



AOTA Critically Appraised Topics and Papers Series

Children and Adolescents With Sensory Processing Disorders/Sensory Integrative Dysfunction

**A product of the American Occupational Therapy Association's Evidence-Based Literature Review Project*

CRITICALLY APPRAISED TOPIC (CAT)

Focused Question

OT Intervention

What occupational therapy interventions (including the effect of context [cultural, physical, social, personal, spiritual, temporal, and visual]) are effective to create, promote, establish, restore, maintain, modify, and prevent future limitations in activities of daily living, instrumental activities of daily living, education/transition, play/leisure, and social participation in children and adolescents whose sensory processing patterns are interfering with everyday life participation?

Clinical Scenario:

The role of the occupational therapist (OT) working with children is to promote their full participation in the occupations of everyday living. Occupational therapists do this using a variety of service models ranging from consultation to direct service delivery. They also use a wide variety of intervention approaches. The specific approach chosen by a therapist in any particular case depends on the perspective the therapist holds on the nature of the problems experienced by the child and the therapist's conceptual perspectives regarding those problems and how best to address them.

Using the terminology introduced by the *International Classification of Functioning, Disability, and Health* (ICF; World Health Organization [WHO], 2001), approaches to intervention used by occupational therapists can be broadly classified in two main domains: impairment-oriented and performance-oriented. The ICF classifies health and well-being into two main domains: a) body function and structure, and b) activity and participation, with impairments in body function and structure leading to activity limitations and participation restrictions. According to the ICF, each domain affects the other, although the relationship is not necessarily direct; rather, it is affected by environmental factors.

Based on underlying conceptual perspectives, interventions can be classified as impairment-oriented (i.e., seeking to reduce or remediate impairment in body function or structure), or performance-oriented (i.e., seeking to improve activity and participation), without attention to underlying impairments. Accordingly, such traditional pediatric occupational therapy interventions as sensory-motor approaches and sensory integration are classified as impairment-oriented, while such emerging approaches such as task-specific training and cognitive approaches are classified as performance-oriented.

This classification has been used to group the studies in the summary of key findings below. Each study was reviewed for its theoretical foundation and, based on the description provided by the study authors, was classified as impairment-oriented or performance-oriented. For example, although the Chia and Chua (2002) article includes gross and fine motor activities as outcome, it has been classified as impairment-oriented because the aim of the intervention, as described by the authors, was to provide normal sensory stimuli facilitating expected normal responses while at the same time remediating neuromotor function—the underlying perspective being that the performance deficits observed are the result of impairment in neuromotor function.

Classifying the approaches using this scheme allows us to differentiate among the approaches being used by therapists and to interpret the breadth of evidence on their effectiveness. Interventions focused on impairments are based on the assumption that competent occupational performance is the direct result of properly functioning nervous and musculoskeletal systems, and dysfunction is the direct result of damaged or abnormal development of one or more of these systems (Kielhofner, 1997; Mathiowetz & Bass Haugen, 1997). Impairment-oriented interventions aim to reduce impairment (e.g., sensory processing dysfunction) and restore function through targeting the impaired body structure and function by use of such approaches as sensory–motor intervention or sensory integration. Performance-oriented interventions aim to improve performance of a specific activity (e.g., being able to ride a bicycle) and participation (e.g., being able to ride a bicycle around the neighborhood with friends) by using systems theories and learning paradigms to guide skill acquisition and task performance.

The diagnoses of children referred to occupational therapy cover the entire spectrum of disabilities, from pervasive developmental disorders to behavioral and emotional problems like anxiety to motor-based learning problems. Consequently, occupational therapy practitioners are faced with a wide range of body function and structure impairments, activity limitations, and participation restrictions to address in their practice.

Studies looking at the characteristics of children referred to OT have identified that children are often referred during the primary grades for difficulty with activities requiring fine motor coordination (e.g., printing, tying shoelaces), gross motor coordination involved in sports, or because of organizational and behavioral problems (Miller, Missiuna, Macnab, Malloy-Miller, & Polatajko, 2001). These children form a heterogeneous group experiencing a variety of activity limitations and participation restrictions. While none of these problems are, in and of themselves, pathognomic, they may be considered to be symptomatic of underlying impairment in body function and structure, or of poor skill acquisition, depending on the conceptual perspective of the therapist. From an impairment reduction perspective, it is considered that these performance problems are indicative of faulty underlying sensory processing, praxis or sensory integration. Sensory processing dysfunction is found in a large number of children with autism, learning disabilities (LD), attention deficit hyperactivity disorder (ADHD), or developmental coordination disorder (DCD). A competing, or perhaps complementary, perspective is that these problems are related to deficits in skill acquisition or performance. The practicing therapist has to determine how best to proceed.

In the research-informed health care climate of today, the therapist’s choice of intervention must be informed not only by his or her underlying conceptual perspective, but by the latest and best evidence regarding the effectiveness of the intervention.

Summary of Key Findings:

Summary of Levels I, II, and III

This review identified two types of articles: individual studies, and reviews. The former were separated first into two models of service delivery: 1) consultation and 2) direct service. The direct service interventions were further categorized as impairment-oriented or performance-oriented, based on underlying conceptual perspectives. The systematic reviews were considered separately to facilitate appraisal and analysis of findings.

INDIVIDUAL STUDIES

CONSULTATION ARTICLES

In consultative approaches, the intervention is focused on capacity building. Typically, the therapist spends most of his or her time discussing the child's needs with a parent or teacher. Three studies investigated the effectiveness of consultative models of service delivery in the school settings and/or with parents. They all show that consultation is effective in facilitating children's achievement of set goals.

In a Level II study aimed at determining the extent to which parents and teachers, with guidance, can assist in the management of children with developmental coordination disorder (DCD), Sugden and Chambers (2003) demonstrated that both teachers and parents were able to provide effective intervention for children with DCD. Every week, parents and teachers were given individualized guidelines coming from the cognitive-motor approach developed by Henderson and Sugden (1992). After the intervention period, the majority of children had improved their motor skills, which were maintained at follow-up 7 weeks later.

Kemmis and Dunn (1996) examined the intervention success of weekly collaborative consultation between therapists and teachers for children identified as having sensory integration dysfunction and learning problems (Level III). During each session, the OT-teacher pair targeted a specific performance problem and developed an intervention strategy for the teacher to use during the next week. Their results showed that this model of service delivery was effective in reaching goals.

Dunn (1990) compared the effectiveness of the direct service delivery model (sensory-motor occupational therapy) to a collaborative consultation model on the attainment of educationally relevant outcomes (such as language, cognition, or motor skills; Level I). The direct service model consisted of individual 60-minute weekly sessions, while the collaborative consultation model consisted of weekly 60-minute teacher-therapist discussion about the child's needs. Both models worked equally well in facilitating children's goal achievement.

Limitations

Interventions provided under a consultative model of service delivery are highly individualized, making it difficult to assess whether other factors may be contributing to the positive results obtained. Furthermore, the time-intensive (60-minute sessions) intervention provided in two of the studies (Dunn, 1990; Kemmis & Dunn, 1996) does not represent the prevalent model of service delivery in school settings, which may limit the usefulness of the findings.

DIRECT SERVICE ARTICLES

In direct service approaches, the therapist spends most of his or her time interacting directly with the child; the interventions being focused on remediating body function and structures, increasing activity and participation, or both. Accordingly, to facilitate comparison of findings amongst studies, the direct service approaches were divided into two categories based on the conceptual foundation of the interventions: 1) impairment oriented—interventions that are primarily focused on remediating body functions and structures; 2) performance-oriented—interventions that are primarily focused on increasing performance of specific activities and participation. Finally, within these two categories, the interventions were named for what they were: sensory-based (e.g., weighted vests, sound therapy), sensory–motor (e.g., sensorimotor handwriting interventions, perceptual motor training), direct skill teaching (e.g., preparatory activities), and cognitive interventions (e.g., CO-OP).

Impairment-oriented Approaches

Classified under this heading are those approaches that aim to remediate a defective or underdeveloped body structure or function by targeting the underlying control mechanism(s) hypothesized to be responsible for the observable impairments; here, sensory processing. While it is typically hypothesized that remediation of the impairment(s) will ultimately lead to an increase in activity performance and participation, the focus of the intervention is remediation of the impairment(s). Included here are sensory–motor approaches.

Impairment-oriented Approaches: Sensory-based

Sensory-based approaches are based on the assumption that the successful integration of input from the sensory systems is necessary for adaptation and the development of motor and cortical functions. Interventions aim to remediate or compensate for the impaired sensory process(es) in order to facilitate performance.

Hall and Case-Smith (2007) investigated the effectiveness of a sensory diet and therapeutic listening program on children with sensory processing disorders and visual–motor delays (Level III). A 4-week sensory diet program was followed by an 8-week therapeutic listening program in addition to the sensory diet. Mixed results were obtained on the sensory profile, a measure of visual motor integration, and a measure of handwriting. The authors reported that their results suggest that the therapeutic-listening program in combination with a sensory diet facilitated substantial improvement in children’s behavior.

Impairment-oriented Approaches: Sensory–motor (perceptual–motor)

Sensory–motor approaches use some combination of sensory input and motor activities to facilitate the expected normal motor response and promote motor skill development. Two studies that investigated the effectiveness of sensory–motor interventions on children with developmental coordination disorder (DCD) reported positive results.

Chia and Chua (2002) conducted a pilot randomized controlled trial (Level I) to investigate the effects of physiotherapy on neuromotor function (e.g., weakness, muscle tightness, vestibular function, gross and fine motor function) of school-aged children with DCD and learning disabilities (LD). The aim of the intervention was to provide normal sensory stimuli while at the same time facilitate expected normal response to these input, and to address any impairments of muscle weakness, tightness, and postural misalignment. Neuromotor function was shown to improve following the 12-week bi-weekly intervention.

Wilson, Thomas, and Maruff (2002) explored the efficacy of a computer-based motor/kinesthetic imagery-based intervention when compared to a conventional sensory–motor intervention and a no-treatment control group (Level I). The aim of the intervention was to remediate motor clumsiness by targeting impairment in the forward modeling of the efference copy of movement thought to be defective in children with DCD. The imagery training group received weekly 60-minute sessions of visual imagery, mental rehearsal, visual modeling, and so on, for 5 weeks. The conventional sensory–motor group received a combination of fine motor, gross motor, and sensory–motor activities tailored to the individual needs of the child. The results of this study suggest that imagery training and sensory–motor training are effective means of improving motor function in children with motor coordination difficulties.

Limitations

Many studies in rehabilitation sciences are plagued with low sample sizes, and thus reduced power of statistical analysis. This was the case for the study by Chia and Chua (2002). Adding to the small sample size, the large within-group variability in Chia and Chua’s study might have had an impact on the results. Nevertheless, positive results were obtained, suggesting a strong effect size.

Performance-oriented Approaches

Classified under this heading are those approaches that aim to increase activity performance and participation on specific tasks. The hypothesis is that activity and participation restrictions result from the interaction among the person, the environment, and the task, instead of the impairments; impairments typically are not considered. Included here are direct skill teaching and cognitive-based approaches. The evidence discussed by the four articles included in this category supports the use of task-specific approaches.

Performance-oriented Approaches: Direct Skills Teaching

The aim of direct skills teaching approaches is, as the name suggests, teaching specific skills such as social skills, throwing a ball, or skating. Such approaches make use of teaching, coaching, and motor learning principles to enable the child to acquire set skills. The evidence suggests that direct skills teaching approaches are effective in enabling children to learn to perform specific skills.

Hepler (1997) investigated the effectiveness of a social skills program when compared to no treatment (Level I). The aim of the intervention was to enable children with LD to acquire social skills. The intervention consisted of a cognitive behavioral program designed to teach specific skills and provide opportunities for friendships between children with and without LD. According to the authors, results suggest that such a social skill program may have a positive effect in improving the peer relations of children with LD.

Hodge, Murata, and Porretta (1999) explored the effect of preparatory activities on motor skill performance of elementary-aged children with LD and attention deficits (Level I). The aim of the preparatory activities was to enable children to increase their performance on throwing, catching, and running. Task-specific warm-up activities were compared to mental preparation and no preparatory activities. Results indicated that mental practice has the potential to positively affect subsequent motor performance involving accuracy tasks.

Limitations

Group distribution in the study by Hepler (1997)—all boys in the treatment group and all girls in the control group—has likely added a confounding variable that compromises analysis comparison given the known influence of gender on social skills.

While the study by Hodge, Murata, and Porretta (1999) is a Level I study using a randomized controlled design, there is a potentially confounding difference between the groups that goes beyond types of preparatory activities received. While children in the mental preparation (MP) group observed the motor skills to be assessed, children in the task specific (TS) group practiced the skill without any demonstration. In other words, an element of teaching was present in the MP group, but absent in the TS group. Accordingly, children in the TS group practiced their own movement pattern (whether it was correct or not), while children in the MP were shown an appropriate movement pattern for completing the skill. This brings into question the results obtained, indicating the need for more research in this area.

Performance-oriented Approaches: Cognitive-based

Cognitive-based approaches focus on increasing the performance of specific activities. However, as opposed to direct skills teaching approaches, cognitive-based approaches aim to guide children in the discovery of cognitive strategies that they can apply to enable their learning of chosen activities. The objective is that children also apply these strategies to other troublesome activities in their daily lives. The evidence suggests that cognitive approaches, such as CO-OP, are effective in enabling children to reach their set goals—and results were found to be replicable in the clinical setting.

Miller, Polatajko, Missiuna, Mandich, and Macnab (2001) conducted a Level I study to evaluate the efficacy of a cognitive approach (Cognitive Orientation to Daily Occupational Performance [CO-OP]) as compared to current sensorimotor occupational therapy practices in improving the functioning of children with DCD. Both groups received 10 individualized 50-minute treatment sessions. CO-OP group participants were guided to discover cognitive strategies to solve their motor problems. The authors reported that while both groups demonstrated improvement following intervention, gains made by the CO-OP group in their performance of problematic motor activities (e.g., handwriting, shoe tying, or skipping) were significantly larger.

Polatajko, Mandich, Miller, and Macnab (2001) audited existing data on CO-OP effectiveness to determine whether the effects reported in earlier studies could be replicated in a clinic by different therapists working with different children (Level III). The results of this review suggest that the effects of the CO-OP method on the children's performance of motor activities, documented since 1994, are replicable.

Limitations

The two groups in the Miller, Polatajko, Missiuna, Mandich, and Macnab (2001) study differed significantly at pretest on some measures, with the CO-OP group being more impaired. However, a co-variate analysis showed that this had no significant effect on the results.

SYSTEMATIC REVIEWS

Sinha, Sinove, Wheeler, and Williams (2006) conducted a systematic review of randomized controlled trials investigating the effectiveness of the sensory-based intervention of sound therapy in autism. They reported mixed results on a large number of outcomes measured (e.g., behavior, language, quality of life) and concluded that no conclusive empirical evidence of effectiveness was available at the moment.

Baranek (2002) conducted a systematic review (Level I) of studies investigating the effectiveness of sensory–motor interventions with children with autism. Twenty-nine studies were found, including studies exploring the effectiveness of sensory integration-based approaches, sensory stimulation techniques, auditory integration training, and related acoustic interventions, visual therapies, sensorimotor handling techniques, and physical exercise. Overall, while positive outcomes were obtained by some studies, mixed results prevailed.

Pless and Carlsson (2000) did a meta-analysis (Level I) to evaluate the effectiveness of interventions for children with DCD. Interventions reviewed were categorized into a) general ability (e.g., facilitation of balance and other physical abilities, training of specific perceptual and motor tasks), b) sensory integration, and c) specific skills (e.g., combination of correctly performed practice of functional skills, appropriate repetition, sufficient guidance and time to facilitate skill retention and generalization). The authors report that their results provide evidence supporting the use of specific skills approaches that are based on the contemporary understanding that specific motor control and motor learning underlies skilled movement.

Swanson and Sachse-Lee (2000) conducted a meta-analysis (Level I) aimed at providing an overview of different interventions for students with LD. Some of the interventions included in the analysis were direct instruction, strategy instruction, and combined approaches. Their results revealed that no significant main effects emerged for the intervention model (i.e., every intervention produced positive effects). However, the authors noted that sensory–motor interventions (more specifically related to handwriting) obtained the lowest effect size when compared to other approaches.

Kavale and Mattson (1983) also conducted a meta-analysis (Level I) to assess the efficacy of sensory–motor training (no population mentioned). Their results suggest that sensory–motor training is not an effective pediatric intervention approach.

Limitations

In addition to the small sample sizes of studies discussed earlier, Baranek (2002) and Swanson and Sachse-Lee (2000) noted that studies in rehabilitation sciences are frequently methodologically weak, causing much difficulty to anyone attempting to summarize key evidence. Furthermore, the heterogeneity found within a specific diagnosis (e.g., autism, LD) likely contributes to the mixed results reported in the literature, and thus compounds the difficulty of conducting a meta-analysis.

Nolan (2004) completed a critical analysis of Kavale and Mattson’s meta-analysis (1983) and uncovered methodological flaws concerning study selection, completeness of data, and analysis value. These flaws bring uncertainty about their result. However, Nolan did not re-do the statistical calculations involved necessary for a meta-analysis; consequently, it is unknown at this time whether the results obtained by Kavale and Mattson would have been different if a more rigorous methodology had been followed.

A meta-analysis is a powerful statistical method for combining the results of a series of independent studies. However, this design might not have been the most appropriate design for use by Pless and Carlsson (2000). A meta-analysis should combine studies conducted for the same general purpose. The studies included in their meta-analysis represent such a large variety of treatment approaches that it brings into question the significance and importance of the result obtained. Furthermore, the comparison of the three intervention categories identified was not

the primary objective of the studies included in the meta-analysis. Accordingly, the authors' conclusions about the relative effectiveness of the different interventions should be interpreted with care.

Summary of Levels IV and V

Interventions were separated in categories as above. Only categories having Level IV and/or V studies are included here.

DIRECT SERVICE

Impairment-oriented Approaches

Sensory-based

Sensory-based approaches are based on the assumption that the successful integration of input from the sensory systems is necessary for adaptation and the development of motor and cortical functions. Interventions aim to remediate/compensate for the impaired sensory process(es) in order to facilitate performance.

Two Level IV studies exploring the effectiveness of a weighted vest on a variety of on-task behaviors reported positive results.

Fertel-Daly, Bedell, and Hinojosa (2001) examined the effectiveness of a weighted vest for increasing attention to a fine motor task and decreasing self-stimulatory behaviors in 5 preschool children with pervasive developmental disorders. Observation of behaviors during fine motor activity included duration of focused attention to task, number of distractions, and duration and type of self-stimulatory behaviors. Positive results were reported overall. The greatest impact was seen in a reduction in the number of distractions while wearing the vest.

VandenBerg (2001) examined the effect of deep touch pressure using weighted vests on visual attention for fine motor activities in 4 children with ADHD. All 4 students demonstrated a significant increase in time on task during a fine motor activity while wearing the weighted vests compared to baseline without the vest.

Limitations

There are numerous limitations inherent in the design of Level IV and V studies. However, the validity of the studies can sometimes be strengthened by simple modifications. For example, in the study by Fertel-Daly, Bedell, and Hinojosa (2001), some behaviors did not return to baseline after the intervention. The use of a multiple baseline design instead of an ABA design would have addressed this. In the study by VandenBerg (2001), an ABA design (instead of AB) would have been preferable to strengthen validity of study.

Sensory-motor

Mixed results were obtained from Level IV studies, although they were mostly positive; this is a different picture from the one painted by the Levels I, II, and III studies described above.

Inder and Sullivan (2004) examined the effect of selected educational kinesiology techniques on the postural responses in 4 children demonstrating the characteristics of DCD. The intervention makes use of specific body movements that are hypothesized to assist the integration and organization of the central nervous system, thereby enhancing performance in somatosensory integration, organization and quality of movement, as well as academic performance. Mixed

results were obtained on equilibrium, specific condition equilibrium scores, and postural sway. Total number of falls decreased significantly for all children from baseline to intervention

Schilling and Schwartz (2004) investigated the effect of therapy balls as seating on engagement and in-seat behavior of 4 children with autism. The use of therapy balls was meant to provide dynamic seating to children with autism to provide them with an opportunity to both actively move and maintain an optimal arousal level while maintaining a productive seating posture. The results of this study suggest that the use of therapy balls as a seating device may be effective in improving in-seat behavior and attention to task in children with autism.

Candler (2003) examined the effectiveness of a 1-week summer day camp on occupational performance in 12 children with sensory modulation disorder. The program included sensory integration therapy and therapeutic riding. For this program, the purpose of the riding experience was to teach riding skill for intrinsic enjoyment, posture, balance, and quality of life. Nine out of the 10 families that participated in postintervention interviews reported an improvement in performance and/or satisfaction for at least one of their goals.

Leemrijse, Meijer, Vermeer, Adèr, and Diemel (2000) evaluated the effects of Le Bon Départ (LBD) treatment and sensory integration (SI) treatment on the motor performance of 6 children diagnosed with DCD (crossover design). LBD is a form of therapy in which music and rhythm play a prominent role. Results demonstrated that during LBD and SI treatment, scores on all measures improved significantly. However, when gains made during LBD were compared to gains made during SI, only scores on a rhythm measure showed a significant difference between interventions.

Limitations

The small sample size, lack of randomization, and lack of a control group of Level IV and V studies limits their generalizability to other samples. Furthermore, the heterogeneity of the diagnoses/problems introduces a great deal of variability into the results limiting confidence in the findings.

Performance-oriented Approaches

Cognitive-based

Results from a Level IV study are in line with those obtained in the Level I and III studies described above.

The results obtained by Polatajko, Mandich, Miller, and Macnab (2001) and described above are similar to those obtained by Martini and Polatajko (1998). The purpose of the study was to see if the positive results achieved earlier (Wilcox, 1994) could be replicated by a different therapist. The results were replicated, increasing the generalizability of the results, and indicating that the effectiveness of the intervention is not dependent on the therapist.

Limitations

Data analysis of Level IV study cannot make use of powerful statistics. In the Martini and Polatajko (1998) study, visual graph inspection was used to determine intervention effects. There are no formal guidelines for such analysis and some would argue with its validity.

Contributions of Qualitative Studies:

N/A

Bottom Line for Occupational Therapy Practice:

The first and certainly most important result from this review is that there is an urgent need for well-controlled studies looking at the effectiveness of frequently used pediatric OT interventions. The heterogeneity of the populations and interventions included in this review limits the ability of occupational therapists to rely on the evidence summarized above to base their clinical decisions. Attention should be directed to developing strong study designs that elucidate the link between intervention and outcome, and outcomes should target participation in everyday life.

SERVICE DELIVERY MODELS

In relation to the two service delivery models, direct service and consultative, reviewed above, both have shown to be effective in facilitating children's achievement of set goals. While OTs might be able to select the model of service delivery of their choice, more frequently it is set by external policies or business models. For example, while consultation is frequently used within the school system, direct service delivery is the norm in private practices. The evidence reviewed above shows that OT intervention with children with sensory processing dysfunctions and related activity and participation restrictions can be effective, regardless of the model of service delivery within which it is conducted. Some outcomes may be more appropriate for one model over another. However, differences were found in the effectiveness of interventions used within the direct service delivery model.

Interventions' Conceptual Foundation

A large number of studies reviewed fell into the impairment-oriented category, likely due to the relative newness of the performance-oriented approaches. This uneven distribution complicates the comparison between both categories of interventions. However, the strong positive results obtained by the performance-oriented approaches are very encouraging and suggest that it would be prudent for occupational therapists to continue to consider using approaches based on contemporary motor learning and motor control theories.

Interestingly, while positive results were obtained for both performance-oriented approaches and impairment-oriented approaches among the single study articles, the evidence presented in the systematic reviews does not appear to support impairment-oriented approaches. Consequently, when looking at the evidence from both the study and review articles, it must be considered that overall results are, at best, mixed for impairment-oriented approaches.

Interventions

Too few studies are available in each group of interventions to draw firm conclusions about their effectiveness. However, sensory-motor interventions have the largest number of studies (six). As mentioned above, these interventions, most frequently used by occupational therapists, are aimed at improving motor performance by participation in activities that specifically target underdeveloped sensorimotor skills (e.g., sitting on a ball to improve balance). The evidence reviewed here (individual studies and systematic reviews) offers mixed results, with sensory-motor interventions reporting some positive effects but also reporting results no better than no

treatment. One reason for such results could be that there is not necessarily a direct relationship between underlying processes and functional performance. Another may be that determining outcome measures that can capture the changes that occur with impairment-oriented intervention is more difficult than it is for performance-based interventions, where skills may be directly practiced or worked on through specific strategy development, meaning that the outcome measure can be tailored very closely to the intervention. Impairment-oriented intervention often first addresses abilities such as state regulation, automaticity of movements, and organization of behavior, which can be more difficult to measure. Furthermore, the underlying body functions and structure impairments of most disorders diagnosed during childhood can benefit from further clarification to enhance development of remediation.

The evidence found in this review indicates that children having sensory processing dysfunction and experiencing difficulties with the performance of daily occupations can benefit from intervention. The findings further suggest that performance-oriented approaches may be more beneficial than impairment-oriented approaches. However, the extant literature is inadequate to form any firm conclusions other than that more careful study is needed.

Review Process:

Procedures for the selection and appraisal of articles

Inclusion Criteria:

- Peer reviewed journal article
- Published after 1996 with additional classic articles
- Published in an English language journal
- Participants in intervention were 21 years of age and younger
- Level I, II, III, or IV evidence
- Intervention is within the scope of practice of occupational therapy, although it did not have to be a common occupational therapy intervention or administered by an occupational therapist or occupational therapy assistant.

Exclusion Criteria:

- Presentations
- Conference proceedings
- Non-peer reviewed research literature
- Research reports
- Dissertations, theses
- Intervention is outside the scope of practice of occupational therapy
- Published prior to 1996
- Diagnoses and clinical conditions: mental retardation, deafness/blindness, spina bifida, cerebral palsy, regulatory disorder, childhood stroke, acquired brain injury, seizure disorders, traumatic brain injury, stroke

Search Strategy

Categories	Key Search Terms
Patient/Client Population	<p>Diagnoses: developmental coordination disorder (DCD); children with handwriting problems; clumsy child syndrome; disorder of attention, motor and perception (DAMP); developmental dyspraxia; fine motor deficits; gross motor deficits; perceptual motor deficits; sensory integrative dysfunction; sensory modulation disorder; sensory modulation dysfunction; sensory motor deficit; sensory processing disorder</p> <p>The following were included if a sensory motor/perceptual motor component was included in the study: ADHD, autism spectrum disorder (including autism, Asperger’s, and PDD), deprivation—sensory deprivation (excluding deaf and blind), dyslexia, Fragile X, fetal alcohol syndrome, learning disabilities, prematurity, specific language disorder</p>
Intervention	<p>Activities of daily living (includes self-care and instrumental activities of daily living), activity, activity groups, adaptive behavior, antisocial behavior, assistive technology, attention, augmentative communication, behavior modification, behavioral intervention (e.g., applied behavioral analysis [Lovaas], and discrete trial training), comprehensive programs (e.g., developmental, TEACCH, LEAP), consultation, cooperative behaviors, decision-making skills training, environmental modification, executive function, exercise, family coping/coping skills, floor time, friendship, functional approaches, handwriting, intervention, job training, massage, natural environment interventions, neurodevelopmental treatment, neuromotor, occupational therapy, oral sensorimotor programs, parent/teacher mediated, peer mediated, peer group, peer interaction, perceptual motor learning, play, pre-vocational, priming, problem solving skills training, relationship-based interventions, routines-based interventions, sensory diet, sensory integration, sensory integrative, social competence, social participation, social skills training, social stories, tactile stimulation, therapeutic listening/auditory integration training, time management, token economy, touch pressure, transitioning, vestibular stimulation, weighted vests/weighted materials, Wilbarger protocol, work</p>
Comparison	<p>Filters based on those developed by the Miner Library at the University of Rochester</p>
Outcomes	<p>Not included in search</p>

Databases and Sites Searched
Medline, PsycInfo, CINAHL, ERIC, BIOSIS Previews, Web of Science (Science Citation Index), Web of Science (Social Science Citation Index), RehabData, OT Seeker, Cochrane Database of Systematic Reviews, Cochrane Controlled Trials Register, DARE--the Database of Abstracts of Reviews of Effectiveness, Campbell Collection, Hand searching of Bibliographies, Hand searching of Journals as needed

Quality Control/Peer Review Process:

Advisory group from within and outside occupational therapy reviewed focused questions and search terms (including diagnoses) developed by AOTA consultant and AOTA staff. The review authors, AOTA consultant, and AOTA staff, in conjunction with a medical librarian with experience in evidence-based reviews, were responsible for searching the literature, selecting research studies of relevance to occupational therapy, critically appraising the studies, and summarizing the information with emphasis on implications for occupational therapy practitioners.
CAT was developed by review authors and reviewed by AOTA consultant and AOTA staff.

Results of Search:

Summary of Study Designs of Articles Selected for Appraisal

Level of Evidence	Study Design/Methodology of Selected Articles	Number of Articles Selected
I	Systematic reviews, meta-analysis, randomized controlled trials	12
II	Two groups, nonrandomized studies (e.g., cohort, case-control)	3
III	One group, nonrandomized (e.g., before and after, pretest– posttest)	2
IV	Descriptive studies that include analysis of outcomes (single subject design, case series)	7
V	Case reports and expert opinion, which include narrative literature reviews and consensus statements	0
	Qualitative studies	0
	TOTAL	24

Limitations of the Studies Appraised

Levels I, II, and III

Limitations included in the narrative above

Levels IV and V

Limitations included in the narrative above

Articles Selected for Appraisal

Baranek, G. (2002). Efficacy of sensory and motor interventions for children with autism. *Journal of Autism and Developmental Disorders*, 32(5), 397–422.

Candler, C. (2003). Sensory integration and therapeutic riding at summer camp: Occupational performance outcomes. *Physical & Occupational Therapy in Pediatrics*, 23(3), 51–63.

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.

Dunn, W. (1990). A comparison of service provision models in school-based occupational therapy services: A pilot study. *Occupational Therapy Journal of Research*, 10(5), 300–320.

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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.

Hepler, J. B. (1997). Evaluating a social skills program for children with learning disabilities. *Social Work with Groups*, 29(3), 21–37.

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.

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This work is based on the evidence-based literature review completed in December 2008 by Helene J. Polatajko, PhD, OT Reg (Ont), OT (C), FCAOT and Noémi Cantin, PhD (student), OT Reg (Ont).

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