**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.

**Ismael, N., Lawson, L. M., & Hartwell, J. (2018). Relationship Between Sensory Processing and Participation in Daily Occupations for Children With Autism Spectrum Disorder: A Systematic Review of Studies That Used Dunn’s Sensory Processing Framework. *American Journal of Occupational Therapy,72*(3). doi:10.5014/ajot.2018.024075**

Research measuring sensory processing in children with autism spectrum disorder (ASD) has shown variability in terms of measures used and participant ages, contributing to difficulty in interpreting and summarizing the findings of these studies. In an attempt to clarify the status of the literature, we conducted a systematic review of studies that focused on participation in daily occupations and evaluated sensory processing in children with ASD aged 5-13 yr using Dunn's sensory processing framework. Evidence from 7 studies shows that sensory processing has a significant impact on participation in daily life of children with ASD. Included studies demonstrated medium and low levels of evidence. Additional research using more robust scientific methods is needed.

**Fraser, K., Mackenzie, D., & Versnel, J. (2017). Complex Trauma in Children and Youth: A Scoping Review of Sensory-Based Interventions. *Occupational Therapy in Mental Health,* *33*(3), 199-216. doi:10.1080/0164212x.2016.126547**

Emerging evidence in neuroscience indicates exposure to complex trauma in children and youth affects brain development—particularly with the ability to process sensory information. This sensory processing challenge has been shown to negatively impact emotional and self-regulation. A developing area of trauma treatment utilizes sensory-based interventions to target these concerns. A scoping review of the literature indicates there is limited, although promising, evidence for the use of these interventions when used as part of an integrated treatment approach. Occupational therapy is in a unique position to contribute to this area of practice due to a background in sensory-based approaches.

**Lowe, M. X., Stevenson, R. A., Wilson, K. E., Ouslis, N. E., Barense, M. D., Cant, J. S., & Ferber, S. (2016). Sensory processing patterns predict the integration of information held in visual working memory. *Journal of Experimental Psychology: Human Perception and Performance*, *42*(2), 294.**

Given the limited resources of visual working memory, multiple items may be remembered as an averaged group or ensemble. As a result, local information may be ill-defined, but these ensemble representations provide accurate diagnostics of the natural world by combining gist information with item-level information held in visual working memory. Some neurodevelopmental disorders are characterized by sensory processing profiles that predispose individuals to avoid or seek-out sensory stimulation, fundamentally altering their perceptual experience. Here, we report such processing styles will affect the computation of ensemble statistics in the general population. We identified stable adult sensory processing patterns to demonstrate that individuals with low sensory thresholds who show a greater proclivity to engage in active response strategies to prevent sensory overstimulation are less likely to integrate mean size information across a set of similar items and are therefore more likely to be biased away from the mean size representation of an ensemble display. We therefore propose the study of ensemble processing should extend beyond the statistics of the display, and should also consider the statistics of the observer.

**Poole, K. L., Schmidt, L. A., Missiuna, C., Saigal, S., Boyle, M. H., & Van Lieshout, R. J. (2016). Childhood motor coordination and adult psychopathology in extremely low birth weight survivors. *Journal of affective disorders*, *190*, 294-299.**

**Objective:** To determine if childhood [motor coordination](http://topics.sciencedirect.com/topics/page/Developmental_coordination_disorder) is associated with lifetime [major depressive disorder](http://topics.sciencedirect.com/topics/page/Major_depressive_disorder) ([MDD](http://topics.sciencedirect.com/topics/page/Major_depressive_disorder)), current [generalized anxiety disorder](http://topics.sciencedirect.com/topics/page/Generalized_anxiety_disorder) ([GAD](http://topics.sciencedirect.com/topics/page/Generalized_anxiety_disorder)), and [attention-deficit/hyperactivity disorder](http://topics.sciencedirect.com/topics/page/Attention_deficit_hyperactivity_disorder) ([ADHD](http://topics.sciencedirect.com/topics/page/Attention_deficit_hyperactivity_disorder)) in adulthood, and to examine if extremely low birth weight (ELBW; <1000 g) status moderates the strength of these associations.

**Method:** Prospective study of a cohort of normal birth weight (NBW) controls and ELBW survivors. Participants completed the short form Bruininks-Oseretsky Test of Motor Proficiency (BOTMP-SF) at age 8. At age 29–36, participants completed the [Mini International Neuropsychiatric Interview](http://topics.sciencedirect.com/topics/page/Mini-international_neuropsychiatric_interview) to diagnose the psychiatric disorders of interest.

**Results:** Birth weight status significantly influenced the strength and direction of associations between childhood motor coordination and adult psychiatric outcomes such that the odds of MDD (*P*interaction=.02) and GAD (*P*interaction=.01) increased with worsening motor scores in NBW adults but not ELBW survivors. Stratified analyses indicated that in NBW adults, for each one-point decrease in BOTMP-SF score, the odds of lifetime MDD increased by 10% (OR=1.10, 95% CI: 1.01–1.20).

**Limitations:** Participant attrition reduced sample size and that may have limited our ability to detect statistically significant results for some of our analyses.

**Conclusion:** Poorer motor coordination in early life has a negative long-term impact on the development of MDD and GAD of individuals born at NBW. The long-term mental health risks of childhood motor coordination problems are significant and highlight the importance of recognizing motor deficits in all children, so that associated psychological difficulties can be identified and treated at an early age.

**Engel-Yeger, B., Palgy-Levin, D., & Lev-Wiesel, R. (2015). Predicting fears of intimacy among individuals with post-traumatic stress symptoms by their sensory profile. *The British Journal of Occupational Therapy*, *78*(1), 51-57.**

**Introduction:** The purpose of the research was: (1) to compare fears of intimacy between people with post-traumatic stress symptoms and healthy controls; (2) to examine the relationships between sensory processing patterns and fears of intimacy among people with post-traumatic stress symptoms; (3) to examine the ability of post-traumatic stress symptoms and sensory processing patterns to predict fears of intimacy.

**Method:** The study consisted of 60 people between 24 and 62 years old. Thirty of the participants had post-traumatic stress symptoms and the other 30 were healthy controls. All participants were involved in an intimate relationship. Participants completed the Post-traumatic Stress Disorder Symptom Scale, the Adolescent/Adult Sensory Profile, and the Fear of Close Personal Relationship Questionnaire.

**Findings:** Higher prevalence of extreme sensory sensitivity, avoidance, and low registration was found among the study group. These patterns significantly correlated with impaired emotional responses associated with intimacy. Low registration and group membership predicted fears of intimacy.

**Conclusion:** Sensory processing difficulties may contribute to the impaired intimate relationships of people with post-traumatic stress symptoms. Occupational therapists may help people with post-traumatic stress symptoms to be aware of their sensory processing difficulties and their impact on social/intimate relationships. This awareness may contribute to the person's ability to cope with post-traumatic stress symptoms, enable better emotional performance, and elevate quality of life.

**Whitcomb, D. A., Carrasco, R. C., Neuman, A., & Kloos, H. (2015). Correlational Research to Examine the Relation Between Attachment and Sensory Modulation in Young Children. *American Journal of Occupational Therapy*, *69*(4), 6904220020p1-6904220020p8.**

This study investigated whether a relation exists between attachment and sensory modulation in young children. Participants were 68 children ages 3–6 yr recruited through the local community. Caregivers were asked to complete a standardized behavioral inventory of sensory modulation patterns, and parent–child interactions were observed in their home. The evaluator categorized these interactions on the basis of items related to attachment security and dependency. Results revealed modest correlations between attachment and sensory modulation: *rs* (66) = .28, *p* = .02. The capacity to predict sensory modulation function by attachment characteristics and the capacity to predict attachment characteristics by sensory modulation function was significant but small (*p* < .05). These findings supporting a relation between attachment and sensory modulation should be considered when assessing and planning treatment of children with problems in one or both of these areas.

**Meredith, P. J., Bailey, K. J., Strong, J., & Rappel, G. (2016). Adult Attachment, Sensory Processing, and Distress in Healthy Adults. *American Journal of Occupational Therapy*, *70*(1), 7001250010p1-7001250010p8.**

**Objective:** To better understand the ways in which adult attachment, sensory processing, and distress may be interrelated in healthy adults.

**Method:** A cross-sectional study design was used with a convenience sample of 116 healthy participants who completed questionnaires before participating in a cold pressor pain-inducement task.

**Results:**  Attachment anxiety was significantly positively correlated with sensory sensitivity as measured using the Highly Sensitive Persons Scale and the Sensory Profile and with distress (i.e., stress, anxiety, and depression). Associations between attachment anxiety and both sensory sensitivity variables were lost when controlling for stress. Attachment avoidance was correlated only with sensory sensitivity measured using the Sensory Profile, and this relationship was retained when controlling for stress. Neither the attachment nor the stress variables were associated with sensation seeking.

**Conclusion:** Findings suggest that developing active coping approaches to deal with sensory sensitivities may be a valuable way to minimize distress. Recommendations for future research are provided.

**Wang, Z. W., Hua, J., & Xu, Y. H. (2015). The Relationship between Gentle Tactile Stimulation on the Fetus and Its Temperament 3 Months after Birth. *Behavioral Neurology*, *2015*.**

**Objective:** The aim of this study was to evaluate the effect of gentle tactile stimulation on the fetus in its temperament 3 months after birth.

**Method:** A total of 302 mother-3-month-infant dyads enrolled the retrospective cohort study. 76 mothers had regular gentle tactile stimulation on the fetus in their pregnancy; 62 mothers had irregular tactile stimulation on the fetus, and the rest of 164 mothers who had no tactile stimulation served as non-exposure group. Temperament was assessed using the EITS (a nine-dimensional scale of temperament).

**Results:** Significant difference in temperament type was found among infants in 3 groups at 3 months of age. In the regular practice group, the babies with easy type temperament accounted for 73.7%, which was higher than that in irregular practice group (53.2%, P = 0.012) and that in the control group (42.1%, P < 0.001). Compared to infants in no practice group, the infants who had received regular gentle tactile stimulation before birth were lower in negative mood (P = 0.047) while higher in adaptability (P < 0.001), approach (P = 0.001), and persistence (P = 0.001), respectively.

**Conclusion:** Regular gentle tactile stimulation on fetus may promote the formation of easy type infant temperament.

**Ismael, N. T., Lawson, L. A. M., & Cox, J. A. (2015). The relationship between children’s sensory processing patterns and their leisure preferences and participation patterns. *Canadian Journal of Occupational Therapy*, *82*(5), 316-324.**

**Background:** Sensory processing patterns may be associated with children's preferences for different activities; however, knowledge about how different sensory processing patterns may relate to children's participation in leisure activities is scarce.

**Purpose:** This study investigated in what leisure activities children with extreme sensory processing patterns participate and if relationships exist between children's sensory processing patterns and their leisure preferences and participation patterns.

**Method:** This correlational study analyzed data from children's Sensory Profiles and reported play and leisure preferences. All 91 children in the sample completed the Children's Assessment for Participation and Enjoyment (CAPE) and the Preferences for Activities of Children (PAC). Parents of children ages 6 to 10 years completed the Sensory Profile, and children ages 11 to 14 years completed the Adolescent/Adult Sensory Profile.

**Findings:** Children with different sensory processing patterns preferred both similar and distinct leisure activities. Low-registration quadrant summary z scores negatively correlated with CAPE overall diversity scores (rs=-.23, p=.03), sensitivity quadrant summary z scores negatively correlated with preferences for social activities (rs=-.23, p=.03) and preferences for skill-based activities (rs=-.22, p=.04), and avoiding quadrant summary z scores negatively correlated with preferences for social activities (rs=-.26, p=.01).

**Implications:** Children's sensory preferences are related to leisure preferences and participation.

**Van Hulle, C., Lemery-Chalfant, K., & Goldsmith, H. H. (2015). Trajectories of Sensory Over-Responsivity from Early to Middle Childhood: Birth and Temperament Risk Factors. *PloS one*, *10*(6), e0129968.**

Sensory over-responsivity, a subtype of sensory modulation disorder, is characterized by extreme negative reactions to normative sensory experiences. These over-reactions can interfere with daily activities and cause stress to children and their families. The etiology and developmental course of sensory over-responsivity is still largely unknown. We measured tactile and auditory over-responsivity in a population-based, typically developing sample of twins (N=978) at age two years via a caregiver report temperament questionnaire and again at age seven years via a sensory over-responsivity symptom inventory. Participating twins were treated as singletons although all analyses controlled for clustering within families. Children were divided into four trajectory groups based on risk status at both ages: low symptom (N=768), remitted (N=75), late-onset (N=112), and chronic (N=24). A subset of children who screened positive for SOR in toddlerhood (N = 102) took part in a pilot study focused on sensory over-responsivity at four years of age. Children in the chronic group had more severe symptoms of sensory sensitivity at age four years, including more motion sensitivity, than the other trajectory groups. Children in the chronic group had a younger gestational age and were more likely to be low birth-weight than the low symptom group. Differences between remitted and late-onset groups and the low-symptoms group were inconsistent across measures. Sensory over-responsivity was modestly correlated across ages (r = .22 for tactile over-responsivity and r = .11 for auditory over-responsivity), but symptoms were more stable among children born prematurely or who had more fearful and less soothable temperaments. A clear implication is that assessment over development may be necessary for a valid sensory processing disorder diagnosis, and a speculative implication is that sensory over-responsivity symptoms may be etiologically heterogeneous, with different causes of transient and stable symptoms.

**2014**

**Sayal, K., Heron, J., Maughan, B., Rowe, R. & Ramchandani, P. (2014), Infant temperament and childhood psychiatric disorder: longitudinal study. *Child Care, Health and Development, 40*, 292–297. doi: 10.1111/cch.12054**

Temperamental characteristics emerge early in life and can shape children's development, adjustment and behaviour. We aimed to investigate the association between early infant temperament and later childhood psychiatric disorder in a community sample. This prospective, population-based study used data from the Avon Longitudinal Study of Parents and Children (ALSPAC). In a sample of 7318 children, we investigated whether temperamental characteristics assessed at the ages of 6 months and 24 months are associated with an independent diagnosis of psychiatric disorder ascertained at age 7 years. After adjusting for confounders, temperamental characteristics assessed at 6 and 24 months of age were associated with psychiatric disorder at age 7 years. In particular, intensity of emotional reaction at age 6 months was associated with later disorder (adjusted odds ratio = 1.56; 95% confidence interval 1.19, 2.04; *P* = 0.002). These associations were stronger in girls and in those children with high levels of intensity at both 6 and 24 months of age. Temperamental characteristics involving high levels of emotional intensity within the first year of life are longitudinally associated with psychiatric disorder in mid-childhood, suggesting that the roots of psychiatric disorder may, in some cases, lie very early in life.

**Aron, E.N., Aron, A., & Jagiellowicz, J. (2012). Sensory Processing Sensitivity: A Review in the Light of the Evolution of Biological Responsivity. Pers Soc Psychol Rev 16, 262-282. doi: 10.1177/1088868311434213**

This article reviews the literature on sensory processing sensitivity (SPS) in light of growing evidence from evolutionary biology that many personality differences in nonhuman species involve being more or less responsive, reactive, flexible, or sensitive to the environment. After briefly defining SPS, it first discusses how biologists studying animal personality have conceptualized this general environmental sensitivity. Second, it reviews relevant previous human personality/temperament work, focusing on crossover interactions (where a trait generates positive or negative outcomes depending on the environment), and traits relevant to specific hypothesized aspects of SPS: inhibition of behavior, sensitivity to stimuli, depth of processing, and emotional/physiological reactivity. Third, it reviews support for the overall SPS model, focusing on development of the Highly Sensitive Person (HSP) Scale as a measure of SPS then on neuroimaging and genetic studies using the scale, all of which bears on the extent to which SPS in humans corresponds to biological responsivity.

**2011**

**Kinnealey M, Koenig KP, & Smith S. (2011). Relationships between sensory modulation and social supports and health-related quality of life. Am J Occup Ther. 2011 May-Jun;65(3):320-7.**

**Objective:** We explored the relationships between sensory modulation and health-related quality of life (HRQOL), social supports, and mental health symptoms of anxiety and depression.

**Method:** Twenty-eight adult volunteers ages 18-60 participated in the study. Fourteen adults were sensory over-responsive (SOR), and 14 adults in a matched comparative group were not sensory over-responsive (NSOR). All participants were tested using self-administered measures of sensory processing.

**Results**: Significant differences were found between SOR and NSOR groups on symptoms of anxiety, depression, and 4 of 8 indicators of HRQOL.

**Conclusions:** Several analyses exploring the relationships among the variables tested suggest that sensory response style, whether comparing SOR and NSOR groups or exploring the correlation of the response quadrants of the Adolescent/Adult Sensory Profile, appears significantly and differentially related to symptoms of affective mental health and quality-of-life indicators, including social participation.

**Davis EE,** [**Pitchford NJ**](http://www.ncbi.nlm.nih.gov/pubmed?term=%22Pitchford%20NJ%22%5BAuthor%5D)**, &** [**Limback E**](http://www.ncbi.nlm.nih.gov/pubmed?term=%22Limback%20E%22%5BAuthor%5D)**.(2011).** [**The interrelation between cognitive and motor development in typically developing children aged 4-11 years is underpinned by visual processing and fine manual control.**](http://www.ncbi.nlm.nih.gov/pubmed/21752007)[**Br J Psychol.**](http://www.ncbi.nlm.nih.gov/pubmed) **2011 Aug;102(3):569-84. doi: 10.1111/j.2044-8295.2011.02018.x.**

We charted the interrelation between cognitive and motor skills in typically developing children aged 4-11 years across broad ability measures from standardized tests and investigated the nature of this relationship by examining effects of age and sex. Results indicated a significant, moderate correlation between gross cognitive and motor scores across all participants. Correlations between indices of the standardized measures and a principal component analysis revealed that visual processing (VP) and fine manual control (FMC) largely accounted for the interrelation between the overall domains. Age and sex affected the strength of gross correlation: 7-year-olds showed a weaker correlation than all other ages and females exhibited a significantly stronger correlation than males. However, the correlation between VP and FMC was constant across all age and sex groups, except 4-year-old males. These findings advance evidence that from an early age, cognitive and motor development is linked by elucidating the underlying nature of this relationship. These results have important implications for clinical, educational, and experimental practice.

**2010**

**Champagne,T. (2010). The influence of posttraumatic stress disorder, depression, and sensory processing patterns on occupational engagement: A case study.** [**Work: A Journal of Prevention, Assessment and Rehabilitation**](http://iospress.metapress.com/content/103190/?p=5b7d5905a07c47b2ba9530b86339f04c&pi=0)**, 38(1).**

The purpose of this article is to provide a brief overview of how Posttraumatic Stress Disorder (PTSD), Depression, and Sensory Processing patterns influence occupational engagement, including work performance. Interventions and outcomes of the Sensory Modulation Program and approaches from Cognitive Behavior Therapy (CBT) are reviewed through single case exploration with a 42 year-old woman in outpatient services. The marked increase in occupational engagement and improved work performance in this single case review demonstrates the need for more research on the use of the Sensory Modulation Program and approaches from CBT with populations with PTSD, Depression, and Sensory Processing disorder.

**Slater R, Fabrizi L,** [**Worley A**](http://www.ncbi.nlm.nih.gov/pubmed?term=%22Worley%20A%22%5BAuthor%5D)**,** [**Meek J**](http://www.ncbi.nlm.nih.gov/pubmed?term=%22Meek%20J%22%5BAuthor%5D)**,** [**Boyd S**](http://www.ncbi.nlm.nih.gov/pubmed?term=%22Boyd%20S%22%5BAuthor%5D)**,** [**Fitzgerald M**](http://www.ncbi.nlm.nih.gov/pubmed?term=%22Fitzgerald%20M%22%5BAuthor%5D)**. (2010). Premature infants display increased noxious-evoked neuronal activity in the brain compared to healthy age-matched term-born infants.** **Neuroimage.** **2010 Aug 15;52(2):583-9.**

This study demonstrates that infants who are born prematurely and who have experienced at least 40 days of intensive or special care have increased brain neuronal responses to noxious stimuli compared to healthy newborns at the same postmenstrual age. We have measured evoked potentials generated by noxious clinically-essential heel lances in infants born at term (8 infants; born 37-40 weeks) and in infants born prematurely (7 infants; born 24-32 weeks) who had reached the same postmenstrual age (mean age at time of heel lance 39.2+/-1.2weeks). These noxious-evoked potentials are clearly distinguishable from shorter latency potentials evoked by non-noxious tactile sensory stimulation. While the shorter latency touch potentials are not dependent on the age of the infant at birth, the noxious-evoked potentials are significantly larger in prematurely-born infants. This enhancement is not associated with specific brain lesions but reflects a functional change in pain processing in the brain that is likely to underlie previously reported changes in pain sensitivity in older ex-preterm children. Our ability to quantify and measure experience-dependent changes in infant cortical pain processing will allow us to develop a more rational approach to pain management in neonatal intensive care.

**Kempen, E. V., Kamp, I. V., Lebret, E., Lammers, J., Emmen, H., & Stansfeld, S. (2010). Neurobehavioral effects of transportation noise in primary schoolchildren: A cross-sectional study. *Environmental Health,9*(1). doi:10.1186/1476-069x-9-25**

**Background:** Due to shortcomings in the design, no source-specific exposure-effect relations are as yet available describing the effects of noise on children's cognitive performance. This paper reports on a study investigating the effects of aircraft and road traffic noise exposure on the cognitive performance of primary schoolchildren in both the home and the school setting.

**Methods:** Participants were 553 children (age 9-11 years) attending 24 primary schools around Schiphol Amsterdam Airport. Cognitive performance was measured by the Neurobehavioral Evaluation System (NES), and a set of paper-and-pencil tests. Multilevel regression analyses were applied to estimate the association between noise exposure and cognitive performance, accounting for demographic and school related confounders.

**Results:** Effects of school noise exposure were observed in the more difficult parts of the Switching Attention Test (SAT): children attending schools with higher road or aircraft noise levels made significantly more errors. The correlational pattern and factor structure of the data indicate that the coherence between the neurobehavioral tests and paper-and-pencil tests is high.

**Conclusions:** Based on this study and previous scientific literature it can be concluded that performance on simple tasks is less susceptible to the effects of noise than performance on more complex tasks.

**Aron, A., Ketay, S., Hedden, T., Aron, E. N., Markus, H. R., & Gabrieli, J. D. (2010). Temperament trait of sensory processing sensitivity moderates cultural differences in neural response. *Social Cognitive and Affective Neuroscience,5*(2-3), 219-226. doi:10.1093/scan/nsq028**

This study focused on a possible temperament-by-culture interaction. Specifically, it explored whether a basic temperament/personality trait (sensory processing sensitivity; SPS), perhaps having a genetic component, might moderate a previously established cultural difference in neural responses when making context-dependent vs context-independent judgments of simple visual stimuli. SPS has been hypothesized to underlie what has been called inhibitedness or reactivity in infants, introversion in adults, and reactivity or responsivness in diverse animal species. Some biologists view the trait as one of two innate strategies-observing carefully before acting vs being first to act. Thus the central characteristic of SPS is hypothesized to be a deep processing of information. Here, 10 European-Americans and 10 East Asians underwent functional magnetic resonance imaging while performing simple visuospatial tasks emphasizing judgments that were either context independent (typically easier for Americans) or context dependent (typically easier for Asians). As reported elsewhere, each group exhibited greater activation for the culturally non-preferred task in frontal and parietal regions associated with greater effort in attention and working memory. However, further analyses, reported here for the first time, provided preliminary support for moderation by SPS. Consistent with the careful-processing theory, high-SPS individuals showed little cultural difference; low-SPS, strong culture differences.

**Cosbey, J., Johnston, S. S., & Dunn, M. L. (2010). Sensory Processing Disorders and Social Participation. *American Journal of Occupational Therapy,64*(3), 462-473. doi:10.5014/ajot.2010.09076**

Participation in social aspects of daily life is crucial to children's development. Although disability status is recognized to affect children's ability to participate in social activities, little is understood about the impact of sensory processing disorders (SPD) on children's social participation. We examined the social participation patterns of 2 groups of children (ages 6-9): (1) children with SPD and (2) their typically developing peers. All children participated in a structured interview to report their social participation patterns, including activity patterns and social networks. We used parent and teacher questionnaires to triangulate the data gathered from the children. Results revealed that the 2 groups of children demonstrated generally similar patterns of activity preferences and use of free time but had significant differences in areas related to intensity and enjoyment of involvement and in their social networks. Implications for future research and interventions are discussed.

[**Roze E**](http://www.ncbi.nlm.nih.gov/pubmed?term=%22Roze%20E%22%5BAuthor%5D)**,** [**Meijer L**](http://www.ncbi.nlm.nih.gov/pubmed?term=%22Meijer%20L%22%5BAuthor%5D)**,** [**Van Braeckel KN**](http://www.ncbi.nlm.nih.gov/pubmed?term=%22Van%20Braeckel%20KN%22%5BAuthor%5D)**,** [**Ruiter SA**](http://www.ncbi.nlm.nih.gov/pubmed?term=%22Ruiter%20SA%22%5BAuthor%5D)**,** [**Bruggink JL**](http://www.ncbi.nlm.nih.gov/pubmed?term=%22Bruggink%20JL%22%5BAuthor%5D)**,** [**Bos AF**](http://www.ncbi.nlm.nih.gov/pubmed?term=%22Bos%20AF%22%5BAuthor%5D)**. (2010).** [**Developmental trajectories from birth to school age in healthy term-born children.**](http://www.ncbi.nlm.nih.gov/pubmed/20921067)***Pediatrics*,*****126(5)*,1134-42.**

**Objective:** To determine the stability of the scores obtained on tests of motor development from birth until school age in healthy, term singletons and to determine if early motor scores are associated with more complex cognitive functions at school age, such as attention and memory.

**Methods:** This longitudinal, prospective cohort study included 77 infants. The motor development of these infants was assessed during the neonatal period with Prechtl's neurologic examination; in early infancy with Touwen's neurologic examination and general movement assessment; at toddler age with Hempel's neurologic examination and the Psychomotor Developmental Index from the Bayley Scales of Infant Development; and at school age with the Movement Assessment Battery for Children. Cognition was determined at toddler age with the Mental Developmental Index from the Bayley Scales of Infant Development; and at school age with an intelligence test and attention and memory tests.

**Results:** The mean absolute difference in standardized motor scores for all time points was 1.01 SD (95% confidence interval: 0.91-1.11). Only the explained proportions of variance of maternal socioeconomic status and verbal intelligence were significant for sustained attention and verbal memory (r(2) = 0.104, P = .030 and r(2) = 0.074, P = .027), respectively. The children's scores on early motor tests added little value for their motor and cognitive development at school age.

**Conclusions:** In healthy children the stability of motor development from birth until school age is low. Maternal socioeconomic status and verbal intelligence rather than the infants' scores on early motor tests signified added value for complex cognitive functions at school age.

[**Alcock KJ**](http://www.ncbi.nlm.nih.gov/pubmed?term=%22Alcock%20KJ%22%5BAuthor%5D)**,** [**Krawczyk K**](http://www.ncbi.nlm.nih.gov/pubmed?term=%22Krawczyk%20K%22%5BAuthor%5D)**. (2010).** [**Individual differences in language development: relationship with motor skill at 21 months.**](http://www.ncbi.nlm.nih.gov/pubmed/20712734)***Dev Sci.*** ***1;13(5),* 677-91.**

Language development has long been associated with motor development, particularly manual gesture. We examined a variety of motor abilities - manual gesture including symbolic, meaningless and sequential memory, oral motor control, gross and fine motor control - in 129 children aged 21 months. Language abilities were assessed and cognitive and socio-economic measures controlled for. Oral motor control was strongly associated with language production (vocabulary and sentence complexity), with some contribution from symbolic abilities. Language comprehension, however, was associated with cognitive and socio-economic measures. We conclude that symbolic, working memory, and mirror neuron accounts of language-motor control links are limited, but that a common neural and motor substrate for nonverbal and verbal oral movements may drive the motor-language association.

**2009**

None

**Prior to 2009**

**Hohmeister, J., Demirakça, S., Zohsel, K., Flor, H., & Hermann, C. (2009). Responses to pain in school-aged children with experience in a neonatal intensive care unit: Cognitive aspects and maternal influences. *European Journal of Pain,13*(1), 94-101. doi:10.1016/j.ejpain.2008.03.004**

Previously, it was shown that school-aged (9-14yr) preterm and fullterm children with neonatal pain exposure exhibit elevated heat pain thresholds and heightened perceptual sensitization to tonic painful heat when tested under standard conditions [Hermann C, Hohmeister J, Demirakca S, Zohsel K, Flor H. Long-term alteration of pain sensitivity in school-aged children with early pain experiences. Pain 2006;125:278-85]. Here, changes in the psychosocial context of pain responses in these children, who had been hospitalized 7 days after birth including 3 days of treatment in a neonatal intensive care unit (NICU), are reported. Nineteen preterm (31 weeks gestational age) and 20 fullterm children (37 weeks gestational age) with NICU experience, recruited retrospectively and selected based on strict exclusion criteria, and 20 fullterm control children participated. Preterm NICU children endorsed more pain catastrophizing as compared to controls. Mothers of preterm children, who had been more severely ill and had been hospitalized longer than fullterm NICU children, were more likely to engage in solicitous pain-related behavior. Maternal influence was also assessed by comparing heat pain thresholds and perceptual sensitization to tonic painful heat obtained in the presence versus absence (i.e. standard testing conditions) of the mother. In all three groups, maternal presence was associated with increased heat pain thresholds. Control children habituated significantly more to tonic heat when their mother was present. The NICU children showed overall significantly less habituation than the controls; there was no modulating effect of maternal presence. Especially in highly vulnerable children such as preterms, neonatal pain exposure and prolonged hospitalization may, aside from neuronal plasticity, promote maladaptive pain-related cognitions and foster parental behavior that reinforces the child's pain response.

## 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.

**Purpose**: The purpose of this article is to present definitions and conceptsabout sensory modulation, illustrate behavioral aspects of sensorymodulation disorders, describe a framework for assessment andintervention, and present advances in research.

**Method**: A review of descriptive and evidence-based literature relatedto the impact of exposure to both prenatal and postnatal traumaon sensory modulation is provided, with additional informationgleaned from recent assessment data on children with a historyof trauma who are served by the Southwest Michigan Children'sTrauma Assessment Center (CTAC).**Clinical Implications:** The review of the literature indicates support for the presenceof sensory modulation disorders among traumatized children.In addition, the emerging data now being gathered on childrenwho have been assessed by CTAC indicate a significant prevalenceof sensory modulation disorders among children with a historyof trauma alone, and those with both trauma and a diagnosisof fetal alcohol spectrum disorder (FASD). Awareness, recognition,and identification of behaviors associated with this disorder,and referral to appropriate professionals, is essential to ensureeffective preventive and intervention services.

**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.**

Childhood trauma may confer risk for adult psychopathology by altering emotional and physiological responses to subsequent stressors. Few studies have distinguished effects of childhood trauma from effects of current Axis I psychopathology on adult psychophysiological reactivity. The authors exposed 90 psychiatrically healthy police cadets to startling sounds under increasing threat of shock while assessing their eyeblink electromyogram (EMG), skin conductance (SC), and heart rate responses. When compared with those who did not endorse early trauma (n = 65), cadets reporting childhood trauma (n = 25) reported less positive emotion and showed greater SC responses across all threat levels. They also showed threat-dependent elevations in reported negative emotions and EMG responses. Results suggest that childhood trauma may lead to long-lasting alterations in emotional and psychophysiological reactivity even in the absence of current Axis I psychopathology.

**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.**

Sensory-processing sensitivity is assumed to be a heritable vulnerability factor for shyness. The present study is the first to examine sensory-processing sensitivity among individuals with social anxiety disorder. The results showed that the construct is separate from social anxiety, but it is highly correlated with harm avoidance and agoraphobic avoidance. Individuals with a generalized subtype of social anxiety disorder reported higher levels of sensory-processing sensitivity than individuals with a non-generalized subtype. These preliminary findings suggest that sensory-processing sensitivity is uniquely associated with the generalized subtype of social anxiety disorder.

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| ***Language, Speech, and Hearing Services in Schools*** Vol.38 109-116 April 2007. doi:10.1044/0161-1461(2007/011)© [American Speech-Language-Hearing Association](http://lshss.asha.org/misc/terms.dtl)  |

**Smith, A. M., Roux, S., Naidoo, N. (., & Venter, D. J. (2005). Food choices of tactile defensive children. *Nutrition,21*(1), 14-19. doi:10.1016/j.nut.2004.09.004**

**Objective:** We explored whether tactile defensive children have picky eating habits because fussy or picky eaters are a general problem to parents and different health professionals.

**Methods:** Children (*n* \_ 62) of both sexes, ages 3 to 10 y, were assigned to an experimental tactile defensive (TD) group (*n* \_ 29) or a control non-TD group (*n* \_ 33). A questionnaire on eating habits was compiled and given to parents for completion during personal interviews (children were screened with a checklist and evaluated for tactile defensiveness with the Winnie Dunn Caregiver profile questionnaire).

**Results:** This research confirmed that the eating habits and food choices of TD and non-TD children differ significantly. TD children had a fair to poor appetite. They hesitated to eat unfamiliar foods, did not eat at other people’s houses, and refused certain foods because of the smell and temperature. They also had a problem eating vegetables. They often gagged and/or bit their inner lips and cheeks. The results showed a definite difference in the limited selection of foods that TD children chose and a pronounced aversion toward textures or consistencies, smells, and temperatures of food as compared with integrated children. **Conclusions:** Fussy or picky eaters should be evaluated more widely than to treat only the feeding problem. Tactile or oral defensiveness can be treated. This report underlines the team approach of health professionals.

**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.**

These authors investigate the relationship between childhood environmental variables and what they call sensory processing sensitivity with the development of adult shyness. These authors have created a tool to examine sensory processing sensitivity (see Aron, 1996, 1999 and Aron & Aron, 1997). They define sensory processing sensitivity as “an individual difference characteristic in which those who are high are particularly sensitive to subtle stimuli, easily over stimulated, prone to ‘pause to check’ in a novel situation, and prefer to reflect and revise their cognitive maps after an experience.” (pg. 181). They relate this concept to temperament literature on inhibitedness, reactivity, and threshold of response. They propose a model whereby sensitivity and adverse childhood experiences interact and lead to negative affect which later leads to shyness. This paper reports the results of 4 studies completed to investigate this model. The subjects were undergraduate level students in the state of NY. They had found previously that approximately 10-35% of students are rated as highly sensitive by their tool. Items on their tool include things like ‘Are you uncomfortable with loud noises?’ This is a lengthy and complex paper with many results reported but generally their results support their proposed model.

[Becker K](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=Search&Term=%22Becker%20K%22%5BAuthor%5D&itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_DiscoveryPanel.Pubmed_RVAbstractPlus), [Holtmann M](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=Search&Term=%22Holtmann%20M%22%5BAuthor%5D&itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_DiscoveryPanel.Pubmed_RVAbstractPlus), [Laucht M](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=Search&Term=%22Laucht%20M%22%5BAuthor%5D&itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_DiscoveryPanel.Pubmed_RVAbstractPlus), & [Schmidt MH](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=Search&Term=%22Schmidt%20MH%22%5BAuthor%5D&itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_DiscoveryPanel.Pubmed_RVAbstractPlus)**.(2004). Are regulatory problems in infancy precursors of later hyperkinetic symptoms?*****Acta Paediatr.*** ***93,* 1463-9.**

**Objective**: To examine whether regulatory problems in infancy predict later hyperkinetic symptoms in childhood and pre-adolescence.

**Methods**: In a prospective longitudinal study of 319 children at risk of later developmental problems and psychopathology, hyperkinetic behavior problems were assessed at the ages of 2, 4.5, 8 and 11 y by means of a standardized parent interview. Infant regulatory problems at the age of 3 months were determined from multiple sources of information. An observational procedure was used to assess the quality of mother-infant interaction.

**Results**: At the age of 3 months, 17% of the infants (n = 55; 27 boys, 28 girls) suffered from multiple regulatory problems. Compared to a control group (n = 264), these children presented more hyperkinetic symptoms throughout childhood. Negativity in the mother-infant interaction and early family adversity each contributed to later hyperkinetic symptoms. When controlling for family adversity, the association between infant multiple regulatory problems and later hyperkinetic problems was rendered insignificant.

**Conclusions**: These findings suggest that multiple regulatory problems may not be a key variable for later hyperkinetic problems. The impact of early family adversity factors clearly outweighed that of infant psychopathology on later behavior disorder.

**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.**

These researchers examined a sample of 127 undergraduate students to investigate the relationships between their negative childhood memories, pessimism and also sensory processing sensitivity. These researchers cite the studies by Aron and colleagues mentioned above and also studies by Millon & Davis regarding hypersensitive temperamental disposition. They use Aron & Aron’s (1997) tool (see above) to measure the student’s sensory processing in relation to the other chosen scales for optimism/pessimism (The Life Orientation Test-Revised) and negative mood (The Profile of Mood States). The authors did find a relationship between the tools they used and the student’s ratings of avoidant personality disorder (APD) based on DSM –IV criteria. The correlation reported between the measure of sensory processing and the rating of APD was .43 which was significant (p = .01). There was a significant negative relationship (r = -.26, p = .01) between sensory processing and the scale rating optimism/pessimism and a positive relationship between sensory processing and negative mood ( r = .42, p=.01).