rather than subtypes of one disorder known as AD/HD.

Although the prevalence of AD/HD in the general population has previously been documented to be between 3-5% (APA, 1994), recent studies have reported higher prevalence rates of 5-10% for the school-aged population (Scahill, Schwab & Stone, 2000). Research on the developmental course of AD/HD demonstrates that it affects persons of all levels of intelligence, and that it persists through adolescence in 50% of diagnosed individuals (Barkley, Fischer, Edlebrock, & Smallish, 1990), and into adulthood in 30%-60% of cases (Weiss & Hetchman, 1986).

Although a number of models and theories have been presented over the years to account for the deficits known to exist in AD/HD, with most emphasizing behavioural inhibition as the fundamental deficiency (e.g., Barkley, 1997a; Quay, 1988; Sergeant & Van Der Meer, 1990; Sonuga-Barke, 2002), recent assertions by Goddard (1996) and Hocking (1997) pertaining to the potential developmental impact of the retention of primitive reflexes have yet to be investigated.

Primitive Reflexes

According to Goddard-Blythe and Hyland (1998), the emergence and strengthening in utero of a set of primitive reflexes (Moro Reflex, Tonic Labyrinthine Reflex [TLR], Asymmetrical Tonic Neck Reflex [ATNR], Symmetrical Tonic Neck Reflex [STNR], Plantar Reflex, Palmer Reflex, Rooting Reflex, and Spinal Galant Reflex) allows a baby to undergo a range of automatic and survival-orientated movements during its first three years of life. If development is normal, these primitive reflexes are progressively inhibited and gradually superseded by postural reflexes (Gold, 1997; Wilkinson, 1994). If, however, they are retained beyond the normal three-year developmental period, the primitive reflexes have the capacity to upset the maturation process and decrease the brain's ability efficiently to process sensory information (Goddard, 1996).

The Moro Reflex, for example, is the body's physiological response to a sudden or potentially threatening source of stress. On awareness of the threat, the brain automatically initiates a reflexive response, which causes the baby to fling its arms upwards and backwards from its body. This expansive gesture triggers a quick gasp of air before the arms are returned to the core body position, providing the baby with the lung capacity to cry for assistance (Goddard, 1996). Whereas the Moro Reflex's gasp and cry reaction is appropriate in a newborn infant, it is deemed inappropriate if it is retained into childhood, since a habitual startle reaction may lead to an overly-reactive routine response to even quite mild exposures to stress (Hannaford, 1995).

Further, it could be argued that, because the Moro Reflex emerges at an earlier stage of development than the ATNR, STNR, and TLR, the Moro acts a *gateway* in the development of the other three reflexes. The Moro's normal lifespan coincides with the period of brain development during which the brainstem and the cerebellum, the two areas responsible for the brain's automatic and highly reactive survival-orientated functions, maintain primary operating control. However, during the 4-12 month period during which the ATNR, STNR, and TLR, are all still active in the body and undergoing inhibition, the mid or limbic regions of the brain are gaining in ascendency. It is also interesting to note that the one reflex (the TLR) that is still present in its backward form during the developmental period (up to the 3rd year of life) when the neural connections between the vestibular, oculomotor and visual perceptual systems and the cortex are being extensively elaborated and myelinated. Therefore, it would seem that the order of reflex inhibition and myelination patterns within the brain may be linked.

As can be seen in Table 1 (next page), there appears to be a high degree of similarity in the presentation of AD/HD symptomatology and physical presentations of the Moro and other primitive reflexes when retained beyond the age at which they should have been inhibited (APA, 2000; Goddard, 1996; Hocking 1997; McGoey, Eckert & DuPaul, 2002; Taylor, 1998, 2002). As indicated in this table, retention of these primitive reflexes may also be linked to academic difficulties experienced by children when they reach school age. Despite this, links between reflex retention and subsequent behavioural and academic difficulties experienced by children with AD/HD have yet to be investigated.

As in almost all other childhood disorders, the severity of symptom presentation in children with AD/HD varies greatly. Some children, for example, manifest all (or almost all) of the symptoms necessary for a diagnosis of AD/HD, while others often present with greatly reduced levels of severity (Ratey & Johnson, 1997). This latter group, who present with reduced severity (sub-syndromal) symptoms, are considered by Ratey and Johnson to have a 'shadow syndrome' of the disorder. Accordingly, Ratey and Johnson assert that the practice of applying a rigid set of diagnostic criteria based on a critical but seemingly arbitrary number of symptoms for diagnostic purposes is inherently problematic. That is, irrespective of the presence or absence of a diagnostic label, most overactive children have problems focussing their attention. In addition, the unpredictable and volatile emotional responses of these children contribute to classroom dysfunction (Barkley, 1998) as their behaviour interferes not only with their own ability to learn, but also with their teachers' ability to teach (Greene et al., 2002; Schlozman & Schlozman, 2000; Sciutto, Terjessen, & Frank, 2000).

Although it has been proposed that the symptomatology and behaviours of children diagnosed with AD/HD overlap significantly with the symptoms presented by children with retained primitive reflexes, this relationship has yet to be investigated empirically.

Table 1
Proposed areas of overlap between retained reflexes and AD/HD symptomatology

Reflexes	Effect of Retained Primitive Reflexes (Goddard, 1996; Hocking, 1997)	AD/HD Symptoms (APA, 2000; Barkley, 1997b; Greene & Chee, 1994; Houghton et al., 1999; Taylor, 1998)
MORO Emerges: 9-12 weeks in utero Inhibited: 2-4 months after birth	Over-reactive Hyperactivity, hypoactivity Oculo-motor problems Tense muscle tone, fatigue Poor visual perception, eyes stimulus bound, photosensitivity Auditory confusion Coordination difficulties Anxious Mood swings Low self-esteem Poor decision making qualities	Impulsivity Hyperactivity Messy work Inability to sit still Inattentive, Easily distracted Does not appear to listen Clumsy Anxious, social clumsiness Inappropriate behaviour Shy, withdrawn Procrastinates, disorganised
TLR Emerges: At birth Inhibited: 2-4 months after birth	Poor balance Easily disorientated Problems re-establishing binocular vision	Poor sense of timing Frequent careless mistakes
ATNR Emerges 18 weeks in utero Inhibited: 3-9 months after birth	Poor eye tracking Difficulty crossing visual midline	Difficulty learning to read Difficulty telling time Left- right confusion
STNR Emerges: 6-9 months after birth Inhibited: 9-11 months after birth	Poor posture Poor eye/hand coordination Focussing difficulties	Problems sitting still in desk Problems learning to swim Problems with ball games

The current research, therefore, sought to assess the relationship between reflex retention and AD/HD symptomatology and academic achievement. Initially, the study examined whether boys diagnosed with AD/HD exhibited higher levels of reflex retention than boys with *shadow* symptoms of the disorder (CLEBs) and boys with no (or near to no) symptoms of the disorder (Ables). A path analysis was then conducted to examine interrelationships amongst the four reflexes, as well as the relationship between these and AD/HD symptomatology and academic achievement.

Method

Participants and design

A sample of 109 boys (Mean age 8.6 yrs, range 7yrs 3m to 10yrs 11m) were recruited from a range of socio-economic areas in the large Western Australian capital city of Perth. Of the 109, 54 were diagnosed by paediatricians as meeting the DSM-IV criteria for AD/HD (AD/HD-PI =14, AD/HD-CT = 20, AD/HD-CO [CT plus a comorbid condition] = 20]).

The 55 non-diagnosed controls were drawn from the same school grade level and geographical district as the AD/HD sample. Approximately 50% of this sample was drawn by asking the parents of the AD/HD boys to invite a non-AD/HD boy from within their son's class or friendship group to participate in the research. The remainder were obtained via advertisements placed in school newsletters. Of the controls, 50% had been referred to a school psychologist at some time during their schooling, but none had been found to meet the criteria for a diagnosis of any childhood disorder. Further, none qualified for special teaching resources within the school. Subsequently, these boys were assigned to one of two subgroups: A Coordination, Learning, Emotional and Behavioural Sub-Group (CLEBs), which comprised 34 boys identified with a non-specific coordination, learning, emotional, or behavioural problem; or a sub-group which comprised 21 boys who did not present with any such difficulties (Ables).

Settings

The neuro-developmental and scholastic assessments were administered in The Centre for Attention & Related Disorders, within the Graduate School of Education, The University of Western Australia. The same room was used for all of the assessments and the furniture layout was identical in each instance.

Instrumentation

All boys who participated in the study completed the same set of tests. Parents were first asked to complete the Long Form of the *Conners' Parent Rating Scale – Revised* (CPRS-R; Conners, 1997) to confirm the status of the diagnostic groups in terms of AD/HD symptomatology. The CPRS-R consists of 80 items which take approximately 20 minutes to administer, although there are no time limits imposed for completion. The scale is relatively easy to complete since raters are required to simply circle one of four options anchored with the words *Not at all true* (Never/Seldom), *Just a little true* (Occasionally), *Pretty much true* (Often/Quite a bit), or *Very much true* (Very Often/Very Frequently). (For a full review of the psychometrics of the CPRS-R see Gianarris, Golden., & Greene, 2001.)

During the period in which parents completed the CPRS-R, all boys completed the Wide Range Achievement Test – Third Edition (WRAT-3, Wilkinson, 1993). The WRAT-3 is one of the most frequently used measures of academic achievement (Spreen & Strauss, 1998) because it is quick, easy to administer, and assesses reading, spelling, and mathematics. It has excellent psychometric properties with alpha coefficients ranging from .85 - .95 over the nine WRAT-3 tests.

The INPP Reflex Assessments (see Blythe & Goddard, 2000) were then administered to all 109 boys. Due to technical difficulties, 14 of the 109 assessments were not video recorded. In these cases, scores were based on the ratings recorded by the first author during the assessment sessions.

In the INPP reflex assessment sessions, participants were requested to perform specific physical activities. For example, the Erect Drop Back Test (Moro Reflex), required the child to stand upright with feet together, head facing straight ahead, eyes closed, elbows pointing out from the body at a 45° angle at shoulder height, forearms pointing inwards, palms facing down and wrists floppy. The tester stands one stride back and directly behind the child braced ready to catch the child and gives the following instruction: *In a few moments time when I blow my whistle I want you to drop back stiff, like a log, into my arms and I promise I will catch you. I will not let you fall.* Positive indicators of this reflex include abduction of the arms on falling backwards, an audible gasp of breath or cry, a change in skin colour and/or a reluctance to complete the test. Responses to the assessment tasks were rated for competency on a five-point scale anchored with appropriate descriptors for each specific reflex.

Procedure

Ethics approval for the research was obtained from the University of Western Australia's Human Research and Ethics Committee. The parents of both the AD/HD and control boys who volunteered to participate received a package which included an information letter about the testing procedures, and a consent form informing the parents of their participatory rights. On receipt of the consent form, the first author contacted the parents to make an appointment for the reflex assessment. Parents were asked to ensure that the child wore shorts and a loose fitting, short-sleeved T-shirt to the session to enhance the child's comfort during the physical tests, as well as allowing a clear observation of muscular, limb and body movements. In collaboration with, and under the supervision of, the family's paediatrician, parents of the boys with AD/HD were requested not to administer their child's prescribed stimulant medication for 20 hours prior to the assessment (see Houghton et al., 1999; West et al., 2002). This was done to eliminate any potential medication masking effects. All parents complied with this request.

Results

The data were analysed in three phases. First, a multivariate analysis of variance (MANOVA) was conducted on scores for the three Conners' (1997) Global Indices (Impulsive, Emotional, and General Problematic Behaviours). This analysis was performed to confirm the differential status of participants in the three diagnostic groups (AD/HDs, CLEBs, and Ables) in terms of AD/HD symptomatology. A second MANOVA was then conducted to compare retention scores for the four reflexes (Moro, ATNR, STNR, and TLR) across the three groups. Finally, a path analysis was performed on scores for the full study sample to explore relationships amongst the four reflex retention measures, as well as the relationship between these measures and scores on the academic achievement and AD/HD symptomatology measures.

Overall Differences Between Diagnostic Groups

All preliminary screening tests performed on scores for the three Conners' Global Indices indicated adequate conformity to MANOVA assumptions in terms of linearity, normality, and homogeneity of variance/dispersion matrices. Mahalanobis distances, calculated separately for each diagnostic group, also indicated no significant multivariate outliers at the $\alpha = .001$ level. Means and standard deviations for scores on the Conners' Global Indices within each of the three groups are shown in Table 2.

Table 2
Descriptive statistics for scores on the Conners' Global Indices

Conners' Global Index	Diagnostic Group	*N*	*M*	*SD*
Impulsive Behaviours	AD/HD	54	15.889	3.903
	CLEB	34	6.353	4.703
	Able	21	3.238	3.534
	Total	109	10.477	6.836
Emotional Behaviours	AD/HD	54	5.093	2.040
	CLEB	34	1.971	2.329
	Able	21	0.667	.796
	Total	109	3.266	2.707
Problematic Behaviours	AD/HD	54	20.407	4.874
	CLEB	34	8.206	6.650
	Able	21	3.429	3.026
	Total	109	13.330	8.902

The MANOVA on Conners' scores indicated a significant multivariate effect for diagnostic group, $V = .681$, $F(3,104) = 18.071$, $p < .001$. Univariate ANOVAs on each of the three individual indices are shown in Table 3. Based on a Bonferroni-corrected α level of .016, the ANOVAs revealed significant differences between the groups in all three of the Conners' AD/HD domains (Impulsive, Emotional, and Problematic Behaviours). Tukey post-hoc tests further confirmed significant differences between all three groups on each index, indicating that the highest scores were reported in the AD/HD group, followed by those in the CLEB group, and then those in the Able group.

Table 3
Univariate ANOVA outcomes for scores on the Conners' Global Indices

Effect	Index	*df*	*MS*	*F*	Sig.	Partial η^2
Diagnostic Group	Impulsive Behaviours	2	19.592	5.139	.007	.088
	Emotional Behaviours	2	25.302	8.211	<.001	.134
	Problematic Behaviours	2	56.891	18.095	<.001	.255
	Impulsive Behaviours	2	44.818	15.473	<.001	.226
Error	Impulsive Behaviours	106	3.812			
	Emotional Behaviours	106	3.082			
	Problematic Behaviours	106	3.144			
	Impulsive Behaviours	106	2.897			

A MANOVA was also used to compare retention scores for the four reflexes across the diagnostic groups. Again, preliminary screening tests indicated adequate conformity to all major MANOVA assumptions. Means and standard deviations for retention scores on the four reflexes are shown in Table 4.

Table 4
Descriptive statistics for scores on the reflex retention measures

Reflex	Diagnostic Group	*N*	*M*	*SD*
Moro	AD/HD	54	2.778	1.839
	CLEB	34	2.118	2.293
	Able	21	1.190	1.601
	Total	109	2.266	2.026
ATNR	AD/HD	54	4.167	1.840
	CLEB	34	3.000	1.826
	Able	21	2.571	1.363
	Total	109	3.495	1.869
STNR	AD/HD	54	4.389	1.847
	CLEB	34	2.353	1.574
	Able	21	2.333	1.880
	Total	109	3.358	2.035
TLR	AD/HD	54	4.000	1.943
	CLEB	34	2.471	1.308
	Able	21	1.857	1.590
	Total	109	3.110	1.916

The MANOVA on reflex retention scores indicated a significant multivariate effect for diagnostic group, $V = .383$, $F(8,208) = 6.166$, $p < .001$. Outcomes of the univariate ANOVAs performed on individual reflex measures are shown in Table 5. Based on a Bonferroni-corrected α level of .012, the groups differed significantly in terms of Moro reflex retention scores, with Tukey post-hoc tests indicating higher scores for AD/HDs than for Ables on this measure. Differences between scores in the CLEB and the other two groups were not significant, however. This pattern of results is consistent with the *shadowy* nature of CLEB symptomatology within the classroom.

Table 5
Univariate ANOVA outcomes for scores on the reflex retention measures

Effect	Reflex	*df*	*MS*	*F*	Sig.	Partial η^2
Diagnostic Group	Moro	2	19.592	5.139	.007	.088
	ATNR	2	25.302	8.211	<.001	.134
	STNR	2	56.891	18.095	<.001	.255
	TLR	2	44.818	15.473	<.001	.226
Error	Moro	106	3.812			
	ATNR	106	3.082			
	STNR	106	3.144			
	TLR	106	2.897			

As indicated in Table 5, significant effects for diagnostic group were also found on the ATNR, STNR, and TLR reflex retention measures. In these cases, however, post-hoc tests indicated significantly higher scores for AD/HDs than for both CLEBs and Ables, with no significant differences between the latter two groups. The difference in the pattern of results for these reflexes versus those obtained for the Moro may be due to the fact that the ATNR, the STNR, and the TLR emerge at a later stage of development than the Moro. As a result, retention differences between AD/HDs, CLEBs, and Ables are likely to be more salient on these later reflexes.

Relationships Between Reflex Retention, AD/HD Symptomatology, and Academic Achievement

The third analysis was designed to address three major goals. The first goal was to provide a further test of the relationships between reflex retention and AD/HD symptomatology. The results reported above indicated significant differences in retention levels across the three diagnostic groups, and confirmed that scores on the three Conners' Global Indices were consistent with the diagnostic status of each group. Despite this, there was also evidence of some variability in AD/HD symptomatology *within* the groups. This result is not surprising. As mentioned previously, AD/HD symptoms are present in most children to varying degrees. Reaching a diagnosis of AD/HD, therefore, relies not on establishing the presence or absence of particular symptoms in referred children, but on establishing that the severity, frequency, or generality of these symptoms deviates from those exhibited by children in the general population. For example, in the domain of inattention, the diagnostic criteria (APA, 1994; pp. 83-85) stipulate that children must exhibit six or more identified symptoms (e.g., *is often easily distracted by extraneous stimuli*) to a degree that is *both maladaptive and inconsistent with developmental level*. Such judgements rely inherently on the imposition of arbitrary cut-off points on continuous rating scales. While this is necessary for classification purposes, the use of cut-off points also reduces the precision and power of analyses designed to explore relationships between these symptoms and other variables. The goal of the third analysis, therefore, was to provide a further test of the relationship between reflex retention and AD/HD, in which AD/HD symptomatology was operationalized as a continuous variable, rather than one that was either present or absent within diagnostic groups. In this analysis, the study sample was not divided into subgroups. Instead, scores on the Conners' AD/HD rating scale were used to represent the levels of AD/HD symptomatology exhibited by all of the study participants.

The second goal of this analysis was to explore the relationships between reflex retention and scores on the reading, spelling, and mathematics subtests of the WRAT-3 (Wilkinson, 1993). As indicated previously (Table 1), reflex retention has been linked theoretically with a number of factors that are likely to impact academic achievement (e.g., reading difficulties, carelessness, problems sitting still). This analysis was designed to provide an empirical test of the relationships between specific retained reflexes and subsequent achievement levels.

The final goal of the analysis was to explore the interrelationships amongst the four retention measures. Although it was not possible to conduct a confirmatory test of the proposed *gateway* hypothesis, the path analysis was designed to evaluate whether the model was *plausible* in light of the interrelationships amongst the reflex measures in the study. In this analysis, direct relationships between the Moro reflex and AD/HD symptoms/achievement levels were compared with indirect relationships between these variables through the ATNR, STNR, and TLR reflexes. According to the *gateway* theory, retention of any of the four reflexes (the Moro, STNR, TLR, and ATNR) would be expected to have unique effects in at least some of these outcome areas. However, if the theory that the Moro acts as a *gateway* for the inhibition of other primitive reflexes holds, at least part of the relationship between Moro retention levels and the AD/HD symptom/achievement levels should be indirect (i.e., mediated by the relationship between the Moro and the other three reflexes).

Descriptive statistics and bivariate correlations for all variables in the path model are shown in Tables 6 and 7, respectively. Initial screening of the scores on all measures indicated no significant violations of multiple regression/path analysis assumptions.

Table 6
Descriptive statistics for variables in the path analysis

Measure	*N*	*M*	*SD*
ATNR	109	2.266	2.026
STNR	109	3.495	1.869
TLR	109	3.358	2.035
Moro Reflex	109	3.110	1.916
Impulsive Behaviours	109	10.477	6.836
Emotional Behaviours	109	3.266	2.707
Problematic Behaviours	109	13.330	8.902
Spelling	109	27.413	5.342
Reading	109	30.596	6.037
Mathematics	109	30.220	7.305

Table 7
Bivariate correlations for variables in the path analysis

Measure	1	2	3	4	5	6	7	8	9	10
1. ATNR	1.00									
2. STNR	.234	1.00								
3. TLR	.257	.311	1.00							
4. Moro	.243	.533	.405	1.00						
5.Impulsive Behaviours	.220	.359	.410	.418	1.00					
6.Emotional Behaviours	.276	.276	.310	.292	.736	1.00				
7.Problematic Behaviours	.258	.356	.391	.395	.946	.880	1.00			
8. Spelling	-.116	.260	.149	.225	.255	.143	.226	1.00		
9. Reading	.072	.145	.213	.117	.341	.272	.330	.380	1.00	
10. Mathematics	-.259	.433	.365	.511	.614	.471	.603	.678	-.022	1.00

Table 8 summarizes the path coefficients and standard errors (in parentheses) obtained for each effect tested in the model. A path diagram of these outcomes is shown in Figure 1.

In the model, statistical significance was assessed at the .05 level (critical t = 1.96 for 103 *df* and α = .05).

As indicated, STNR retention levels were significantly related to scores in all three of the Conners' AD/HD domains (*t*s > 2.010), while TLR retention related significantly both to Impulsive Behaviours and to Problematic Behaviours (*t*s > 2.188). All of these relationships were positive, indicating that higher levels of retention were linked with higher levels of AD/HD symptomatology. TLR retention levels also correlated significantly with achievement in mathematics (t = -3.983). In this case, however, the relationship was negative, indicating that high retention levels were linked with lower achievement levels. A similar relationship was observed between ATNR retention and mathematics achievement (t = -2.344). Somewhat surprisingly, however, this was the only significant effect for ATNR retention within the model.

Table 8
Direct and indirect effects in the path analysis

Measure	Type of Effect	**Effect Variable**			
		Moro Reflex	ATNR	STNR	TLR
ATLR	Direct	.234(.094)*			
STNR	Direct	.257(.093)*			
TLR	Direct	.243(.094)*			
Impulsive Behaviours	Direct	.066(.091)	.146(.085)	.258(.086)*	.219(.086)*
	Indirect	.154(.050)*			
Emotional Behaviours	Direct	.173(.096)	.118(.091)	.183(.091)*	.113(.091)
	Indirect	.102(.045)*			
Problematic Behaviours	Direct	.116(.091)	.155 (.086)	.236(.087)*	.189(.086)*
	Indirect	.143(.048)*			
Spelling	Direct	-.184(.095)	-.184(.095)	-.041(.096)	-0.101(0.096)
	Indirect	-.078(.045)			
Reading	Direct	.004(.103)	.090(.097)	.187(.097)	-.008(.097)
	Indirect	.067(.046)			
Mathematics	Direct	-.097(.087)	-.191(.082)*	-.149(.082)	-.325(.082)*
	Indirect	-.162(.051)*			

* Significant at α = .05

As expected, there was a strong positive relationship between Moro reflex retention scores and retention levels for all three of the remaining reflexes (*t*s > 2.488). Importantly, however, the Moro had no significant direct effects on any of the AD/HD symptomatology or achievement variables. All of the significant effects associated with Moro Reflex retention were indirect (i.e., mediated by the other reflexes).

In terms of indirect effects, Moro retention levels correlated significantly (*t*s > 2.278) with scores on the Conners' Impulsivity (*p* = .102, *SE* = .050), Emotional (*p* = .102, *SE* = .045), and Problematic (*p* = .143, *SE* = .048) Behaviours indices. In all cases, the relationships were positive, indicating that higher retention levels were linked with higher levels of AD/HD symptomatology.

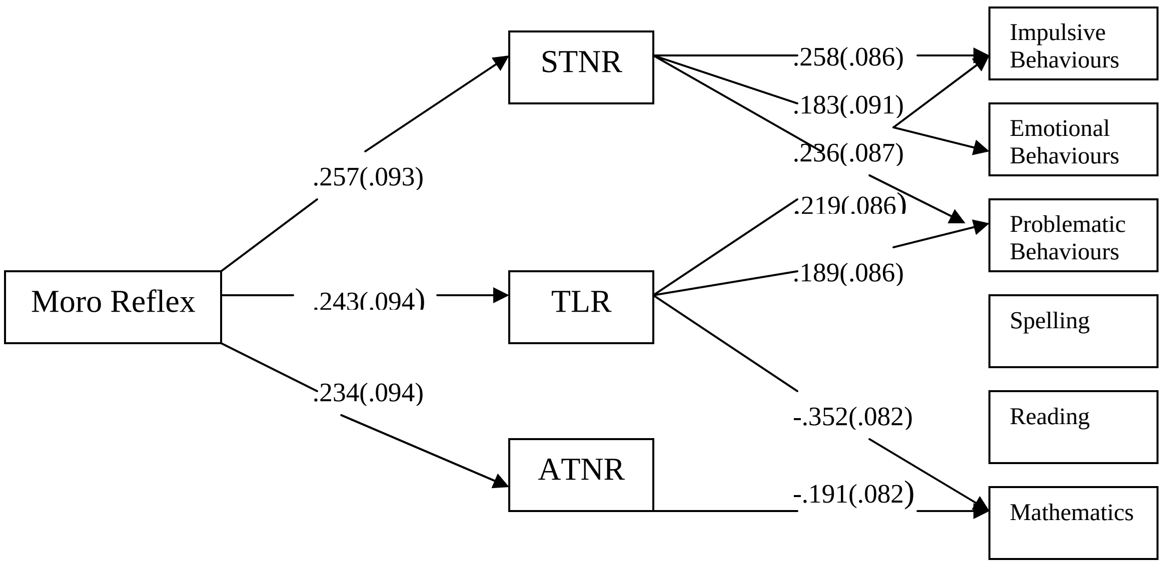

Figure 1: Path diagram of significant relationships between reflex retention levels, AD/HD symptomatology, and academic achievement

As indicated in Figure 1, all of these effects were mediated primarily by the Moro → STNR → AD/HD and the Moro → TLR → AD/HD compound paths. There was also a significant indirect relationship between Moro retention levels and mathematics achievement (*p* = -.162, *SE* = .051). In this case, the relationship was negative, indicating that higher retention levels were linked with lower achievement. As indicated in Figure 1, this relationship was mediated primarily by the Moro → TLR → Achievement and Moro → ATNR → Achievement compound paths. These results are consistent with the hypothesis that the Moro reflex does not impact student outcomes directly, but has effects in these areas by first impacting the inhibition of the other reflexes. It also supports the notion that higher levels of retained Moro reflex are linked with higher levels of AD/HD symptomatology, as well as with lower achievement levels in the area of mathematics.

Discussion

This study explored relationships between four reflexes (the Moro, the ATNR, the STNR, and the TLR) and the AD/HD symptomatology and academic performance of young boys with and without attention, learning, emotional, behavioural, and coordination problems. As an emergent field of study, there is little comparative research available within which the current findings can be framed. This paucity does not limit the applicability of the present study's findings, however. These findings should not be viewed as definitive. Rather, they should be viewed as a basis for scaffolding future research within the field.

The first analysis in the study examined the differences amongst the three diagnostic groups on the Conners' Global Indices (Impulsive, Emotional, and Problematic Behaviours). In all three of these domain areas, results were consistent with the diagnostic group classifications (i.e., significantly higher scores in the AD/HD versus the CLEB and Able groups). Participants in the CLEB group also, however, had significantly higher scores across all of the Global Indices than those in the Able group. This finding supports the notion that the CLEBs and Ables within the study did not represent a single homogeneous group. Further, the results point to the existence of a group of children in the *general population* who present with *shadowy* symptoms of AD/HD. These symptoms may not be pervasive enough to meet the cut-off criteria for a diagnosis, but in this study, were sufficient to distinguish these children from others in the general population. These results suggest that children cannot be fitted neatly into simple categories (e.g., diagnosed versus non-diagnosed), and that research studies that rely on the presence of a particular disorder should assess the variability that exists within, as well as between, groups.

The second analysis examined the incidence of age-inappropriate levels of primitive reflex retention within the three diagnostic groups. The findings indicated clear and significant differences in the retention levels of the AD/HD versus the Able group. Specifically, the Able group had significantly fewer symptoms of Moro, ATNR, STNR, and TLR reflex retention than the AD/HD group. The AD/HD group also demonstrated significantly higher levels of ATNR, STNR, and TLR retention than the CLEB group, although there was no significant difference between these groups on the Moro retention measure. These results suggest a significant relationship between AD/HD classifications and reflex retention.

The outcomes of the path analysis also provided evidence of the overlap between AD/HD symptomatology and reflex retention. In particular, STNR retention was significantly related to scores on all three of the Conners' Global Indices, while TLR retention was related both to Impulsive and to Problematic Behaviours. This analysis further indicated significant direct relationships between two of the reflexes (TLR and ATNR) and academic achievement in mathematics. These findings highlight the potential significance of reflex retention in predicting various learning and behavioural problems experienced by school-aged children.

Finally, the path analysis indicated that retained Moro Reflexes did not relate directly to any of the AD/HD or achievement variables. Rather, all of the effects for Moro retention were mediated by its relationship with ATNR, STNR, and TLR retention levels. Whilst preliminary, these results support the notion that the Moro Reflex acts as a *gateway* for the inhibition of other reflexes, owing to the developmental stage at which it emerges. It should be kept in mind, however, that all of these reflexes were assessed at the same time point within this study. Thus, further studies that adopt a longitudinal approach are needed before any firm conclusions about the relationships amongst these reflexes, and their links to AD/HD symptomatology and academic achievement, can be drawn.

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