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Children with Attention Deficit and Hyperactivity Disorder: Persistence of Primitive Reflexes & Related Motor Activity Issues

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Abstract
To identify which primitive reflex is higher and its associated problem with motor performance in children with ADHD.14 children with ADHD (4–6 years old) from pediatric clinic of Surat were checked for the presence of the asymmetric tonic neck reflex, symmetric tonic neck reflex, tonic labyrinthine reflex, Palmer, Galant, and Moro reflex test method given by sally Goddard. Motor skills were checked with the motor proficiency test (MOT 4–6 test) in those18 tasks. A child with ADHD has reflex activity in the following areas: ATNR right (42.9%), Galan right (21.4%), STNR extension (28.6%), and Moro (35.7%). Motor skills are inversely related to retained permeative reflex. ADHD Children with increased reflex activity facing difficulty on the MOT test. This study shows that ADHD symptoms are closely linked with persistence of primitive reflexes. The association between persisting primitive reflexes and motor skills suggests that ADHD symptoms may represent a compensation for unfinished developmental phases related to declining reflexes.
Keywords: *ADHD; Motor Skills; MOT (Motor Proficiency Test); Persistent Primitive Reflexes; Physical Development*

1. Introduction
Primitive reflexes, attention deficit hyperactivity disorder (ADHD), and motor skills development are interconnected aspects of pediatric neurology and developmental psychology. Primitive reflexes are innate movements controlled by the central nervous system and typically seen in infants in response to specific stimuli. These reflexes, such as the Moro reflex or the asymmetrical tonic neck reflex (ATNR), play a crucial role in early motor development but are expected to integrate as the child grows older.[1] However, in some children, these primitive reflexes persist beyond infancy. Such persistence has been associated with developmental challenges, including delays in motor skills acquisition and difficulties in coordination, balance, and posture control.[2] This phenomenon is particularly relevant in the context of ADHD, a neurodevelopmental disorder characterized by symptoms of inattention, hyperactivity, and impulsivity. [3] Children with ADHD often exhibit deficits in executive functions, which include the ability to plan, organize, and regulate behavior. These deficits can impact their motor skills development, leading to difficulties in activities requiring coordination and fine motor control. [4] Moreover, the presence of persistent primitive reflexes in children with ADHD has been linked to greater motor impairment and reduced adaptive functioning.[5] Understanding the intricate relationship between persistent primitive reflexes, ADHD, and motor skills development is crucial for designing effective therapeutic interventions. Research suggests that interventions aimed at integrating primitive reflexes through movement-based therapies can improve motor skills and potentially mitigate some of the challenges associated with ADHD.[1][2] In summary, exploring these connections provides

insights into how neurological factors impact motor development and functional outcomes in children with ADHD. This introduction sets the stage for further exploration into interventions that target both primitive reflex integration and motor skills enhancement in clinical and educational settings.

2. Method

A cross-sectional observational study was conducted on Children with ADHD aged 4 to 6. Parents were informed about the study purpose and process. Children who were ready to volunteer for the study were included according to the inclusion and exclusion criteria, then informed consent was obtained from parents, and information questionnaires were filled out by parents.

2.1. Procedure

The study was done to test the integration of reflexes during extension and flexion variants for ATNR, STNR, TLR, Galant, Palmer, Moro, and MOT 4–6. Each reflex was examined up to 5 times to obtain the best positive answers. Assessment of Reflex Activity [6] ATNR and STNR were tested in the four-point knee position with the head in the middle. During the ATNR, rotation of the head to the right or left is observed in changes in the body with the movements of the trunk and pelvis.

2.2. The scoring of ATNR was as followed

1. No movement of the opposite arm, shoulder, or hip (no reflex occurs);
2. A slight deflection of the opposite arm or movement of the shoulder or hip (reflex present in 25%);
3. Clear deflection of the opposite arm with or without involving the shoulder or hip (reflex present in 50%);
4. Significant deflection of the opposite arm with or without involving the shoulder or hip (reflex present more than 50%);
5. Descent of the opposite arm as a result of the rotation of the head. Uncontrolled hip movement can also occur (reflex survived 100% on the facial side).

The STNR was tested in two variants: when the child's head was extended, symptoms such as extending upper limbs, sitting on the heels, or trunk movements were observed, and when the child's head was flexed, elbows were bent, pelvis lifted, or knees extended. The therapist also assessed the intensity of current compensations.

2.3. The scoring of STNR was as followed

1. No reaction;
2. Shaking of one or two arms or minimal movement of the trunk;
3. Elbow movement and/or hips or bending of the spine;
4. Deflection of the arms when lowering the head and spontaneous straightening of the hands when lifting the head;
5. Bending arms or going back to sitting on the heels.

The TLR measurement was taken while standing position with feet on hips and hands-on body. Children were asked to close their eyes like ATNR and STNR. For TLR extension, Compensations including hand or UE movements, standing on toes, and disturbance/loss of balance were observed, and fist holding, knee deflection, and disturbances/ loss of balance for TLR flexion.

2.4. The scoring of TLR was as followed

1. No reaction;
2. Minimal balance disturbances whilst changing head position;
3. Balance disturbances during the test and/or muscle tone change;
4. The child almost loses balance and/or shows disorientation after the task;
5. Loss of balance and/or significant muscle tone change whilst attempting balance stabilization. Dizziness and nausea may occur.

The Palmar grasp was caused by skin irritation. It was bought on by applying submaximal pressure with a spatula to the palm.

2.5. The scoring of the palmar reflex was as followed

1. Lack of reflex,
2. Low activity,
3. Medium activity,
4. High activity,
5. Maximum activity.

A Galant reflex was observed by drawing a vertical line with the thumb along the thoracic and lumber

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region. After stimulation, the movement was present at the stimulation side (children could scratch the affected area).

2.6. The scoring of the Galant reflex was as followed

1. No reaction;
2. On the stimulated side, outward hip movements occur at 15°, with the possible hypersensitivity and tickling sensation;
3. On the stimulated side, outward hip movements occur at 30°, with the possible hypersensitivity and tickling sensation;
4. On the stimulated side, outward hip movements occur at 45°, with the possible hypersensitivity and tickling sensation;
5. On the stimulated side, outward hip movements occur at 45°, thereby affecting the child's balance with the possible hypersensitivity and tickling sensation.

The Moro reflex was tested by turning the back of the assistant's arm and tilting the head back. Wait for whether the child bends his knees, pulls his arms out of the way, maintains the movement during the backing up, or makes other hand movements. It was recommended to close the eyes beginning while heading Movements.

2.7. The scoring of Moro reflexes was as followed

1. No reaction (arm will remain in starting position);
2. Slight movement of the arms outside and/or redness of the skin;
3. A definite partial abduction of the arms and an intake of breath and/or a little reluctance to take part in the test, difficulty falling backward;
4. 75% abduction of arm and/or the participant is shaken by the test procedure and/or holding his/her breathe, skin redness, or pallor;
5. Full abduction of arm and/or very significant irritation during the test procedure, possible screaming, significant resistance to test, or anxiety.

APRs have fully integrated into the child's central nervous system, leading to no reaction. The reflex activity level was determined based on compensatory movements, emotional reactions, and changes in breathing patterns, grimaces, or the pout of lips.The lower the reflex integration, the higher the score. The maximum score was 40 points was converted into reflex activity level on a scale of 0 to 4. Table 1 The degree of primitive reflex integration scale Final scores in APR examination Level of reflex activity

Table 1 The Degree of Primitive Reflex Integration Scale

Final scores in APR examination	Level of reflex activity
0-3	No activity
4-15	Low
16-25	Medium
26-35	High
36-40	Max

Motor Proficiency Test (MOT) Assessment [7] The MOT 4–6 involved 18 items with a high-performance rating. It requires children to have good balance, cooperation, and concentration and is easy to repeat, evaluate, challenge preschoolers' skills, and show their physical strength. These activities were classified into four types of performance: (a) stability, (b) locomotion, (c) object control, and (d) fine movement skills. Description of Items - 0. Forward jump in a hoop 1. Forward balance (b) 2. Placing dots on a sheet (d) 3. Grasping a tissue with toes (d) 4. Sideward jump (b) 5. Catching a stick (c) 6. Carrying balls from one box to another (b, c) 7. Reverse balance (b) 8. Throwing at a target disk (c) 9. Collecting matches (d) 10. Passing through a hoop (a, b) 11. Jumping in a hoop on 1 foot, standing on 1 leg (a, b) 12. Catching a tennis ring (c) 13. Jumping jacks (b) 14. Jumping over the cord (b) 15. Rolling around the long axis of the body (a, b) 16. Standing up while holding a ball on the head (b, c) 17. Jumping and turning in a hoop (a, b). The test was graded on a three-point scale, showing 0 mean not completed, 1 mean completed 50% of the child's capacity, and 2 mean fully mastered. This question contains a total of 34 points.The higher the scores, the higher the skill. The points were converted to a five-point scale describing child development accelerated (4), very

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good (3), normal (2), delayed (1), or altered (0). Each activity was examined 3 times to obtain the best positive answers. Table 2 The MOT test range scale Final scores of MOT examination Level of Motor activity.

Table 2 The MOT Test Range Scale

Final scores of MOT examination	Level of Motor activity
0-8	Altered
9-15	Delated
16-25	Normal
26-29	Very good
30-34	Accelerated

3. Results and Discussion

3.1. Results

Statistical analysis IBM SPSS Statistics version 21 (IBM Corp., Armonk, NY, USA) was used to analyze the results, which were considered significant if $p < 0.05$ and with a confidence interval of 95%. The mean and standard deviation of age, gender, and BMI were calculated. The Kolmogorov-Smirnov test was used to determine a normal distribution, which suggested that the distribution of the data results was not normal. So, Spearman's correlation coefficient was used to determine the relationship between quantitative variables, which was a nonparametric test. (The p-value is <0.05).

Table 3 Descriptive Characteristics of the Children with ADHD

Characteristics	Mean ± SD
Gender	M-12,F-2
Age (years)	4.91 ± 0.67
Birth weight (Kg)	2.82 ± 0.28
started walking _Age(month)	15.35 ± 2.59
Diagnosed age (month)	29.28 ± 6.20
Screen time (hrs.)	2.42 ± 0.93
Mother age (years)	24.82 ± 1.71
Father age (years)	27.02 ± 1.52

3.1.1. Test of reflex activity level

The results of the score obtained during the evaluation of all reflexes (up to 40 scores) were converted to the level of reflex activity. The results showed 64.28% had a low reflex activity level. 28.57% children were showing moderate levels of reflex activity. High level of reflex activity were not observed in any of the children, The results for the reflex activity levels are shown in Figure 1.

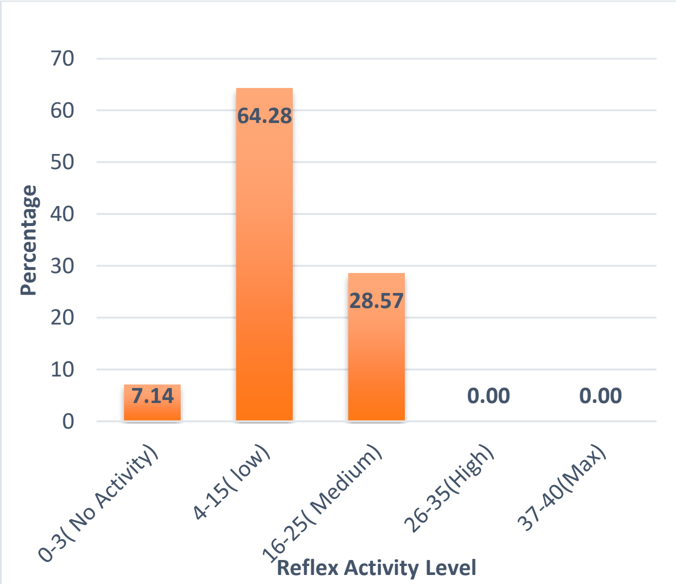

Figure 1 The Results for the Level of Reflex Activity

3.1.2. Results of the APR Examination

The most common reflexes of ADHD children were GALANT L, STNR_R, STNR_L and TLR E. Slightly fewer children showed a MORO (40.3%). Palmar grasp was not frequent. The results expressed as a percentage are shown in Table 3.2 MOT 4–6 Results. The most difficult tasks for the child were reverse balance (No. 7), Throwing at a target disk (No.8), Passing through a hoop (No.10), Jumping in a hoop on 1 foot, standing on 1 leg (No.11), Catching a tennis ring (No. 12), jumping jacks (No. 13), Rolling around the long axis of the body (No.15) about 30 to 40% of children did not complete these tasks. Tables 1.2. and 1.3. show the percentage results for children with the maximum and minimum scores achieved by children in MOT 4–6.

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Table 4 The Results of The Examination of Reflexes

Scale	ATNR R	ATNR L	GALANT R	GALANT L	PALMER R	PALMER L
0	21.40%	42.90%	57.10%	42.90%	50.00%	64.30%
1	42.90%	21.40%	21.40%	42.90%	28.60%	14.30%
2	21.40%	7.10%	7.10%	14.30%	14.30%	14.30%
3	14.30%	14.30%	14.30%	0%	7.10%	7.10%
4	0%	14.30%	0%	0%	0%	0%

Table 5 Reflexes Examination

Scale	STNR F	STNR E	TLR F	TLR E	MORO
0	50.00%	35.70%	71.40%	57.10%	7.10%
1	14.30%	14.30%	7.10%	28.60%	50.00%
2	21.40%	28.6%	21.4%	0.00%	42.90%
3	14.30%	14.30%	0%	14.30%	0%
4	0%	7.10%	0%	0%	0%

Table 6 The Results of MOT 4–6 for Tasks 1–8

Scale	1	2	3	4	5	6	7	8
0	0.00	7.10%	0.00	21.40%	42.90%	0.00	28.60%	21.04%
1	64.30%	57.10%	57.10%	57.10%	35.70%	50.00%	57.10%	57.10%
2	35.70%	35.70%	42.90%	21.40%	21.40%	50.00%	14.30%	21.30%

Table 7 The Results of MOT 4–6 for Tasks 9–17

Scale	9	10	11	12	13	14	15	16	17
0	7.10%	0.00	35.70%	35.70%	7.10%	14.30%	28.80%	7.10%	14.30%
1	64.30%	50.00%	35.70%	28.60%	57.10%	57.10%	35.70%	71.40%	64.30%
2	28.60%	50.00%	28.60%	35.70%	35.70%	28.80%	35.70%	21.40%	21.40%

3.1.3. The Results of the Motor Proficiency Test and Active Primitive reflex Activity

Statistical analysis showed that reflex activity was inversely correlated with motor proficiency (MOT 4-6), $p < 0.05$. Consequently, children with strong activity of reflex lead to low motor proficiency. There is also a positive relationship between MOT level and individual reflex activity. The strongest statistically significant correlations were for ATNR_L,GALANT_R, PALMAR_R, STNR_F, and TLR_F, The correlation coefficient analysis between MOT 4-6 and reflex activity is shown in Table 3.4.

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Table 8 The Correlation Coefficient Between Active Primitive Reflex and Mot Levels

Reflex	Correlation Coefficient	P –Value
ATNR_R	-0.114	0.699
ATNR_L	-0.602[a]	0.023
GALANT_R	-0.020[a]	0.946
GALANT_L	-0.343	0.230
PALMER_R	-0.197	0.499
PALMER_L	0.547[a]	0.043
STNR_F	-0.804[b]	0.001
STNR_E	-0.344	0.228
TLR_F	-0.758[b]	0.002
TLR_E	-0.516	0.059
MORO	0.091	0.758

[a] Correlation is significant at $p < 0.05$ level
[b] Correlation is significant at $p < 0.01$ level

The correlations between individual MOT 4–6 tasks and APR levels were found. Placing dots on a sheet (No. 2), reverse balance (No. 7), Throwing at a target disk (No.8), Passing through a hoop (No.10), Jumping in a hoop on 1 foot, standing on 1 leg (No.11), Catching a tennis ring (No. 12), jumping jacks (No. 13), Rolling around the long axis of the body (No.15) and jumping and turning in a hoop (No.17) had the strongest correlations with total tonic reflex scores. The relationships between each Task of MOT 4-6 with the levels of reflex activity were presented in Table 3.5.

Table 9 Coefficient Correlation

MOT 4 – 6 task	Coefficient Correlation	P –Value
Forward balance	0.391	0.167
Placing dots on a sheet	-0.642*	0.013
Grasping a tissue with toes	-0.505	0.066
Sideward jump	-0.245	0.398
Catching a stick	- 0.351	0.219
Carrying balls from one box to another	- 0.410	0.145
Reverse balance	-0.523*	0.050
Throwing at a target disk	-0.599*	0.023
Collecting matches	0.254	0.381
Passing through a hoop	-0.803**	0.001
Jumping in a hoop on 1 foot, standing on 1 leg	-0.633*	0.015
Catching a tennis ring	-0.633*	0.015
Jumping jacks	-0.325	0.257
Jumping over a cord	-0.403	0.153
Rolling around the long axis of the body	-0.788**	0.00
Standing up while holding a ball on the head	-0.022	0.940
Jumping and turning in a hoop	-0.577*	0.031

***Correlation is significant at $p < 0.05$ level**
****Correlation is significant at $p < 0.01$ level**

3.2. Discussion

Our study aimed to verify whether the level of APR is associated with motor performance in children with ADHD. Which primitive reflex activity is higher in children with ADHD. The study of APR with motor skills is an important aspect of the development screening, which is untouched. We hypothesized that the increased primary reflexes were linked to decreased motor performance in children with ADHD. Children with ADHD exhibit low to moderate levels of reflex activity. The higher their reflex activity, the more difficult it is for them to complete specific motor tasks. Many studies have shown that the retained basic reflex influences ADHD behavior, motor skills, and learning.Children with ADHD frequently experience delays and deficits in motor skills development. Research indicates that these deficits can manifest in various ways, including challenges in gross motor skills (e.g., balance, coordination) and fine motor skills (e.g., handwriting, manipulating small objects)[4]. The presence of persistent primitive reflexes in children with ADHD exacerbates these motor difficulties, potentially leading to greater impairment in motor coordination and adaptive functioning in daily activities.[1][5]. The relationship between persistent primitive reflexes, ADHD, and motor skills development is complex and multifaceted. Several mechanisms may contribute to this interplay: Neurological Overlaps: Both ADHD and persistent primitive reflexes involve alterations in neurological pathways and sensory-motor integration processes. [12] These alterations can affect motor planning, execution, and control. Executive Function Deficits: Deficits in executive functions associated with ADHD, such as impulsivity and poor planning, may hinder the ability to learn and perform motor tasks effectively.[5]. Compensatory Strategies: Children with ADHD and persistent primitive reflexes may develop compensatory strategies or adaptive behaviors to manage motor challenges, but these strategies may not fully address underlying motor coordination deficits. [4] Understanding the interrelationships between persistent primitive reflexes, ADHD, and motor skills development is crucial for developing effective clinical strategies. Future research should focus on longitudinal studies to elucidate the trajectory of motor development in children with ADHD and persistent reflexes, as well as randomized controlled trials to evaluate the efficacy of different intervention approaches. Understanding the interrelationships between persistent primitive reflexes, ADHD, and motor skills development is crucial for developing effective clinical strategies. Future research should focus on longitudinal studies to elucidate the trajectory of motor development in children with ADHD and persistent reflexes, as well as randomized controlled trials to evaluate the efficacy of different intervention approaches.

Conclusion

Based on the study's findings linking ADHD symptoms with persistence of primitive reflexes and their association with motor skills, it appears that ADHD symptoms could potentially manifest as a compensatory mechanism for incomplete developmental phases involving these reflexes. This implies that individuals with ADHD might exhibit symptoms as a result of lingering primitive reflexes that have not fully integrated, affecting their motor coordination and potentially other aspects of neurological development. Further research into the mechanisms underlying these associations could provide insights into both the etiology of ADHD and potential therapeutic interventions aimed at addressing developmental delays in reflex integration.

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