**Sensory Integration and Praxis in Autism: Implications for Social Participation**

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Abelenda, J., Mailloux, Z., & Smith Roley, S. (2015, September). Dyspraxia in autism spectrum disorders: evidence and implications.*Sensory. Integration Special Interest Section Quarterly, 38*(3), 1–4.

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Washington, DC: Author.

Autism Speaks (September 25, 2012). Top 8 autism therapies – Reported by parents. Retrieved [www.autismspeaks.org](http://www.autismspeaks.org).

Ayres, A. J. (1965). Patterns of perceptual–motor dysfunction in children: A factor analytic study. *Perceptual and Motor Skills, 20,* 335–368.

Ayres, A. J. (1966). Interrelationships among perceptual–motor functions in children. *American Journal of Occupational Therapy, 20,* 68–71.

Ayres, A. J. (1969). Deficits in sensory integration in educationally handicapped children. *Journal of Learning Disabilities, 2,* 160.

Ayres, A. J. (1972). Types of sensory integrative dysfunction among disabled learners. *American Journal of Occupational Therapy, 26,* 13–18.

Ayres, A. J. (1977). Cluster analyses of measures of sensory integration. *American Journal of Occupational Therapy, 31,* 362–366.

Ayres, A.J. (1979, 2005). *Sensory integration and the child.* Los Angeles, CA: Western Psychological Services.

Ayres, A. J., & Tickle, L. S. (1980). Hyper-responsivity to touch and vestibular stimuli as a predictor of positive response to sensory integration procedures by autistic children. *American Journal of Occupational Therapy*, *34*, 375–381.

Ayres, AJ (1989). *The Sensory Integration and Praxis Tests Manual.* LA, CA: Western Psychological Services.

Ayres, A.J. & Cermak, S. (2011). *Ayres Dyspraxia Monograph.* Torrance, CA. Pediatric Therapy Network.

Ayres, A. J., & Tickle, L. S. (1980). Hyper-responsivity to touch and vestibular stimuli as a predictor of positive response to sensory integration procedures by autistic children. *American Journal of Occupational Therapy*, *34*, 375–381.

Baker, A., Lane, A., Angley, M., & Young, R. (2008). The relationship between sensory processing patterns and behavioral responsiveness in autistic disorder: A pilot study. *Journal of Autism and Developmental Disorders, 38,* 867-875.

Baranek, G.T., David, F.J., Poe, M.D., Stone, W.L., & Watson, L.R. (2006). The Sensory Experiences Questionnaire: Discriminating response patterns in young children with autism, developmental delays, and typical development. *Journal of Child Psychology and Psychiatry, 47(6),* 591-601.

Ben-Sasson, A., Cermak, S. A., Orsmond, G. I., Tager-Flusberg, H., Carter, A. S., Kadlec, M. B., & Dunn, W. (2007). Extreme sensory modulation behaviors in toddlers with autism spectrum disorders. American Journal of Occupational Therapy, 61, 584–592.

Ben-Sasson, A., Hen, L., Fluss, R., Cermak, S.A., Engel-Yeger, B. & Gal, Y. (2008). A meta-analysis of sensory modulation symptoms in individuals with autism spectrum disorders. *Journal of Autism and Developmental Disorders, 39,* 1-11.

Case-Smith, J., Weaver, L.L., & Fristad, M.A. (2014). A systematic review of sensory processing interventions for children with autism spectrum disorders. *Autism,* 1-16. <http://aut.sagepub.com/content/early/2014/01/29/1362361313517762>

Case-Smith, J. & Bryan, T. (1999). The effects of occupational therapy with sensory integration emphasis on preschool age children with autism. *American Journal of Occupational Therapy, 53*, 489-97.

Cermak, S.A., Curtin, C., & Bandini, L.G. (2010). Food selectivity and sensory sensitivity in children with Autism Spectrum Disorders. *Journal of American Dietetic Association; 110,* 238-246.

[Crane, L](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=Search&Term=%22Crane%20L%22%5BAuthor%5D&itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_DiscoveryPanel.Pubmed_RVAbstractPlus)., [Goddard, L](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=Search&Term=%22Goddard%20L%22%5BAuthor%5D&itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_DiscoveryPanel.Pubmed_RVAbstractPlus)., & [Pring, L](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=Search&Term=%22Pring%20L%22%5BAuthor%5D&itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_DiscoveryPanel.Pubmed_RVAbstractPlus). (2009). Sensory processing in adults with autism spectrum disorders. *Autism**,* *13*(3), 215–228.

Dawson, G., & Watling, R. (2000). Interventions to facilitate auditory, visual, motor integration in autism: A review of the evidence. *Journal of Autism and Developmental Disorders, 30* (5), 415-421.

Dawson, G., & Adams, A. (1984). Imitation and social responsiveness in autistic children. *Journal of Abnormal Child Psychology, 12*, 209–226.

De Jaegher, H. (2013). Embodiment and sense-making in autism. *Frontiers in Integrative Neuroscience, 7,* 15.

Donnellan, A. M., Hill, D. A., & Leary, M. R. (2013). Rethinking autism: Implications of sensory and movement differences for understanding and support. *Frontiers in Integrative Neuroscience, 6,* 124.

Dowell, L.R., Mahone, E.M., & Mostofsky, S.H. (2009). Associations of postural knowledge and basic motor skill with dyspraxia in autism: Implications for abnormalities in distributed connectivity and motor learning. *Neuropsychology 23*(5), 563-570.

Dunn, W., Myles, B. S., & Orr, S. (2002). Sensory processing issues associated with Asperger

 Syndrome: A preliminary investigation. *American Journal of Occupational Therapy,*

 *56*(1), 97-102.

Dziuk, M.A., Gidley Larson, J.D., Apostu, A., Mahone, E.M., Denckla, M.B., & Mostofsky, S.H. (2007). Dyspraxia in autism: Association with motor, social and communicative deficits. *Developmental Medicine and Child Neurology*, *49*: 734-739.

Gowen, E., & Hamilton, A. (2012). Motor abilities in autism: A review using computational context. Journal of Autism and Developmental Disorders. DOI 10.1007/s10803-012-1574-0.

Green, S. a, Ben-Sasson, A., Soto, T. W., & Carter, A. S. (2012). Anxiety and sensory over-responsivity in toddlers with autism spectrum disorders: bidirectional effects across time. *Journal of Autism and Developmental Disorders*, *42*(6), 1112–9. doi:10.1007/s10803-011-1361-3

Hadders-Algra, M. & Carlberg, E.B. (2008). *Postural control: A key issue in developmental disorders.* London, England: Mac Keith Press.

Henderson, S.E., Sugden, D.A., & Barnett, A.L. (2007). *Movement Assessment Battery for Children – 2 2nd Edition (Movement ABC-2).*  London: Harcourt Assessment.

Henderson, A., Llorens, L., Gilfoyle, E., Myers, C., & Prevel, S. (Eds.). (1974). *The development of sensory integrative theory and practice: A collection of the works of A. Jean Ayres*. Dubuque, IA: Kendall/Hunt.

IaroccI, G. & McDonald, J. (2006). Research: Sensory Integration and the Perceptual Experience of Persons with Autism. *Journal of Autism and Developmental Disord*ers. 36, 77-90.

Iwanaga, R., Honda, S., Nakane, H., Tanaka, K., Toeda, H., & Tanaka, G. (2014). Pilot study: Efficacy of sensory integration therapy for Japanese children with high functioning autism spectrum disorder. *Occupational Therapy International, 21*, 4–11.

Jones, V. & Prior, M. (1985). Motor imitation abilities and neurological signs in autistic children. *Journal of Autism and Developmental Disorders, 15*(1), 37-46.

Kapp, S. K. (2013). Empathizing with sensory and movement differences: moving toward sensitive understanding of autism. *Frontiers in Integrative Neuroscience, 7*, 38.

Klin, A., Jones, W., Schultz, R., & Volkmar, F. (2003). The enactive mind, or from actions to cognition: Lessons from autism. *Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences, 358*(1430), 345–360.

Lane, A.E., Young, R.L., Baker, A.E.Z. & Angley, M.T. (2010). Sensory processing subtypes in autism: Association with adaptive behavior. *Journal of Autism and Developmental Disorders. 40,* 112-122.

Lane, A. E., Dennis, S. J., & Geraghty, M. E. (2011). Brief report: Further evidence of sensory subtypes in autism. *Journal of Autism and Developmental Disorders, 41,* 826–831.

Lane, A. E., Molloy, C. A., & Bishop, S. L. (2014). Classification of children with autism spectrum disorder by sensory subtype: A case for sensory-based phenotypes. *Autism Research, 7,* 322–333. <http://dx.doi.org/10.1002/aur.1368>

Liss, M., Saulnier, C., Fein, D., & Kinsbourne, M. (2006). Sensory and attention abnormalities in autistic spectrum disorders. Autism, 10, 155–172.

Mailloux, Z., Mulligan, S., Smith Roley, S., Blanche, E., Cermak, S., Coleman, G. G., . . . Lane, C. J. (2011). Verification and clarification of patterns of sensory integrative dysfunction. *American Journal of Occupational Therapy, 65*, 143–151.

Marco, EJ, Hinkley, LBN, Hill SS, & Magarajan SS (2011). Sensory processing in autism: A review of neurophysiologic findings. *Pediatric Research,* 69(5), 48-54R.

MacNeil, L. K., & Mostofsky, S. H. (2012). Specificity of dyspraxia in children with autism. *Neuropsychology, 26*, 165–171.

McDuffie, A., Turner, L., Stone, W., Yoder, P., Wolery, M., & Ulman, T. (2007). Developmental correlates of different types of motor imitation in young children with autism spectrum disorders. *Journal of Autism and Developmental Disorders. 37,* 401-412.

Miller Kuhaneck, H., Henry, D., & Glennon, T. (2007). *The Sensory Processing Measure-Classroom.* Los Angeles: Western Psychological Services.

Minshew, N.J., Sung, K., Jones, B., & Furman, J. (2004). Underdevelopment of the postural control system in autism. *Neurology, 63*, 2056-2061. Retrieved on 5/17/06 from www.neurology.org.

Mostofsky, S.H., Dubey, P., Jerath, V.K., Jansiewicz, E.M., Goldberg, M.C., & Denckla, M.B. (2006). Developmental dyspraxia is not limited to imitation in children with autism spectrum disorders. *Journal of the International Neuropsychological Society. 12,* 314-326.

Mulligan, S. (1998). Patterns of sensory integration dysfunction: A confirmatory factor analysis. *American Journal of Occupational Therapy*, *52,* 819–828.

Parham, L.D., Cohn, E., Spitzer, S., Koomar, J.A., Miller, L.J., Burke, J.P., Summers, C.A. (2007). Fidelity in sensory integration intervention research. *American Journal of Occupational Therapy*, *61*(2), 216-227.

Parham L. D., & Ecker, C. L. (2007). *Sensory Processing Measure (SPM) Home Form*. Los Angeles: Western Psychological Services.

Parham, L.D., Mailloux, Z., & Roley, S.S.  (2000). *Sensory processing and praxis in high functioning children with autism*. Unpublished manuscript.

Parham, L.D., Smith Roley, S., May-Benson, T., Koomar, J., Brett-Green, B., Burke, J.P., …& Schaaf, R.C. (2011). Development of a fidelity measure for research on effectiveness of *Ayres Sensory Integration®* intervention. *American Journal of Occupational Therapy*, 65, 2, 133-142.

Pfeiffer, B. a., Koenig, K., Kinnealey, M., Sheppard, M., & Henderson, L. (2011). Effectiveness of sensory integration interventions in children with Autism Spectrum Disorders : A pilot study. *American Journal of Occupational Therapy*, *65*(1), 76–85. doi:10.5014/ajot.2011.09205

Reynolds, S., & Lane, S. J. (*2009*). Sensory over-responsivity and anxiety in children with ADHD. *The American Journal of Occupational Therapy, 63, 4*, 433-440.

Reynolds, S., Thacker, I., & Lane, S.J. (2012). Sensory processing, physiological stress, and sleep behaviors in children with and without autism spectrum disorders. *Occupational Therapy Journal of Research 32,*(1), 246-257*.* DOI: 10.3928/15394492-20110513-02

Reynolds, S., Millette, A., & Devine, D.P. (2012). Sensory and motor characterization in the postnatal valproate rat model of autism. *Developmental Neuroscience.* 1-10.DOI: 10.1159/000336646

Rizzolati, G. & Fadiga, L., Gallese, V., Fogassi, L. (1996). Premotor cortex and the recognition of motor actions. *Cognitive brain research 3* (2), 131-141.

Rogers, S. J., Bennetto, L., McEvoy, R., & Pennington, B. F. (1996). Imitation and pantomime in high‐functioning adolescents with autism spectrum disorders. *Child Development, 67*, 2060–2073.

Rogers, S.J. & Ozonoff, S. (2005). Annotation: What do we know about sensory dysfunction in autism? A critical review of the empirical evidence. *Journal of* *Child Psychology and Psychiatry, 46,* 1235-1268.

Schaaf, R.C. (2011). Interventions that address sensory dysfunction for individuals with autism spectrum disorders: Preliminary evidence for the superiority of sensory integration compared to other sensory approaches. In B Reichow, P Doehring, DV Cichetti, & FR Volkmar (Eds).  *Evidence-based practices and treatments for children with Autism*

Schaaf, R., Benevides, T., Mailloux, Z., Faller, P., Hunt, J., van Hooydonk, E.,… Kelly, D. (2013). An intervention for sensory difficulties in children with autism: A randomized trial. *Journal of Autism and Developmental Disorders*, *44*, 1493–1506.

Schaaf, R. & Mailloux, Z. (2015). A clinicians guide for implementing Ayres Sensory Integration: Promoting participation for children with autism. Baltimore, MD: AOTA Press. (pp.245-273). NY, NY: Springer.

Schoen, S.A., Miller, L.J., Brett-Green, B.A., & Nielsen, D.M. (2009). Physiological and behavioral differences in sensory processing: A comparison of children with autism spectrum disorder and sensory modulation disorder. *Frontiers Integrated Neuroscience; 3*(29) Epub 2009 Nov 3.

Siaperas, P., Ring, H.A., McAllister, C.J., Henderson, S., Barnett, A., Watson, P., & Holland, A.J.. (2011). Atypical movement performance and sensory integration in Asperger’s syndrome. *Journal of Autism and Developmental Disorders,* 42(5), 718-725. DOI 10, 1007//s10802-011-1301-2.

Smith, I.M. & Bryson, S.E. (2007). Gesture imitation in autism: II. Symbolic gestures and pantomimed object use. *Cognitive Neuropsychology. 24*(7),679-700.

Smith Roley, S., Mailloux, Z., Parham, L. D., Schaaf, R. C., Lane, C. J., & Cermak, S. (2015). Sensory integration and praxis patterns in children with autism. *American Journal of Occupational Therapy, 69*, 1–8. http://dx.doi.org/10.5014/ajot.2015.012476

Teitelbaum, P., Teitelbaum, O., Nye, J., Fryman, J., & Maurer, R.G. (1998). Movement analysis in infancy may be useful for early diagnosis of autism. *Proceedings of the National Academy of Sciences, 95,* 13982–13987.

Tomchek, S. D., & Dunn, W. (2007). Sensory processing in children with and without autism: A comparative study using the Short Sensory Profile. *American Journal of Occupational Therapy, 61,*190-200.

van Jaarsveld, A., Mailloux, Z., Smith Roley, S., Raubenheimer, J.(2015). [Patterns of sensory integration dysfunction in children from South Africa](http://www.mendeley.com/c/7375813254/p/20555231/van-jaarsveld-2014-patterns-of-sensory-integration-dysfunction-in-children-from-south-africa/). *South African Journal of Occupational Therapy 44* (2), 2-6.

Watson, L.R., Patten, E., Baranek, G.T., Poe, M., Boyd, B.A., Freuler, A., Lorenzi, J. (2011).

 [Differential associations between sensory response patterns and language, social, and communication measures in children with autism or other developmental disabilities.](http://www.ncbi.nlm.nih.gov/pubmed/21862675)

 *Journal of Speech Language and Hearing Research. 54*(6), 1562-76.

Williams, M.S., & Shellenberger, S. (1996). *“How Does Your Engine Run?”® A leader’s guide to the Alert Program® for self-regulation*. Albuquerque, NM: TherapyWorks, Inc.

Woodard, C., R., Goodwin, M.S., Zelazo, P.R. Zelazo, Aube, D. Scrimgeour, M., Ostehothoff, T., & Brickley, M. (2012). A comparison of autonomic behavioral, and parent-report measures of sensory sensitivity in young children with autism. *Research in Autism Spectrum Disorders*, 6, 1234-1246.

Zones of Regulation - <http://www.zonesofregulation.com/>

Zwaigenbaum, L., Bauman, M.L., Choueiri, R., Fein, D., Kasari, C., Pierce, K., Stone, W., Yirmiya, N., Buie, T., Carter, A., Davis, P., Estes, A., Granpeesheh, D., Hansen, R.L., McPartland, J.S., Mailloux, Z., Natowicz, M., newschaffer, C., Robins, D., Smith Roley, S., Wagner, S., Wtherby, A. (in press).Early identification, screening, and intervention in autism: attaining best outcomes. *Pediatrics.*