

# The Developmental Characteristics of Vestibular and Proprioceptive Functions in Children Aged 3 To 12: A Comparison between Linear and Nonlinear Models

Shao-Hsia Chang<sup>1</sup>, Nan-Ying Yu<sup>2</sup>

<sup>1</sup>Department of Occupational Therapy, I-Shou University  
No.8, Yida Rd., Jiaosu Village Yanchao District, Kaohsiung City, Taiwan  
stacey12@isu.edu.tw

<sup>2</sup>Department of Physical Therapy, I-Shou University  
No.8, Yida Rd., Jiaosu Village Yanchao District, Kaohsiung City, Taiwan  
ying@isu.edu.tw

## Extended Abstract

Sensory integration (SI) is one of the important intervention strategies in paediatric occupational therapy. The evaluation of sensory integration is crucial for providing a foundation of the evidence-based intervention. Based on the assessment of the children's development of the sensory, motor, and praxis skills, Evaluation in Ayres Sensory Integration (EASI) has been developed for providing a valid evaluation tool in clinical practice (ASI®). There are four major categories including a total of 20 subtests. The ASI® has been working on standardized norms according to individual districts and ethnics for the generalized use in the globe. Taiwan EASI team has joined the project and started this study to explore the developmental characteristics of Evaluation in Ayres Sensory Integration.

Sensory integration generally develops along a normal sequence. However, few studies have examined how age factor affects sensory integration function in children during development. Most studies used statistical method (ex. ANOVA or linear regression) to analyse the age factor affecting on the development of sensory integration [1, 2]. However, nonlinear hyperbolic models are found especially valuable to clinical applications because the defining characteristics of the developmental process such as initial levels, rates of change during developmental spurts, and asymptotic levels can be estimated [3]. This study aimed to characterize the age factor of sensory integration tests. This study aimed to explore and compare linear regression and hyperbolic functions. The study population comprised 209 children aged 3 to 12 years. Subjects were scored on six subsets of vestibular and proprioceptive functions. Linear regression and nonlinear curve fitting were used to investigate the nature and shape of the relationship between children's age and scores of sensory integration tests. The parameters were estimated using the least-squares minimization techniques. The overall variances explained (R<sup>2</sup>) for the 6 vestibular and proprioceptive functions were 39.6% to 46.3% and 48.3% to 54.2% in linear and nonlinear models, respectively. The sum of squared errors of the linear model is from 3944.5 to 4223.6, and in the nonlinear model it is reduced to from 2943.1 to 3832.7.

The ultimate goal of this study is to construct an EASI-based database for clinical applications. The result of this study provides clinical applications in the confirmation of SI problems. With the promising results of this study, the hyperbolic model can be used for a reference to norm data and to precisely characterize the evaluation result and for accumulating the clinical data of the evidence-based practice in a long-term plan.

## References

- [1] C.-K. Lin, H.-M. Wu, H.-Y. Wang, M.-H. Tseng, and C.-H. Lin, "Age as a factor in sensory integration function in Taiwanese children," *Neuropsychiatric Disease and Treatment*, pp. 995-1001, 2013.
- [2] L. Lamash, P. Grady-Dominguez, Z. Mailloux, L. D. Parham, R. C. Schaaf, S. S. Roley, and E. Gal, "EASI Praxis tests: Age trends and internal consistency," *The American Journal of Occupational Therapy*, vol. 76, no. 2, 2022.
- [3] K. J. Grimm, N. Ram, and F. Hamagami, "Nonlinear growth curves in developmental research," *Child development*, vol. 82, no. 5, pp. 1357-1371, 2011.