Objectivization of the Asymmetrical Tonic Neck Reflex (ATNR) Assessment Using the Schilder Test in Physiotherapy

Dominik Sanitra

University of Žilina

Department of Theoretical Electrical Engineering and Biomedical Engineering, Research Centre of the University of Žilina

Univerzitná 8215/1, 010 26 Žilina, Slovakia

dominiksanitra2@gmail.com

Abstract. *Active primitive reflexes are involuntary motor responses present during early infancy that should gradually diminish or become suppressed by the neocortex during normal neurological development. Persistence of these reflexes in later stages of life may indicate neurodevelopmental dysfunction and can affect posture, balance, and motor coordination. This work focuses on the objective assessment of the Asymmetrical Tonic Neck Reflex (ATNR) using the Schilder Test. The proposed wearable measurement system combines physiological and kinematic monitoring. Heart rate and peripheral blood oxygen saturation (SpO_2) are measured using a MAX30102 photoplethysmography (PPG) sensor, while upper-limb motion is recorded using an ICM20948 accelerometer. Both sensors are controlled by an ESP32 microcontroller, which performs data acquisition, synchronization, signal preprocessing, and wireless transmission of the measured data to a personal computer via a ESP-NOW protocol. The system records involuntary arm movements. Signal processing includes artifact suppression, low-pass filtering of the PPG signal, and extraction of physiological and motion parameters. The recorded data are subsequently analyzed to identify characteristic patterns associated with retained primitive reflexes, including elevated heart rate and excessive involuntary movement in response to the expected stimulus. Experimental observations demonstrated that healthy subjects exhibit only minor physiological arm deviations, corresponding to a baseline of a few degrees of angular displacement. In contrast, subjects with clinically confirmed retained ATNR showed substantially larger deviations, typically reaching several tens of degrees during head rotation. These findings suggest that quantitative motion analysis can improve the objectivity and reproducibility of ATNR assessment compared with conventional visual evaluation.*

Keywords. Active primitive reflexes, Asymmetrical Tonic Neck Reflex (ATNR), Schilder Test, Photoplethysmography (PPG), ESP32, wearable sensing technology

References

Leisman, G. and Melillo, R. (2025), Evaluating Primitive Reflexes in Early Childhood as a Potential Biomarker for Developmental Disabilities. J Paediatr Child Health, 61: 846-851. https://doi.org/10.1111/jpc.70053

Pecuch, A., Gieysztor, E., Wolańska, E., Telenga, M., & Paprocka-Borowicz, M. (2021). Primitive Reflex Activity in Relation to Motor Skills in Healthy Preschool Children. *Brain Sciences*, *11*(8), 967. https://doi.org/10.3390/brainsci11080967

Provazník, A., Musálek, M., Bob, P., Větrovský, T., Malambo, C., Silva, A. F., & Anderson, D. (2026). Persisting primitive reflexes and motor and cognitive development in children: A systematic review. *Acta Psychologica, 266*, Article 106827. https://doi.org/10.1016/j.actpsy.2026.106827

Kalemba, A., Lorent, M., Blythe, S. G., & Gieysztor, E. (2023). The correlation between residual primitive reflexes and clock reading difficulties in school-aged children—A pilot study. *International Journal of Environmental Research and Public Health, 20*(3), Article 2322. https://doi.org/10.3390/ijerph20032322

Analog Devices, *MAX30102: High-Sensitivity Pulse Oximeter and Heart-Rate Sensor for Wearable Health Data Sheet*, Rev. 1, Nov. 2018. [Online]. https://www.analog.com/en/products/max30102.html

TDK InvenSense, *ICM-20948: World's Lowest Power 9-Axis MEMS MotionTracking™ Device Datasheet*, Rev. 1.6. [Online]. https://invensense.tdk.com/products/motion-tracking/9-axis/icm-20948/