

Arranging the Room to Engage the Child and Aspects of the Environment That Can Impact Performance

This section will include summaries of the literature from the field of education on the importance of room set up for learning and also will include information about the sensory affordances of objects / activities and how they can enhance performance.

2009

Hatice Zeynep Inan (2009). The Third Dimension in Preschools: Preschool Environments and Classroom Design *European Journal of Educational Studies* 1(1) 55
http://www.ozelacademy.com/EJES_vn1_Inan.pdf

Hatice Zeynep Inan, (2009). Understanding Features of Amiable Environments That Can Nourish Emergent Literacy Skills of Preschoolers *Australian Journal of Basic and Applied Sciences* , 3(3): 2510-2518 <http://www.insipub.com/ajbas/2009/2510-2518.pdf>

Kirkorian HL, Pempek TA, Murphy LA, Schmidt ME, & Anderson DR. (2009). The impact of background television on parent-child interaction. *Child Dev.* 80(5), 1350-9.

Raymond, J.(2009). Interactions of attention, emotion and motivation. *Prog Brain Res.* 176, 293-308.

Sandseter, E. (2009). Affordances for risky play in preschool: The importance of features in the play environment. *Early Childhood Education Journal*, 36(5), 439-446.

Ya-huei Wang (2009). Open Space Learning Circle and Active Learning in English Communication Class *European Journal of Social Sciences*, 11, 3 http://www.eurojournals.com/ejss_11_3_13.pdf

An interesting link about designing educational environments more generally
http://www.futurelab.org.uk/resources/documents/handbooks/outdoor_learning_spaces2.pdf

A Book of interest By Alison Clark Transforming Children's Spaces Children's and adults' participation in designing learning environments

Prior to 2009

Bertenthal , B.I. (1996). Origins and early development of perception, action, and representation *Annual Review of Psychology.* 47, 431-459 .

De Barros, K.M.F.T., Fragosos, A.G.C., de Oliveira, A.L.B., Filho, J.E.C., & de Castro, R.M. (2003). Do environmental influences alter motor abilities acquisition? *Arq Neuropsiquiatr*, 61, (2-A), 170-175.*
Evans, G.W. (2006). Child development and the physical environment. *Annual Review of Psychology*,57,423-451.

Gibson,E.J. & Walker, A.S. (1984). Development of Knowledge of Visual-Tactual Affordances of Substance. *Child Development*,55, 453-460.

Gingold, William (1971) The Effects of Physical Environment on Children's Behavior in the Classroom. ERIC ED120942

Grezes, J. & Decety J. (2002). Does visual perception of object afford action? Evidence from a neuroimaging study. *Neuropsychologia*, 40, 212-222.

Klatte M, Meis M, Sukowski H, & Schick A. (2007). Effects of irrelevant speech and traffic noise on speech perception and cognitive performance in elementary school children. *Noise Health*. 9, 64-74.

Lewis, Michael. (1992). Individual differences in response to stress. *Pediatrics*, 90 (3), 487-490.

McEvoy, M.A., Fox, J.J. & Rosenberg, M.S. (1991). Organizing Preschool Environments Suggestions for Enhancing the Development/Learning of Preschool Children with Handicaps Topics in Early Childhood Special Education, 11(2), 18-28

Montesano, L. Lopes, M. Bernardino, A. Santos-Victor, J. (2007). Learning Object Affordances: From Sensory--Motor Coordination to Imitation: *Robotics, IEEE Transactions*, 24, 15-26.
http://www.robotcub.org/misc/review3/07_Montesano_Lopes_Bernardino_Santos-Victor.pdf

Pavese, Antonella; Buxbaum, & Laurel J. (2007). Action matters: The role of action plans and object affordances in selection for action. *Visual Cognition*, 9, 559-590.

Taylor Martina, Daniel L. Schwartzb (2005). Physically Distributed Learning: Adapting and Reinterpreting Physical Environments in the Development of Fraction Concepts *Cognitive Science* 29, 587-625.

Vetter, P. & Wolpert, D.M. (2000). Context estimation for sensorimotor control. *Journal of Neurophysiology*, 84, 1026-34.

van Hof P, van der Kamp J, & Savelsbergh GJ. (2008). The relation between infants' perception of catchableness and the control of catching. *Developmental Psychology*, 44, 182-94.

Weinstein, C.S. (1979). The Physical Environment of the School: A Review of the Research. *Review of Educational Research*, 49, 577-610.

Weinstein, C. S. (1977). Modifying Student Behavior in an Open Classroom through Changes in the Physical Design. *American Educational Research Journal*, 14, 3, 249-62.

Woolner, P., Hall, E., Higgins, S., McCaughey, C., & Wall, K. (2007). A Sound Foundation? What We Know about the Impact of Environments on Learning and the Implications for Building Schools for the Future. *Oxford Review of Education*, 33, 47-70.

A Pedagogy of Connection: The Place of Play
<http://www.cecde.ie/english/pdf/Vision%20into%20Practice/Brennan.pdf>

Optimal Learning Spaces <http://www.oecd.org/dataoecd/38/47/43834191.pdf>


Elegant Interior and Exterior Play Spaces for Young Children
<http://www.cecde.ie/english/pdf/Vision%20into%20Practice/Kalinowski.pdf>

Support of Optimal Arousal

This section will include summaries of articles on arousal and the neurobiology of arousal...suggesting that optimal arousal level is important for learning to occur.

Cosand, L.D., Cavanagh, T.M., Brown, A.A., Courtney' C.G., Rissling,A.J., Schell, A.M., & Dawson, M.E. (2008). Arousal, working memory, and conscious awareness in contingency learning ^T
Consciousness and Cognition, 17(4),1105-1113.

Dillon, D.G., & Labar, K.S. (2005). Startle modulation during conscious emotion regulation is arousal-dependent. *Behavioral Neuroscience*, 119, 1118-24.

Lee, T.R., Davis, J.M., Vye, N., & Bransford, J.D. (2008). Do higher levels of arousal predict better learning? an investigation of learning and physiological responses. International Conference on Learning Sciences, 72-74  Pdf (136 KB)

Pliner P, Loewen R. (2002). The effects of manipulated arousal on children's willingness to taste novel foods. *Physiol Behav.* 2002 Aug;76(4-5):551-8.

Collaboration of Activity Choice

This section will include summaries of articles on the impact of choice making from the field of psychology and from the behavioral literature.

This inclusion is not meant to imply that specific behavioral strategies are related to Ayres' Sensory Integration Approach. However, research on choice and choice making often is found within the behavioral literature.

2009

Anderson, Christine J.; (2009). Choice as an intervention in the academic setting for female residents of a juvenile home. Dissertation Abstracts International Section A: Humanities and Social Sciences, Vol 69(7-A) pp. 2668. [Dissertation]

Chris; Sabiston, Catherine M.; Raedeke, Thomas D.; Ha, Amy S. C.; Sum, Raymond K. W. (2009). Self-determined motivation and students' physical activity during structured physical education lessons and free choice periods. *Lonsdale, Preventive Medicine: An International Journal Devoted to Practice and Theory*, 48(1), 69-73. [Journal Article]

Clark, Cindy Dell (Ed.) (2009). 'It's only play if you get to choose': Children's perceptions of play, and adult interventions. *Factor*, June; ; *In: Transactions at play*. Lanham, MD, US: University Press of America. pp. 129-146. [Chapter]

von Mizener, Briana H.; Williams, Robert L. (2009). The effects of student choices on academic performance. *Journal of Positive Behavior Interventions*, 11(2), 110-128. [Journal Article]

Prior to 2009

Anderson, A., Hattie, J., & Hamilton, R. (2005). Locus of Control, Self-Efficacy, and Motivation in Different Schools: Is moderation the key to success? *Educational Psychology*, 25, 517-535.

Chapparo CJ, & Hooper E. (2002). When is it work? Perceptions of six-year-old children. *Work*. 19(3):291-302.

Cordova, D. I. (1993). The effects of personalization and choice on students' intrinsic motivation and learning. Unpublished PHD, Stanford University (0212).

Creed TA, & Kendall PC. (2005). Therapist alliance-building behavior within a cognitive-behavioral treatment for anxiety in youth. *Journal of Consulting & Clinical Psychology*, 73, 498-505.

Crone, E.A. & van der Molen, M.W. (2007) Development of Decision Making in School-Aged Children and Adolescents: Evidence From Heart Rate and Skin Conductance Analysis *Child Development*, 78 , 1288-1301.

Dibley S.& Lim L.(1999). Providing Choice Making Opportunities Within and Between Daily School Routines. *Journal of Behavioral Education*, 9, 117-132.

Dunlap G, dePerczel M, Clarke S, Wilson D, Wright S, White R, & Gomez A.(1994). Choice making to promote adaptive behavior for students with emotional and behavioral challenges. *Journal of Applied Behavioral Analysis*, 27, 505-18.

Durik, A.M., & Harackiewicz, J.M. (2007). Different strokes for different folks: How individual interest moderates the effects of situational factors on task interest. *Journal of Educational Psychology*. 99, 597-610.

Fisher WW, Thompson RH, DeLeon IG, Piazza CC, Kuhn DE, Rodriguez-Catter V, Adelinis JD. (1999). Noncontingent reinforcement: effects of satiation versus choice responding. *Research in Developmental Disability*.20, 411-27.

Graff RB, & Libby ME. (1999). A comparison of pre-session and within-session reinforcement choice. *Journal of Applied Behavioral Analysis*, 32, 161-73.

Fisher WW, Thompson RH, Piazza CC, Crosland K, & Gotjen D. (1997). On the relative reinforcing effects of choice and differential consequences. *Journal of Applied Behavioral Analysis*, 30, 423-38.

Foster-Johnson L, Ferro J, & Dunlap G.(1994). Preferred curricular activities and reduced problem behaviors in students with intellectual disabilities. *Journal of Applied Behavioral Analysis*, 27, 493-504.

Katz, I. & Assor, A. (2007). When Choice Motivates and When It Does Not. *Educational Psychology Review*, 19 (4).

Lalli JS, Mauro BC, & Mace FC. (2000). Preference for unreliable reinforcement in children with mental retardation: the role of conditioned reinforcement. *Journal of Applied Behavioral Analysis*, 33, 533-44.

Lee Kern, Christina M. Vorndran, Alexandra Hilt, Joel E. Ringdahl, Barry E. Adelman & Glen Dunlap (1998). Choice as an Intervention to Improve Behavior: A Review of the Literature. *Journal of Behavioral Education*, 8(2), 151-169.

Lerman DC, Iwata BA, Rainville B, Adelinis JD, Crosland K, & Kogan J. (1997). Effects of reinforcement choice on task responding in individuals with developmental disabilities. *Journal of Applied Behavioral Analysis*, 30, 411-22.

McCormick, K.M., Jolivet, K., & Ridgley, R. (2003). Choice Making as an Intervention Strategy for Young Children. *Young Exceptional Children*, 6, 3-10.

Patall, E.A., Cooper, H., & Robinson, J.C. (2008). The effects of choice on intrinsic motivation and related outcomes: A meta-analysis of research findings. *Psychological Bulletin*, 134, 270-300.

Powell S, & Nelson B. (1997). Effects of choosing academic assignments on a student with attention deficit hyperactivity disorder. *Journal of Applied Behavioral Analysis*, 30, 181-3.

Romaniuk, C. Miltenberger, R., Conyers, C. Jenner, N., Jurgens, M., & Ringenberg, C. (2002). The influence of activity choice on problem behaviors maintained by escape versus attention. *Journal of Applied Behavioral Analysis*, 35, 349-362.

Romin W. & Tafarodi (2002). Putting Oneself in the Task: Choice, Personalization, and Confidence. *Personality and Social Psychology Bulletin*, 28, 648-658.

Roscoe EM, Iwata BA, & Goh HL. (1998). A comparison of noncontingent reinforcement and sensory extinction as treatments for self-injurious behavior. *Journal of Applied Behavioral Analysis*, 31, 635-46.

Smith RG, Iwata BA, & Shore BA. (1995). Effects of subject- versus experimenter-selected reinforcers on the behavior of individuals with profound developmental disabilities. *Journal of Applied Behavioral Analysis*, 28, 61-71.

Sprague J, Holland K, & Thomas K. (1997). The effect of noncontingent sensory reinforcement, contingent sensory reinforcement, and response interruption on stereotypical and self-injurious behavior. *Research in Developmental Disabilities*, 18, 61-77.

Tessing JL, Napolitano DA, McAdam DB, DiCesare A, & Axelrod S. (2006). The effects of providing access to stimuli following choice making during vocal preference assessments. *Journal of Applied Behavioral Analysis*, 39, 501-6.

Van Tubbergen, M., Warschausky, S., Birnholz, J., & Baker, S. (2008). Choice beyond preference: Conceptualization and assessment of choice-making skills in children with significant impairments. *Rehabilitation Psychology*. 53, 93-100.

Vismara, L.A. & Lyons, G.L. (2007). Using Perseverative Interests to Elicit Joint Attention Behaviors in Young Children With Autism. *Journal of Positive Behavior Interventions*, 9, 214-228.

Waldron-Soler KM, Martella RC, Marchand-Martella NE, & Ebey TL. (2000). Effects of choice of stimuli as reinforcement for task responding in reinforcement for task responding in preschoolers with and without developmental disabilities. *Journal of Applied Behavioral analysis*, 33, 93-6.

Watanabe M. & Sturmey, P. (2003). The Effect of Choice-Making Opportunities During Activity Schedules on Task Engagement of Adults with Autism. *Journal of Autism and Developmental Disorders*, 33.

Creation of Play Context

This section will include articles from literature on play and the importance of play (both to learning and for its own sake).

2009

Bundy, A C.; Lockett, T., Tranter, P., Naughton, G.A. Wyver, S. R.; Ragen, J., & Spies, G. (2009). The risk is that there is 'no risk': A simple, innovative intervention to increase children's activity levels. *International Journal of Early Years Education*, 17(1), 33-45. [Journal Article]

Kangas, M. (2009). Creative and playful learning: Learning through game co-creation and games in a playful learning environment. *Thinking Skills and Creativity*, Nov 27.

McInnes, K., Howard, J., Miles, G. & Crowley, K. (2009). Behavioural differences exhibited by children when practising a task under formal and playful conditions. *Educational and Child Psychology*, 26(2), 31-39. [Journal Article]

Porter CL. (2009). Predicting preschoolers' social-cognitive play behavior: attachment, peers, temperament, and physiological regulation. *Psychol Rep.* 104(2), 517-28.

Sackett, Anna L. (2009). Promoting flow: An investigation of the effects of various task conditions on flow. *Dissertation Abstracts International: Section B: The Sciences and Engineering*, 69(10-B), 6462. [Dissertation]

Sevier-Laws, J. (2009). An investigation of inclusive Early Childhood Education teachers' perspectives and use of constructivism and play in classrooms to enhance children's ability to construct knowledge. ; *Dissertation Abstracts International Section A: Humanities and Social Sciences*, 69(9-A), 3448. [Dissertation]

Siraj-Blatchford, I. (2009). Conceptualising progression in the pedagogy of play and sustained shared thinking in early childhood education: A Vygotskian perspective. *Educational and Child Psychology*, 26(2), 77-89. [Journal Article]

Whitebread,D., Coltman,P., Jameson, H., & Lander, R. (2009). Play, cognition and self-regulation: What exactly are children learning when they learn through play? *Educational and Child Psychology*, 26(2), 40-52. [Journal Article]

Prior to 2009

Bernard-Opitz V, Ing S, & Kong TY.(2004). Comparison of behavioural and natural play interventions for young children with autism. *Autism*, 8, 319-33.

Cross LA, & Coster WJ. (1997). Symbolic play language during sensory integration treatment. *AJOT*, 51, 808-14.

Dunkerley E, Tickle-Degnen L, & Coster WJ. (1997). Therapist-child interaction in the middle minutes of sensory integration treatment. *AJOT*, 51, 799-805.

Fiese BH. (1990). Playful relationships: a contextual analysis of mother-toddler interaction and symbolic play. *Child Development*, 61, 1648-56.

Ginsburg, K.R. and the Committee on Communications and the Committee on Psychosocial Aspects of Child and Family Health (2007). The Importance of Play in Promoting Healthy Child Development and Maintaining Strong Parent-Child Bonds. *PEDIATRICS*. 119 182-191.

Heal, N.A. & Hanley, G.P. (2007). Evaluating Preschool Children's Preferences for Motivational Systems during Instruction. *Journal of Applied Behavioral Analysis*, 40, 249-261.

Panksepp, j. & Burgdorf J. (2003). "Laughing" rats and the evolutionary antecedents of human joy? *Physiology & Behavior*, 79, 533- 547

Panksepp, J. Burgdorf, J., Turner, C. & Gordon, N. (2003). Modeling ADHD-type arousal with unilateral frontal cortex damage in rats and beneficial effects of play therapy. *Brain and Cognition*, 52, 97-105.

Pellis SM, & McKenna MM. (1992). Intrinsic and extrinsic influences on play fighting in rats: effects of dominance, partner's playfulness, temperament and neonatal exposure to testosterone propionate. *Behavioral Brain Research*, 28, 135-45.

Peyton JL, Bass WT, Burke BL, & Frank LM. (2005). Novel motor and somatosensory activity is associated with increased cerebral cortical blood volume measured by near-infrared optical topography. *Journal of Child Neurology*, 20, 817-21.

Tanta KJ, Deitz JC, White O, & Billingsley F. (2005). The effects of peer-play level on initiations and responses of preschool children with delayed play skills. *AJOT*, 59, 437-45.

Effectiveness Studies of Ayres SI

2009

Wuang YP, Wang CC, Huang MH, & Su CY. (2009). Prospective study of the effect of sensory integration, neurodevelopmental treatment, and perceptual-motor therapy on the sensorimotor performance in children with mild mental retardation. *Am J Occup Ther.* 63(4),441-52.

Prior to 2009

Mailloux Z, May-Benson TA, Summers CA, Miller LJ, Brett-Green B, Burke JP, Cohn ES, Koomar JA, Parham LD, Roley SS, Schaaf RC, & Schoen SA. (2007). Goal attainment scaling as a measure of meaningful outcomes for children with sensory integration disorders. *AJOT*, 61, 254-9.

Miller, L. J., Coll, J. R., & Schoen, S. A. (2007). A randomized controlled pilot study of the effectiveness of occupational therapy for children with sensory modulation disorder. *American Journal of Occupational Therapy*, 61, 228-238.

Miller, L. J., Schoen, S. A., James, K., & Schaaf, R. C. (2007). Lessons learned: A pilot study on occupational therapy effectiveness for children with sensory modulation disorder. *American Journal of Occupational Therapy*, 61, 161-169.

Parham LD, Cohn ES, Spitzer S, Koomar JA, Miller LJ, Burke JP, Brett-Green B, Mailloux Z, May-Benson TA, Roley SS, Schaaf RC, Schoen SA, & Summers CA. (2007). Fidelity in sensory integration intervention research. *AJOT*, 61, 216-27.

Schaaf RC, & Nightlinger KM. (2007). Occupational therapy using a sensory integrative approach: a case study of effectiveness. *AJOT*, 61, 239-46.

Smith SA, Press B, Koenig KP, & Kinnealey M. (2005). Effects of sensory integration intervention on self-stimulating and self-injurious behaviors. *AJOT*, 59, 418-25.

Watling RL, & Dietz J. (2007). Immediate effect of Ayres's sensory integration-based occupational therapy intervention on children with autism spectrum disorders. *AJOT*, 61, 574-83.

Effectiveness Studies of Other Interventions Using Sensory or Motor Activities

This section will include summaries from the literature on motor learning, the impact of exercise, and other interventions that would not be considered Ayres' SI intervention because they do not meet the principles as outlined in this website.

2009

Ginny L. Van Rie & L. Juane Heflin (2009). The effect of sensory activities on correct responding for children with autism spectrum disorders. *Research in Autism Spectrum Disorders*, Volume 3, Issue 3, p. 783-796,

Bart O, Bar-Haim Y, Weizman E, Levin M, Sadeh A, Mintz M. (2009). Balance treatment ameliorates anxiety and increases self-esteem in children with comorbid anxiety and balance disorder. *Res Dev Disabil.* 30(3):486-95. Epub 2008 Sep 4.

[Lambourne K, Audiffren M, Tomporowski PD. \(2009\). Effects of Acute Exercise on Sensory and Executive Processing Tasks. Med Sci Sports Exerc. 2009 Dec 14. \[Epub ahead of print\]](#)

[Niklasson M, Niklasson I, Norlander T. \(2009\). Sensorimotor therapy: using stereotypic movements and vestibular stimulation to increase sensorimotor proficiency of children with attentional and motor difficulties. Percept Mot Skills.108\(3\),643-69.](#)

[Rauch F. \(2009\). Vibration therapy. Dev Med Child Neurol. 2009 Oct;51 Suppl 4:166-8.](#)

[Riethmuller AM, Jones R, Okely AD.\(2009\). Efficacy of interventions to improve motor development in young children: a systematic review. Pediatrics. 2009 Oct;124\(4\):e782-92. Epub 2009 Sep 7.](#)

[Rosenkranz K, Butler K, Williamon A, Rothwell JC. \(2009\). Regaining motor control in musician's dystonia by restoring sensorimotor organization. J Neurosci. 29\(46\),14627-36.](#)

[Rothlisberger M, Michel E. \(2009\). \[Development and evaluation of a motor coordination training for children in special-needs classes\] Prax Kinderpsychol Kinderpsychiatr.58\(3\),215-30. \[Article in German\]](#)

[Tsai CL. \(2009\). The effectiveness of exercise intervention on inhibitory control in children with developmental coordination disorder: using a visuospatial attention paradigm as a model. Res Dev Disabil.30\(6\),1268-80. Epub 2009 Jun 3.](#)

Prior to 2009

[Waternberg N, Waiserberg N, Zuk L, & Lerman-Sagie T. \(2007\). Developmental coordination disorder in children with attention-deficit-hyperactivity disorder and physical therapy intervention. Developmental Medicine & Child Neurology, 49, 920-5.](#)

Molteni, R., Wu, A., Vaynman, S., Ying, Z., Barnard, R.J., & Gomez-Pinilla, F. (2004). Exercise reverses the harmful effects of consumption of a high fat diet on synaptic and behavioral plasticity associated to the action of brain derived neurotrophic factor. Neuroscience, 123, 429-440.

SIGN note: Of course we do not know how alike we are to rats, but, if the same results can be found in humans, it is yet another reason we need to change our diets. Can our children's diets be hindering their learning?

[Müller SV, von Schweder AJ, Frank B, Dengler R, Münte TF, & Johannes S. \(2002\). The effects of proprioceptive stimulation on cognitive processes in patients after traumatic brain injury. Arch Phys Med Rehabil,83, 115-21.](#)

[Niemeijer AS, Smits-Engelsman BC, Reynders K, & Schoemaker MM.\(2003\). Verbal actions of physiotherapists to enhance motor learning in children with DCD. Hum Mov Sci. 22, 567-81.](#)

Rine, R.M., Braswell, J., Fisher, D., Joyce, K., Kalar, K., & Shaffer, M. (2004). Improvement of motor development and postural control following intervention in children with sensorineural hearing loss and vestibular impairment. International Journal of Pediatric Otorhinolaryngology, 68, 1141-1148.

SIGN note: This treatment protocol would not be considered Ayres' SI because it does not meet the principles as outlined. It was not child directed, did not focus on the provision of appropriate sensory opportunities or the just right challenge for example. However, it does support the idea that interventions that require active movement can lead to improvements in motor skills even in those with severe sensory processing impairments due to sensory receptor and pathway damage.

Schoemaker, M.M, & Niemeijer, A.S. (2003). Effectiveness of neuromotor task training for children with developmental coordination disorder: A Pilot Study . Neural Plasticity, 10, 155-163.

[Torvinen S](#), [Kannus P](#), [Sievänen H](#), [Järvinen TA](#), [Pasanen M](#), [Kontulainen S](#), [Järvinen TL](#), [Järvinen M](#), [Oja P](#), & [Vuori I](#). (2002). Effect of four-month vertical whole body vibration on performance and balance. *Med Sci Sports Exerc.* 34, 1523-8.

Other Citations of Interest

Chia, L. C., & Chua, L. W. (2002). Effects of physiotherapy on school-aged children with developmental coordination disorder and learning difficulties: A pilot study. *Physiotherapy Singapore*, 5(4), 75-80.

Hartshorn, K., Olds, L., Field, T., Delage, J., Cullen, C., & Escalona, A. (2001). Creative movement therapy benefits children with autism. *Early Child Development and Care*, 166, 1-5.

Hodge, S. R., Murata, N. M., & Porretta, D. L. (1999). Enhancing motor performance through various preparatory activities involving children with learning disabilities. *Clinical Kinesiology*, 53(4), 76-82.

Inder, J. M., & Sullivan, S. (2004). Does an educational kinesiology intervention alter postural control in children with a developmental coordination disorder? *Clinical Kinesiology*, 58(4), 9-26.

Kavale, K., & Mattson, P. D. (1983). One jumped off the balance beam: Meta-analysis of perceptual-motor training. *Journal of Learning Disabilities*, 16(3), 165-173.

Pless, M., & Carlsson, M. (2000). Effects of motor skill intervention on developmental coordination disorder: A meta-analysis. *Adapted Physical Activity Quarterly*, 17(4), 381-401.

Wilson, P., Thomas, P., & Maruff, P. (2002). Motor imagery training ameliorates motor clumsiness in children. *Journal of Child Neurology*, 17(7), 491-498.

Ensuring the Physical Safety of the Client

This section will include literature on factors related to exploration in children and risk taking in children.

2009

Figner, Bernd; Mackinlay, Rachael J.; Wilkening, Friedrich; Weber, Elke U. (2009). Affective and deliberative processes in risky choice: Age differences in risk taking in the Columbia Card Task. *Journal of Experimental Psychology: Learning, Memory, and Cognition*. 35(3), 709-730.

Prior to 2009

[Christensen P](#), [Mikkelsen MR](#). (2008). Jumping off and being careful: children's strategies of risk management in everyday life. *Sociol Health Illn.* 2008 Jan;30(1):112-30.

[DiLillo D](#), & [Tremblay G](#). (2001). Maternal and child reports of behavioral compensation in response to safety equipment usage. *J Pediatr Psychol.* 26, 175-84.

[Heck A](#), [Collins J](#), [Peterson L](#). (2001). Decreasing children's risk taking on the playground. *J Appl Behav Anal.* 2001 Fall;34(3):349-52.

[Hillier LM](#), & [Morrongiello BA](#). (1998). Influence of safety gear on parental perceptions of injury risk and tolerance for children's risk taking. *J Pediatr Psychol.* 23, 229-38.

[Morrongiello BA](#), [Lasenby-Lessard J](#). (2007). Psychological determinants of risk taking by children: an integrative model and implications for interventions. *Inj Prev.* 13(1):20-5.

[Morrongiello BA](#), [Lasenby-Lessard J](#), [Matheis S](#). (2007). [Understanding children's injury-risk behaviors: the independent contributions of cognitions and emotions](#). *J Pediatr Psychol*. 2007 Sep;32(8):926-37. Epub 2007 May 23.

[Morrongiello BA](#), [Walpole B](#), & [Lasenby J](#). (2007). Understanding children's injury-risk behavior: wearing safety gear can lead to increased risk taking. *Accid Anal Prev*. 39, 618-23.

Morrongiello, B.A. & Matheis, S. (2007). Addressing the Issue of Falls off Playground Equipment: An Empirically-Based Intervention to Reduce Fall-Risk Behaviors on Playgrounds *Journal of Pediatric psychology*, 32, 819-830.

Morrongiello, B.A. & Major, K. (2002). Influence of safety gear on parental perceptions of injury risk and tolerance for children's risk taking *Inj Prev*, 8, 27-31

Morrongiello, B.A. & Rennie, H. (1998). Why Do Boys Engage in More Risk Taking Than Girls? The Role of Attributions, Beliefs, and Risk Appraisals. *Journal of Pediatric Psychology* 23, 33-43.

[Schwebel DC](#), & [Bounds ML](#). (2003). The role of parents and temperament on children's estimation of physical ability: links to unintentional injury prevention. *J Pediatr Psychol*. 28, 505-16.

Interesting Links

See <http://www.naeyc.org/about/positions/pdf/PSDAP98.PDF>

Also see <http://www.journal.naeyc.org/btj/200505/06Resources.asp>

Maximization of the Child's Success

This section will include literature from the field of motor learning, regarding feedback from performance and literature from the field of psychology/learning regarding scaffolding for successful performance and engagement. We will also include relevant literature on self esteem and how to best foster it.

2009

[Ford P](#), [Hodges NJ](#), [Mark Williams A](#). (2009). [An evaluation of end-point trajectory planning during skilled kicking](#). *Motor Control*. 13(1):1-24.

[Gilmore L](#), [Cuskelly M](#). (2009). [A longitudinal study of motivation and competence in children with Down syndrome: early childhood to early adolescence](#). *J Intellect Disabil Res*. 2009 May;53(5):484-92. Epub 2008 Mar 19.

[Robinson LE](#), [Goodway JD](#). (2009). [Instructional climates in preschool children who are at-risk. Part I: object-control skill development](#). *Res Q Exerc Sport*. 80(3):533-42.

[Savion-Lemieux T](#), [Bailey JA](#), [Penhune VB](#). (2009). [Developmental contributions to motor sequence learning](#). *Exp Brain Res*. 2009 May;195(2):293-306. Epub 2009 Apr 11.

Prior to 2009

[Al-Abood SA](#), [Davids KF](#), & [Bennett SJ](#).(2001). Specificity of task constraints and effects of visual demonstrations and verbal instructions in directing learners' search during skill acquisition. *Journal of Motor Behavior*, 33, 295-305.

[Emanuel, M.](#), [Jarus, T.](#), & [Bart, O](#). (2008). Effect of focus of attention and age on motor acquisition, retention, and transfer: a randomized trial. *Physical Therapy*, 88, 251-60.

Engel, A., Burke, M., Fiehler, K., Bien, S., & Rösler, F. (2008). Motor learning affects visual movement perception. *European Journal of Neuroscience*, 27, 2294-2302.

[Fine, M.S.](#), & [Thoroughman, K.A.](#) (2007). Trial-by-trial transformation of error into sensorimotor adaptation changes with environmental dynamics. *Journal of Neurophysiology*, 98, 1392-404.

[Ford, P.](#), [Hodges, N.J.](#), & [Williams, A. M.](#) (2007). Examining action effects in the execution of a skilled soccer kick by using erroneous feedback. *Journal of Motor Behavior*, 39, 481-90.

[Granados, C.](#) & [Wulf, G.](#) (2007). Enhancing motor learning through dyad practice: contributions of observation and dialogue. *Research Quarterly on Exercise and Sport*, 78, 197-203.

[Hayes, S.J.](#), [Ashford, D.](#), & [Bennett S.J.](#) (2008). Goal-directed imitation: the means to an end. *Acta Psychologica*, 127, 407-15.

[Hodges NJ](#), [Franks IM](#). (2002). Modelling coaching practice: the role of instruction and demonstration. *Journal of Sports Science*, 20, 793-811.

[Horn, R.R.](#), [Williams, A.M.](#), [Hayes, S.J.](#), [Hodges, N.J.](#), & [Scott, M.A.](#) (2007). Demonstration as a rate enhancer to changes in coordination during early skill acquisition. *Journal of Sports Science*, 25, 599-614.

[Keetch KM](#), [Lee TD](#). (2007). The effect of self-regulated and experimenter-imposed practice schedules on motor learning for tasks of varying difficulty. *Research Quarterly on Exercise and Sport*, 78, 476-86.

[Mackrout I](#), & [Proteau L](#). (2007). Specificity of practice results from differences in movement planning strategies. *Experimental Brain Research*, 183, 181-193.

[Mount J](#). (1987). Effectiveness of visual vs kinesthetic instruction for learning a gross motor skill. *Perceptual & Motor Skills*, 65, 715-20.

[Mullen, R.](#), [Hardy, L.](#), & [Oldham, A.](#) (2007). Implicit and explicit control of motor actions: revisiting some early evidence. *British Journal of Psychology*, 98, 141-56.

[Tjernström F](#), [Fransson PA](#), & [Magnusson M](#). (2005). Improved postural control through repetition and consolidation. *Journal of Vestibular Research*, 15, 31-9.

[Tzetzis G](#), [Votsis E](#). (2006). Three feedback methods in acquisition and retention of badminton skills. *Perceptual and Motor Skills*, 102, 275-84.

[Wilde H](#), [Magnuson C](#), & [Shea CH](#). (2005). Random and blocked practice of movement sequences: differential effects on response structure and movement speed. *Research Quarterly on Exercise and Sport*, 76, 416-25.

[Wills, A.J.](#), [Lavric, A.](#), [Croft, G.S.](#), & [Hodgson, T.L.](#) (2007). Predictive learning, prediction errors, and attention: evidence from event-related potentials and eye tracking. *Journal of Cognitive Neuroscience*, 19, 843-54.

[Wulf G](#), [McNevin N](#), & [Shea CH](#). (2001). The automaticity of complex motor skill learning as a function of attentional focus. *Quarterly Journal of Experimental Psychology A*, 54, 1143-54.

[Wulf G](#), [Shea C](#), & [Park JH](#). (2001). Attention and motor performance: preferences for and advantages of an external focus. *Research Quarterly on Exercise and Sport*, 72, 335-44.

Sensory-Motor Deficits in Children With Developmental Coordination Disorder, Attention Deficit Hyperactivity Disorder & Autistic Disorder

2009

Amy J. Newmeyer^{1†}, Christa Aylward², Rachel Akers³, Keiko Ishikawa⁴, Sandra Grether⁵, Ton deGrauw⁶, Carol Grasha⁵ and Jaye White⁵ (2009). Results of the Sensory Profile in Children with Suspected Childhood Apraxia of Speech [Physical & Occupational Therapy in Pediatrics](#), 29(2), 203-218.

Andrea Faber Taylor & Frances E. Kuo (2009). Children With Attention Deficits Concentrate Better After Walk in the Park. [Journal of Attention Disorders](#) Volume 12 (5), 402-409

[Baron-Cohen S, Ashwin E, Ashwin C, Tavassoli T, Chakrabarti B.\(2009\). Talent in autism: hyper-systemizing, hyper-attention to detail and sensory hypersensitivity. *Philos Trans R Soc Lond B Biol Sci*. 2009 May 27;364\(1522\):1377-83.](#)

Ben-Sasson, A. Carter, A.S. & Briggs-Gowan, M.J. (2009). Sensory Over-Responsivity in Elementary School: Prevalence and Social-Emotional Correlates [Journal of Abnormal Child Psychology](#), 37 (5).

[Cairney J, Hay JA, Veldhuizen S, Missiuna C, Fought BE. \(2009\). Developmental coordination disorder, sex, and activity deficit over time: a longitudinal analysis of participation trajectories in children with and without coordination difficulties. *Dev Med Child Neurol*. \[Epub ahead of print\]](#)

[Chang SH, Yu NY.Characterization of motor control in handwriting difficulties in children with or without developmental coordination disorder. *Dev Med Child Neurol*.. \[Epub ahead of print\]](#)

[Dockstader C, Gaetz W, Cheyne D, Tannock R. \(2009\). Abnormal neural reactivity to unpredictable sensory events in attention-deficit/hyperactivity disorder. *Biol Psychiatry*. 66\(4\):376-83. Epub 2009 May 31.](#)

[Dowell LR, Mahone EM, Mostofsky SH. \(2009\). Associations of postural knowledge and basic motor skill with dyspraxia in autism: implication for abnormalities in distributed connectivity and motor learning. *Neuropsychology*. 2009 Sep;23\(5\):563-70.](#)

[Dowell LR, Mahone EM, Mostofsky SH. \(2009\). Associations of postural knowledge and basic motor skill with dyspraxia in autism: implication for abnormalities in distributed connectivity and motor learning. *Neuropsychology*. 23\(5\):563-70.](#)

[Emck C, Bosscher R, Beek P, Doreleijers T. \(2009\). Gross motor performance and self-perceived motor competence in children with emotional, behavioural, and pervasive developmental disorders: a review. *Dev Med Child Neurol*. 2009 Jul;51\(7\):501-1](#)

Emmanuelle Jasmin, Mélanie Couture, Patricia McKinley, Greg Reid, Eric Fombonne & Erika Gisel. (2009). Sensori-motor and Daily Living Skills of Preschool Children with Autism Spectrum Disorders. [Journal of Autism and Developmental Disorders](#), 39, 231-41.

[Fuentes CT, Mostofsky SH, Bastian AJ. \(2009\). Children with autism show specific handwriting impairments. *Neurology*. 73\(19\):1532-7.](#)

[Gerrard S, Rugg G. \(2009\). Sensory impairments and autism: a re-examination of causal modelling. *J Autism Dev Disord*. 39\(10\),1449-63. Epub 2009 Jun 2.](#)

[Glazebrook C, Gonzalez D, Hansen S, Elliott D.\(2009\). The role of vision for online control of manual aiming movements in persons with autism spectrum disorders. *Autism*, 13\(4\):411-33.](#)

[Green D, Charman T, Pickles A, Chandler S, Loucas T, Simonoff E, Baird G.\(2009\). Impairment in movement skills of children with autistic spectrum disorders. *Dev Med Child Neurol*. 51\(4\):311-6. Epub 2008 Feb 3.](#)

[Klein VC, Gaspardo CM, Martinez FE, Grunau RE, Linhares MB. \(2009\). Pain and distress reactivity and recovery as early predictors of temperament in toddlers born preterm. *Early Hum Dev.* 85\(9\):569-76. Epub 2009 Jun 26.](#)

[Kopp S, Beckung E, Gillberg C. \(2009\). Developmental coordination disorder and other motor control problems in girls with autism spectrum disorder and/or attention-deficit/hyperactivity disorder. *Res Dev Disabil.* \[Epub ahead of print\]](#)

[Martin NC, Piek J, Baynam G, Levy F, Hay D. \(2009\). An examination of the relationship between movement problems and four common developmental disorders. *Hum Mov Sci.* 2009 Nov 25. \[Epub ahead of print\]](#)

[Marton K. \(2009\). Imitation of body postures and hand movements in children with specific language impairment. *J Exp Child Psychol.* 102\(1\):1-13. Epub 2008 Sep 27.](#)

[Newmeyer AJ, Aylward C, Akers R, Ishikawa K, Grether S, deGrauw T, Grasha C, White J. \(2009\). Results of the Sensory Profile in children with suspected childhood apraxia of speech. *Phys Occup Ther Pediatr.* 29\(2\):205-207.](#)

Oti, R.S. (2009). Atypical Sensory Behaviors in Young Children with Autism Spectrum Disorders. Dissertation.

[Pan CY, Tsai CL, Chu CH. \(2009\). Fundamental Movement Skills in Children Diagnosed with Autism Spectrum Disorders and Attention Deficit Hyperactivity Disorder. *J Autism Dev Disord.* \[Epub ahead of print\]](#)

Phoebe P.P. Cheung, & Andrew M.H. Siu (2009). A comparison of patterns of sensory processing in children with and without developmental disabilities. *Research in Developmental Disabilities*, 30, 6, 1468-1480

Rieke, E.F., Anderson, D. (2009). Adolescent/adult sensory profile and obsessive-compulsive disorder. *American Journal of Occupational Therapy* 63 (2), 138 - 145.

[Rogers SJ. \(2009\). What are infant siblings teaching us about autism in infancy? *Autism Res.* 2\(3\):125-37.](#)

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. *Front Integr Neurosci.*; 3:29.
<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2776488/>

[Shum SB, Pang MY. \(2009\). Children with attention deficit hyperactivity disorder have impaired balance function: involvement of somatosensory, visual, and vestibular systems. *J Pediatr.* 155\(2\), 245-9. Epub 2009 May 15.](#)

[Vieira S, Quercia P, Michel C, Pozzo T, Bonnetblanc F. \(2009\). Cognitive demands impair postural control in developmental dyslexia: a negative effect that can be compensated. *Neurosci Lett.* 462\(2\):125-9. Epub 2009 Jul 2.](#)

[Wang TN, Tseng MH, Wilson BN, Hu FC. \(2009\). Functional performance of children with developmental coordination disorder at home and at school. *Dev Med Child Neurol.* 51\(10\), 817-25. Epub 2009 Mar 12.](#)

Yu-Han Chen, Jacqui Rodgers & Helen McConachie (2009). Restricted and Repetitive Behaviours, Sensory Processing and Cognitive Style in Children with Autism Spectrum Disorders *Journal of Autism and Developmental Disorders*, 39, 635-42.

Prior to 2009

Astill, S., & Utley, A. (2006). Two-handed catching in children with developmental coordination disorder. *Motor Control*, 10(2), 109-124.

Gillberg, C., & Kadesjo, B. (2003). Why bother about clumsiness? The implications of having developmental coordination disorder (DCD). *Neural Plasticity*, 10, 59-68.

Molloy, C. A., Kietrich, K. N., & Bhattacharya, A. (2003). Postural stability in children with autism spectrum disorder. *Journal of Autism and Developmental Disorders*, 33(6), 643-652.

SIGN note: The study findings seem to support the Ayres' SI postulate that children with ASD have deficits in sensory integration contributing to balance difficulties. However, the study does not provide a link between difficulties in balance and sensory integration to problems in functional activities. It does provide evidence that some children with ASD are overdependent on visual cues for maintaining their balance. The study is limited by the small number of subjects and the use of an apparently nonstandardized questionnaire to assess the presence of motor deficits. Reviewed by Katherine Inamura, 10/28/2005

Piek, J. L., & Dyck, M. J. (2004). Sensory-motor deficits in children with developmental coordination disorder, attention deficit hyperactivity disorder and autistic disorder. *Human Movement Science*, 23, 475-488.

SIGN note: This article supports the Ayres' SI principles of deficits in sensory integration contributing to problems in motor coordination, deficits in visual-spatial perception and kinesthetic perception being associated with poor motor skills, and difficulties with sensory processing and motor coordination contributing to problems in social interaction. The article indirectly supports the possible appropriateness of the sensory integrative treatment approach with children having DCD and those having a comorbid diagnosis of autism or ADHD. There was a report of a research finding that children with ADHD tend to have significant difficulty with planning action sequences. This finding also indirectly supports the use of the SI treatment approach with some children with ADHD. Reviewed by Katherine Inamura, 11/15/2005

S. Parush, H. Sohmer, A. Steinberg, M. Kaitz (2007). Somatosensory function in boys with ADHD and tactile defensiveness. *Physiology & Behavior* 90, 553-558.

Potential long term impacts of poor sensory processing and of traumatic events on sensory processing

This section will include summaries of articles from the psychology literature on temperament, shyness, behavioral inhibition and what they term sensory processing sensitivity. Also will be included certain relevant abstracts regarding long term effects of childhood trauma if related to sensory processing in some way.

2009

Prior to 2009

Annatjie M. Smith, M.Sc., Saartjie Roux, D.Med.Sci.*, N. T. (Raj) Naidoo, Ph.D., Daniel J. L. Venter, B.Sc.Hons (2005). Food choices of tactile defensive children *Nutrition* 21, 14-19.

Aron, E.N., Aron, A., & Davies, K.M. (2005). Adult shyness: The interaction of temperamental sensitivity and an adverse childhood environment. *Personality and Social Psychology Bulletin*, 31, 181-97.

Atchison, B.J. (2007). Sensory Modulation Disorders Among Children With a History of Trauma: A Frame of Reference for Speech-Language Pathologists Language, Speech, and Hearing Services in Schools, 38, 109-116.

[Becker K](#), [Holtmann M](#), [Laucht M](#), & [Schmidt MH](#). (2004). Are regulatory problems in infancy precursors of later hyperkinetic symptoms? [Acta Paediatr.](#) 93, 1463-9.

[Hohmeister J](#), [Demirakça S](#), [Zohsel K](#), [Flor H](#), & [Hermann C](#). (2008). Responses to pain in school-aged children with experience in a neonatal intensive care unit: Cognitive aspects and maternal influences. [Eur J Pain.](#)

Meyer, B., & Carver, C.S. (2000). Negative childhood accounts, sensitivity, and pessimism: a study of avoidant personality disorder features in college students. *Journal of Personality Disorders*, 14, 233-48.

Pole, N., Neylan, T.C., Otte, C., Metzler, T.J., Best, S.R., Henn-Haase, C., Marmar, C.R. (2007). Associations between childhood trauma and emotion-modulated psychophysiological responses to startling sounds: a study of police cadets. *Abnormal Psychology*, 116, 352-61.

Stefan G. Hofmann* and Stella Bitran (2007) Sensory-processing sensitivity in social anxiety disorder: Relationship to harm avoidance and diagnostic subtypes. *J Anxiety Disord*, 21, 944-54.

Provision of Sensory Opportunities

This section includes articles from the literature on specific sensory processing, and outcomes of enriched environments (both human and animal literature are included).

2009

Ali, Ata E. A.; Wilson, Yvette M.; Murphy, Mark;(2009). [A single exposure to an enriched environment stimulates the activation of discrete neuronal populations in the brain of the fos-tau-lacZ mouse.](#)

[Benedetti BL](#), [Glazewski S](#), [Barth AL](#). (2009). [Reliable and precise neuronal firing during sensory plasticity in superficial layers of primary somatosensory cortex.](#) *J Neurosci.* 29(38):11817-27.

[Bruno RM](#), [Hahn TT](#), [Wallace DJ](#), [de Kock CP](#), [Sakmann B](#). (2009). [Sensory experience alters specific branches of individual corticocortical axons during development.](#) *J Neurosci.* 29(10):3172-81.

Catlow, Briony J.; Rowe, Amanda R.; Clearwater, Courtney R.; Mamcarz, Maggie; Arendash, Gary W.; Sanchez-Ramos, Juan (2009). [Effects of environmental enrichment and physical activity on neurogenesis in transgenic PS1/APP mice.](#) *Brain Research*, Vol 1256, 173-179. [Journal Article]

[Catlow BJ](#), [Rowe AR](#), [Clearwater CR](#), [Mamcarz M](#), [Arendash GW](#), [Sanchez-Ramos J](#).(2009). [Effects of environmental enrichment and physical activity on neurogenesis in transgenic PS1/APP mice.](#) *Brain Res.* 1256:173-9. Epub 2008 Dec 24.

de Carvalho, Cristiane Ribeiro; Pandolfo, Pablo; Pamplona, Fabrício Alano; Takahashi, Reinaldo Naoto (2009). [Environmental enrichment reduces the impact of novelty and motivational properties of ethanol in spontaneously hypertensive rats.](#) *Behavioural Brain Research*, Dec 3, 2009.

[Gottfried JA](#), [Wu KN](#). (2009). [Perceptual and neural pliability of odor objects.](#) *Ann N Y Acad Sci.* 1170:324-32.

[Guzzetta A](#), [Baldini S](#), [Bancale A](#), [Baroncelli L](#), [Ciucci F](#), [Ghirri P](#), [Putignano E](#), [Sale A](#), [Viegi A](#), [Berardi N](#), [Boldrini A](#), [Cioni G](#), [Maffei L](#). (2009). [Massage accelerates brain development and the maturation of visual function.](#) *J Neurosci.* 29(18):6042-51.

Harrar, Vanessa; Harris, Laurence R. (2009). [Eye position affects the perceived location of touch](#). *Experimental Brain Research*, 198(2-3), 403-410. [Journal Article]

Hughes, Robert N.; Collins, Michelle A. (2009). [Enhanced habituation and decreased anxiety by environmental enrichment and possible attenuation of these effects by chronic \$\alpha\$ -tocopherol \(vitamin e\) in aging male and female rats](#).

Hyde KL, Lerch J, Norton A, Forgeard M, Winner E, Evans AC, Schlaug G. (2009). [Musical training shapes structural brain development](#). *J Neurosci*. 2009 Mar 11;29(10):3019-25.

Kelsch W, Lin CW, Mosley CP, Lois C. (2009). [A critical period for activity-dependent synaptic development during olfactory bulb adult neurogenesis](#). *J Neurosci*. 2009 Sep 23;29(38):11852-8.

Lewis CM, Baldassarre A, Committeri G, Romani GL, Corbetta M. (2009). [Learning sculpts the spontaneous activity of the resting human brain](#). *Proc Natl Acad Sci U S A*. 106(41):17558-63. Epub 2009 Oct 5.

Mégevand P, Troncoso E, Quairiaux C, Muller D, Michel CM, Kiss JZ. (2009). [Long-term plasticity in mouse sensorimotor circuits after rhythmic whisker stimulation](#). *J Neurosci*. 29(16):5326-35.

Nag, Nupur; Moriuchi, Jennifer M.; Peitzman, Cassandra G. K.; Ward, Bonnie C.; Kolodny, Nancy H.; Berger-Sweeney, Joanne E. (2009). [Environmental enrichment alters locomotor behaviour and ventricular volume in Mecp2^{1lox} mice](#). *Behavioural Brain Research*, 196(1), 44-48. [Journal Article]

Nithianantharajah J, Hannan AJ. (2009). [The neurobiology of brain and cognitive reserve: mental and physical activity as modulators of brain disorders](#). *Prog Neurobiol*. 89(4),369-82. Epub 2009 Oct 9.

Pawlowicz, Artur; Demner, Adam; Lewis, Mark H (2009). [Effects of access to voluntary wheel running on the development of stereotypy](#). *Behavioural Processes*, Nov 26, 2009.

Pawlowicz A, Demner A, Lewis MH. (2009). [Effects of access to voluntary wheel running on the development of stereotypy](#). *Behav Processes*. Nov 26. [Epub ahead of print]

Peña Y, Prunell M, Rotllant D, Armario A, Escorihuela RM. (2009). [Enduring effects of environmental enrichment from weaning to adulthood on pituitary-adrenal function, pre-pulse inhibition and learning in male and female rats](#). *Psychoneuroendocrinology*. 34(9):1390-404. Epub 2009 May 29.

Sale, Alessandro; Berardi, Nicoletta; Maffei, Lamberto (2009). [Enrich the environment to empower the brain](#). *Trends in Neurosciences*, 32(4), 233-239. [Journal Article]

Simonetti T, Lee H, Bourke M, Leamey CA, Sawatari A. (2009). [Enrichment from birth accelerates the functional and cellular development of a motor control area in the mouse](#). *PLoS One*. 4(8):e6780.

Tall JM. (2009). [Housing supplementation decreases the magnitude of inflammation-induced nociception in rats](#). *Behav Brain Res*. 197(1):230-3. Epub 2008 Aug 19.

Trickett, Sarah L.; Guy, Jonathan H.; Edwards, Sandra A. (2009) [The role of novelty in environmental enrichment for the weaned pig](#). *Applied Animal Behaviour Science*, Vol 116(1-2), 45-51. [Journal Article]

Veyrac A, Sacquet J, Nguyen V, Marien M, Jourdan F, Didier A. (2009). [Novelty determines the effects of olfactory enrichment on memory and neurogenesis through noradrenergic mechanisms](#). *Neuropsychopharmacology*. 2009 Feb;34(3):786-95. Epub 2008 Oct 22.

[Viel S, Vaugoyeau M, Assaiante C. \(2009\). Adolescence: a transient period of proprioceptive neglect in sensory integration of postural control. *Motor Control*. 13\(1\):25-42.](#)

[Zajac MS, Pang TY, Wong N, Weinrich B, Leang LS, Craig JM, Saffery R, Hannan AJ. \(2009\). Wheel running and environmental enrichment differentially modify exon-specific BDNF expression in the hippocampus of wild-type and pre-motor symptomatic male and female Huntington's disease mice. *Hippocampus*. Jun 4. \[Epub ahead of print\]](#)

[Zhu SW, Codita A, Bogdanovic N, Hjerling-Leffler J, Ernfors P, Winblad B, Dickins DW, Mohammed AH. \(2009\). Influence of environmental manipulation on exploratory behaviour in male BDNF knockout mice. *Behav Brain Res*. 197\(2\):339-46. Epub 2008 Oct 5.](#)

Prior to 2009

Alessandro Sale,^{1*} Maria Cristina Cenni,² Francesca Ciucci,¹ Elena Putignano,¹ Sabrina Chierzi,¹ & Lamberto Maffei. (2007). Maternal Enrichment during Pregnancy Accelerates Retinal Development of the Fetus *PLoS ONE*, 2, e1160.

Bark, K. Wheeler, J.W. Premakumar, S. & Cutkosky, M.R (2008). Comparison of Skin Stretch and Vibrotactile Stimulation for Feedback of Proprioceptive Information. This paper appears in: [Haptic interfaces for virtual environment and teleoperator systems, 2008. haptics 2008. symposium 71-78.](#)

Brown, J., Cooper-Kuhn, C. M., Kempermann, G., Van Praag, H., Winkler, J., Gage, F. H., Kuhn, H. G. (2003). Enriched environment and physical activity stimulate hippocampal but not olfactory bulb neurogenesis. *European Journal of Neuroscience*, 17, 2042-2046.

[Cancedda L, Putignano E, Sale A, Viegi A, Berardi N, Maffei L. \(2004\). Acceleration of visual system development by environmental enrichment. *Journal of Neuroscience*, 24, 4840-8.](#)

Engineer, N.D., Percaccio, C.R., Pandya, P.K., Moucha, R., Rathbun D.L. & Kilgard, M.P. (2004). Environmental Enrichment Improves Response Strength, Threshold, Selectivity, and Latency of Auditory Cortex Neurons *Journal of Neurophysiology*, 92, 73-82,

Francis, D.D. Diorio, J. Plotsky, P.M., & Meaney, M.J. (2002). Environmental Enrichment Reverses the Effects of Maternal Separation on Stress Reactivity. *The Journal of Neuroscience*, 22, 7840-7843.

Florence , S.L., Boydston, T.A., Hackett, H., Lachoff, Taub, Strata, F., & Niblock, M.M. (2001). Sensory enrichment after peripheral nerve injury restores cortical, not thalamic, receptive field organization. *European Journal of Neuroscience*, 13, 1755-1766.

Hay, L, Bard, C., Ferrel, C., Olivier, I., & Fleury, M. (2005). Role of proprioceptive information in movement programming and control in 5 to 11-year old children. *Human Science Movement*, 24, 139-154.

SIGN note: This study provides information about the developmental trends in typical children relative to the use of proprioceptive sensations to direct hand movements. The findings could expand Ayres' SI theory on the effects of vision and proprioception on praxis.

Reviewed by Katherine Inamura, 11/18/2005

Jiao, Y., Zhang, C., Yanagawa, Y., & Sun, Q. (2006). Major Effects of Sensory Experiences on the Neocortical Inhibitory Circuits. *Journal of Neuroscience*, 26, 8691-8701



[Kreppner, J. M.; Rutter, M., Beckett, C., Castle, J., Colvert, E., Groothues, C., Hawkins, A., O'Connor, T.G., Stevens, S., Sonuga-Barke, & Edmund J. S. \(2007\). Normality and Impairment following Profound](#)

Early Institutional Deprivation: A Longitudinal follow-up into Early Adolescence. *Developmental Psychology*, 43 , 931-946.

Matthew S Grubb and Ian D Thompson (2004). The influence of early experience on the development of sensory systems. *Current Opinion in Neurobiology* 2004, 14:503-512

Morley-Fletcher, S., Rea, M., Maccari, S., & Laviola, G. (2003). Environmental enrichment during adolescence reverses the effects of prenatal stress on play behaviour and HPA axis reactivity in rats. *European Journal of Neuroscience* 18, 3367-3374.

N. Benaroya-Milshtein, N. Hollander, A. Apter, T. Kukulansky, N. Raz, A. Wilf, I. Yaniv, & C.G. Pick (2004). Environmental enrichment in mice decreases anxiety, attenuates stress responses and enhances natural killer cell activity. *European Journal of Neuroscience* 20, 1341-1347.

Percaccio , , C.R., Pruettea, A.L., Mistrya, S.T., Chen, Y.H. a & Kilgard, M.P. (2007). Sensory experience determines enrichment-induced plasticity in rat auditory cortex [Brain Research](#), 1174, 76-91.

Praag, H. V., Kempermann, G., Gage, F.H. (2000). Neural Consequences of Environmental Enrichment. *Macmillan Magazines LTD*, 1 , 191-198.

Restivo, L., Ferrari, F., Passino, E., Sgobio, C., Bock, J., Oostra, B.A., Bagni, C., & Ammassari-Teule, M., †(2005). Enriched environment promotes behavioral and morphological recovery in a mouse model for the fragile X syndrome. *Neuroscience*, 102, 11557-11562.

[Schmuckler MA](#), & [Jewell DT](#). (2007). Infants' visual-proprioceptive intermodal perception with imperfect contingency information. [Developmental Psychobiology](#), 49, 387-98.

Sober, S. J. & Sabes, P. N. (2005). Flexible strategies for sensory integration during motor planning. *Nature Neuroscience*, 8(4), 490-497.

SIGN note: This study provides information about the integration of proprioceptive and visual sensations to direct hand movements in adults. The findings could expand Ayres' SI theory on the effects of vision and proprioception on praxis.

Reviewed by Katherine Inamura, 1/28/2006

Soto-Faraco, S., Ronald, A., & Spence, C. (2004). Tactile selective attention and body posture: assessing the multisensory contributions of vision and proprioception. *Perception & Psychophysics*, 66 (7), 1077-1094.

SIGN note: The study's findings contribute to the understanding of how visual, proprioceptive, and tactile input is integrated to assist in attention to and interpretation of localized tactile sensations, important in Ayres' SI theory. This information could be helpful in refining tests of tactile perception. It also seems to lend support for the principle of providing varied, multi-sensory enriched activities to promote better integration of sensory information.

Reviewed by Katherine Inamura, 11/18/2005

S. Lores-Arnaiz, J. Bustamante, A. Czernizyniec, P. Galeano, M. González Gervasoni, A. Rodil Martínez, N. Paglia, V. Cores, & M.R. Lores-Arnaiz (2007). [Exposure to enriched environments increases brain nitric oxide synthase and improves cognitive performance in prepubertal but not in young rats](#). *Behavioural Brain Research*, 184, 117-123.

van Praag, H., Kempermann, G. & Gage, F.H. (1999). Running increases cell proliferation and neurogenesis in the adult mouse dentate gyrus. *Nature Neuroscience* 2, 266 - 2

Neuroscience and other research that may be related to sensory processing / sensory integration theory.

2009

[Alvarado JC, Stanford TR, Rowland BA, Vaughan JW, Stein BE. \(2009\). Multisensory integration in the superior colliculus requires synergy among corticocollicular inputs. J Neurosci. 29\(20\):6580-92.](#)

[Block HJ, Bastian AJ. \(2009\). Sensory reweighting in targeted reaching: Effects of conscious effort, error history, and target salience. J Neurophysiol. Oct 21. \[Epub ahead of print\]](#)

[Crepeau-Hobson, M. Franci \(2009\). The relationship between perinatal risk factors and sensory processing difficulties in preschool children. ; Journal of Developmental and Physical Disabilities, 21\(4\), 315-328. \[Journal Article\]](#)

[Diekhof EK, Biedermann F, RubeSAMEN R, Gruber O. \(2009\). Top-down and bottom-up modulation of brain structures involved in auditory discrimination. Brain Res. 1297:118-23. Epub 2009 Aug 21.](#)

[Fetsch CR, Turner AH, DeAngelis GC, & Angelaki DE. \(2009\). Dynamic reweighting of visual and vestibular cues during self-motion perception. J Neurosci. 9;29\(49\):15601-12.](#)

[Hofer SB, Mrcic-Flogel TD, Bonhoeffer T, & Hübener M.\(2009\). Experience leaves a lasting structural trace in cortical circuits. Nature. 457\(7227\):313-7. Epub 2008 Nov 12.](#)

[Jax SA, Coslett HB. \(2009\). Disorders of the perceptual-motor system. Adv Exp Med Biol. 629:377-91.](#)

[Klemen J, Büchel C, Rose M.\(2009\). Perceptual load interacts with stimulus processing across sensory modalities. Eur J Neurosci. 29\(12\):2426-34. Epub 2009 May 26.](#)

[Lee LJ, Chen WJ, Chuang YW, Wang YC. \(2009\). Neonatal whisker trimming causes long-lasting changes in structure and function of the somatosensory system. Exp Neurol. 219\(2\):524-32. Epub 2009 Jul 18.](#)

[Lee LJ. \(2009\). Neonatal fluoxetine exposure affects the neuronal structure in the somatosensory cortex and somatosensory-related behaviors in adolescent rats. Neurotox Res. 15\(3\):212-23. Epub 2009 Mar 4.](#)

[Lemasson BH, Anderson JJ, Goodwin RA. \(2009\). Collective motion in animal groups from a neurobiological perspective: the adaptive benefits of dynamic sensory loads and selective attention. J Theor Biol. 261\(4\):501-10. Epub 2009 Aug 20.](#)

[Lijffijt M, Lane SD, Meier SL, Boutros NN, Burroughs S, Steinberg JL, Gerard Moeller F, Swann AC. \(2009\). P50, N100, and P200 sensory gating: relationships with behavioral inhibition, attention, and working memory. Psychophysiology. 46\(5\):1059-68. Epub 2009 Jun 8.](#)

[Miller LJ, Nielsen DM, Schoen SA, & Brett-Green BA. \(2009\). Perspectives on sensory processing disorder: a call for translational research. Front Integr Neurosci. 3:22. Epub 2009 Sep 30.](#)

[Pennartz CM. \(2009\). Identification and integration of sensory modalities: neural basis and relation to consciousness. Conscious Cogn. 18\(3\):718-39. Epub 2009 May 5.](#)

[Pinkernelle J, Abraham A, Seidel K, Braun K. \(2009\). Paternal deprivation induces dendritic and synaptic changes and hemispheric asymmetry of pyramidal neurons in the somatosensory cortex. Dev Neurobiol. 69\(10\):663-73.](#)

[Restuccia D, Zanini S, Cazzagon M, Del Piero I, Martucci L, Della Marca G. \(2009\). Somatosensory mismatch negativity in healthy children. Dev Med Child Neurol. 51\(12\):991-8.](#)

[Sarlegna, F.R., Przybyla, A., Sainburg, R.L. \(2009\). The influence of target sensory modality on motor planning may reflect errors in sensori-motor transformations. Neuroscience 164 \(2\), pp. 597-610](#)

[Simon-Dack SL, Cummings SE, Reetz DJ, Alvarez-Vazquez E, Gu H, Teder-Sälejärvi WA. \(2009\). "Touched" by light: event-related potentials \(ERPs\) to visuo-haptic stimuli in peri-personal space. *Brain Topogr.* 21\(3-4\):261-8. Epub 2009 Apr 29.](#)

[Stein BE, Perrault TJ Jr, Stanford TR, & Rowland BA. \(2009\). Postnatal experiences influence how the brain integrates information from different senses. *Front Integr Neurosci.* 3:21. Epub 2009 Sep 30.](#)

[van Ee R, van Boxtel JJ, Parker AL, Alais D. \(2009\). Multisensory congruency as a mechanism for attentional control over perceptual selection. *J Neurosci.* 16;29\(37\):11641-9.](#)

[Weierich MR, Wright CI, Negreira A, Dickerson BC, & Barrett LF. \(2009\). Novelty as a dimension in the affective brain. *Neuroimage.* Sep 28. \[Epub ahead of print\]](#)

[Werkhoven PJ, van Erp JB, Philippo TG. \(2009\). Counting visual and tactile events: the effect of attention on multisensory integration. *Atten Percept Psychophys.* 71\(8\):1854-61.](#)

[Withagen R, van Wermeskerken M. \(2009\). Individual differences in learning to perceive length by dynamic touch: evidence for variation in perceptual learning capacities. *Atten Percept Psychophys.* 71\(1\):64-75.](#)

Prior to 2009

Benjamin A. Rowland* and Barry E. Stein (2008) Temporal profiles of response enhancement in multisensory integration *Frontiers in Neuroscience* www.frontiersin.org 2(2), 218

Bernabei, P., Fenton, G., Fabrizi, A., Camaioni, L., & Perucchini, P. (2003). Profiles of sensorimotor development in children with autism and with developmental delay. *Perceptual & Motor Skills*, 96, 1107-1116. SIGN note : imitation difficulties may indicate dyspraxia in this population. It has been hypothesized that dyspraxia may be at the route of some of the difficulties experienced by children with autism.

Bradley, M. M., Lang, P. J., & Cuthbert, B. N. (1993). Emotion, novelty, and the startle reflex: habituation in humans. *Behav Neurosci*, 107(6), 970-980.

Buhlmann, U., Wilhelm, S., Deckersbach, T., Rauch, S. L., Pitman, R. K., & Orr, S. P. (2007). Physiologic responses to loud tones in individuals with obsessive-compulsive disorder. *Psychosom Med*, 69(2), 166-72.

Cirulli, F., Berry, A., & Alleva, E. (2003). Early Disruption of the mother-infant relationship: effects on brain plasticity and implications for psychopathology. *Neuroscience and Biobehavioral Reviews*, 27, 73-82.

Coombes, S. A., Cauraugh, J. H., & Janelle, C. M. (2007). Emotional state and initiating cue alter central and peripheral motor processes. *Emotion*, 7(2), 275-284.

Elsner, B., Hommel, B., Mentschel, C., Drzezga, A., Prinz, W., Conrad, B., & Siebner, H. (2002). Linking actions and their perceivable consequences in the human brain. *Neuroimage*, 17(1), 364-372.

Garralda, M. E., Connell, J., & Taylor, D. C. (1991). Psychophysiological anomalies in children with emotional and conduct disorders. *Psychol Med*, 21(4), 947-957.

Goldsmith, H.H., Van Hulle, C.A., Arneson, C.L., Schreiber, J.E. & Gernsbacher, M.A. (2006). A Population-Based Twin Study of Parentally Reported Tactile and Auditory Defensiveness in Young Children. *Journal of Abnormal Child Psychology*, 34 (3).

- Imamizu, H., Higuchi, S., Toda, A. & Kawato M. (2007). Reorganization of brain activity for multiple internal models after short but intensive training, *Cortex*, 43(3), 338-349.
- Khalifa, S., Isabelle, P., Jean-Pierre, B., & Manon, R. (2002). Event-related skin conductance responses to musical emotions in humans. *Neurosci Lett*, 328(2), 145-149.
- Lipp, O. V., Siddle, D. A., Dall, P.J. (1997). The effect of emotional and attentional processes on blink startle modulation and on electrodermal responses. *Psychophysiology*, 34(3), 340-347.
- Nietro-Sampedro, M. & Nieto-Diaz, M. (2005). Neural Plasticity: Changes with Age. *Journal of Neural Transmission*, 112, 3-27.
- Piek, J.P., Dyck, M.J., Nieman, A., Anderson, M., Hay, D., Smith, L.M., McCoy, M., & Hallmayer, J. (2004). The relationship between motor coordination, executive functioning and attention in school aged children. *Archives of Clinical Neuropsychology*, 19, 1063-1076.
- Reynolds, S. & Lane, S.J. (2007). Diagnostic Validity of Sensory Over-Responsivity: A Review of the Literature and Case Reports. *Journal of Autism and Developmental Disorders- Online Oct*.
- Sánchez-Navarro, J. P., Martínez-Selva, J.M., & Román, F. (2006). Uncovering the relationship between defence and orienting in emotion: cardiac reactivity to unpleasant pictures. *Int J Psychophysiol*, 61(1), 34- 46.
- Schmidt, L.A. & Fox, N.A. (1998). Fear-potentiated startle responses in temperamentally different human infants. *Developmental Psychobiology*, 32, 113-20.
- Sethre-Hofstad, L., Stansbury, K., & Rice, M. A. (2002). Attunement of maternal and child adrenocortical response to child challenge. *Psychoneuroendocrinology*, 27(6), 731-47.
- Skolnick, A. I., & Davidson, R. I. (2002). Affective modulation of eyeblink startle with reward and threat. *Psychophysiology*, 39(6), 835- 850.
- Tieman, J. G., Peacock, L. J., Cureton, K. J., & Dishman, R. K. (2001). Acoustic startle eyeblink response after acute exercise. *Int J Neurosci*, 106(1-2), 21-33.
- Vianna, E. P., & Tranel, D. (2006). Gastric myoelectrical activity as an index of emotional arousal. *Int J Psychophysiol*, 61(1), 70-76.
- Vogt, S., Buccino, G., Wohlschläger, A. M., Canessa, N., Shah, N.J., Zilles, K., Eickhoff, S. B., Freund, H. J., Rizzolatti, G., Fink, G. R. (2007). Prefrontal involvement in imitation learning of hand actions: Effects of practice and expertise. *Neuroimage*. ***