

The relationship between developmental dyspraxia and sensory responsivity in children aged four to eight years — Part II

Karin Buitendag, BOcc Ther, MOcc Ther (UP)

Director of Occupational Therapy- Sensory Therapies and Research Centre, Denver USA

M.C. Aronstam, MOcc Ther (UP)

Senior Lecturer, Department of Occupational Therapy, University of Pretoria

ABSTRACT

The relationship between developmental dyspraxia and sensory responsivity was investigated through correlation of the SIPT, Sensory Profile and Sensory Profile School Companion scores. The statistical analysis of data did not reveal an unambiguous relationship, but offered some significant weak inverse correlations and one significant weak positive correlation that were discussed in a preceding article. These findings gave rise to suggestions for future research which will be discussed in this article. Furthermore, clinical analysis of the data set produced interesting results that are worth mentioning and discussion. The integration of results from statistical analysis and clinical analysis are provided in this article and may offer valuable information about children's sensory responsivity tendencies in the presence of certain types of developmental dyspraxia. The limitations of this study are given to guide researchers in the selection of methodology and measurement instruments for future research studies.

Key words: developmental dyspraxia, sensory responsivity, Sensory Integration and Praxis Tests, Sensory Profile, Sensory Profile School Companion, relationship

Introduction

This study was conducted to provide empirical research data that could assist in confirming a relationship between developmental dyspraxia and sensory responsivity and subsequently clarifying the nature of such a relationship. Evidence of a confirmed relationship and clarification of the nature of such a relationship could consequently be used to fill an existing void in occupational therapy literature and provide valuable information to guide and refine intervention approaches in the treatment of developmental dyspraxia.

The background to the research study was given in part I¹ of this article, indicating the lack of evidence in the literature to support a confirmed relationship between developmental dyspraxia and sensory responsivity. The lack of evidence and the consequent effects on the treatment of developmental dyspraxia was mentioned. In the literature review, the two frames of reference which form the theoretical and intervention backbone of developmental dyspraxia, namely, sensory integration (SI) and motor learning were discussed. The overlap or shared perspectives of both frames of reference were used to explain how both support

the proposed relationship between developmental dyspraxia and sensory responsivity.

The results from 73 subjects who were tested using the Sensory Integration and Praxis Tests (SIPT), the Sensory Profile (SP) and Sensory Profile School Companion (SPSC), as discussed in Part I of this research article, did not support a relationship between developmental dyspraxia and sensory responsivity. Conversely it revealed inverse correlations between certain SIPT groups and sensory systems, sensory under- responsiveness (SUR) and sensory over- responsiveness (SOR) as well as one significant weak correlation between SOR and generalised SI dysfunction which highlighted the role of SOR in generalised SI dysfunction. In addition, the inverse correlations supported the possibility that auditory detection does not play a role in ideation in visio- and somatodyspraxia and proposed that bilateral integration and sequencing deficits may only have a concomitant relationship with sensory responsivity and are most likely caused by deficient sensory discrimination. Finally results suggested that dyspraxia on verbal command is not related to auditory SOR, but that poor auditory processing may rather be due to SUR of the auditory system.

Methodology

Aim

The aim of the study as it pertains to part II of the research paper was to conduct clinical analysis of the data set to:

- ❖ Examine the sample in terms of the demographic characteristics of the sample such as age, gender and percentage distribution of types of developmental dyspraxia.
- ❖ Examine the percentage distribution of types of dyspraxia in the sample with SUR and SOR in subjects with sensory modulation disorder (SMD).

Method

Clinical analysis was conducted to examine the demographic characteristics of the sample ($n=73$) by dividing the sample into a male and a female group and reflecting the ages of the subjects in the male and female groups in a sequential chronological order ranging from four years to eight years. The sample was furthermore examined in terms of percentage distribution of the types of developmental dyspraxia by reflecting the percentage of the subjects identified with respectively bilateral integration and sequencing deficit, generalised SI dysfunction, dyspraxia on verbal command and visio- and somatodyspraxia.

To examine the percentage distribution of the types of developmental dyspraxia in the sample with SUR and SOR, the sample ($n=73$) was divided into two groups- a group with sensory modulation disorder and a group without. The group with sensory modulation disorder was examined through clinical analysis to determine the percentage distribution of SIPT groups (bilateral integration and sequencing deficit, dyspraxia on verbal command, generalised SI dysfunction and visio-and somatodyspraxia) in terms of quadrant scores of sensory modulation disorder measurement instruments (Sensory Profile and Sensory Profile School Companion) and combined quadrant scores of measurement instruments grouped as SOR and SUR.

Population

The sample consisted of 73 subjects who were tested with the SIPT and identified with developmental dyspraxia according to four SIPT groups namely bilateral integration and sequencing deficit, generalised SI dysfunction, dyspraxia on verbal command and visio-and somatodyspraxia. The 73 subjects were also tested with the Sensory Profile and Sensory Profile School Companion to identify sensory modulation disorder. The data set obtained from testing 73 subjects was used in statistical analysis as well as clinical analysis. The sample ($n=73$) was clinically analysed in terms of demographic characteristics and percentage distribution of SIPT groups in the total sample.

The sample was subsequently divided into two groups- a

group with sensory modulation dysfunction and a group without in order to conduct further clinical analysis. The group with sensory modulation disorder consisted of subjects who were identified with SOR or SUR through the sensory modulation measurement instruments.

Data Analysis

Clinical analysis was conducted in addition to statistical analysis of the data set. This was done firstly with the aim of viewing the data set from a different angle and secondly, due to the lack of statistical support of a relationship between developmental dyspraxia and sensory responsivity. Clinical analysis to explore the demographic characteristics of the sample in terms of gender and age, was conducted by dividing the sample into a male and female group and portraying gender in sequential chronological age groups ranging from four to eight years. In addition, the sample was analysed to depict the percentage distribution of the four SIPT groups in the sample.

In an effort to examine the distribution of the types of dyspraxia in the sample with SMD, the sample was divided into two groups – a group with sensory modulation disorder and a group without. The group with SMD subjected to clinical analysis and the following was portrayed in the analysis:

- ❖ Distribution of SIPT groups in sample with SMD in terms of quadrant scores on the Sensory Profile
- ❖ Distribution of SIPT groups in sample with SMD in terms of quadrant scores on the Sensory Profile School Companion
- ❖ Distribution of SIPT groups in sample with SMD in terms of SUR and SOR of the Sensory Profile and Sensory Profile School Companion
- ❖ Distribution of the SIPT groups in sample with SUR and SOR on the Sensory Profile
- ❖ Distribution of SIPT groups in sample with SOR and SUR on the Sensory Profile School Companion

Results

Summary of Statistical Analysis offered in Part I

An in depth discussion of the results of statistical analysis was offered in Part I¹ of this article. A brief summary of the results is given to re-orient the reader. Results from the statistical analysis offered significant weak inverse correlations and one positive correlation between types of dyspraxia and sensory over-or under responsiveness. The positive correlation was between SOR and generalised SI dysfunction ($p=0.068$; $r=0.214$) that led to the supposition that in the case of generalised SI dysfunction, there is a probability that SOR will occur and as such either result in avoidance behaviour or withdrawal. The researcher further posited that SOR may very well contribute to the severity of generalised SI dysfunction.

Weak inverse correlations between a bilateral integration and sequencing (BIS) deficit and SUR (one correlation) ($p=0.076$; $r= -0.208$) and SOR (four correlations) ($p=0.08$; $r= -0.205$); ($p=0.041$; $r= -0.023$); ($p=0.064$; $r= -0.217$); ($p=0.046$; $r= -0.046$) were observed which led the researcher to questioning the role of sensory responsivity in bilateral integration and sequencing results from clinical analysis. The internal consistency of the data set from the Sensory Profile proved to be varied and indicated a greater range of varying consistency when compared to the Sensory Profile School Companion. The reasons for this variation and the implications thereof will be addressed in the limitations section of this article.

Clinical Analysis

Sample Size

The 73 subjects in the sample (Figure 1) consisted out of 49 males and 24 females with the largest number of males in the age group five years and the largest number of females in the age group seven years. Subjects were from the Gauteng province and the Western Cape Province.

sentation of SIPT groups. The seeking quadrant has the highest representation of SIPT groups on the Sensory Profile.

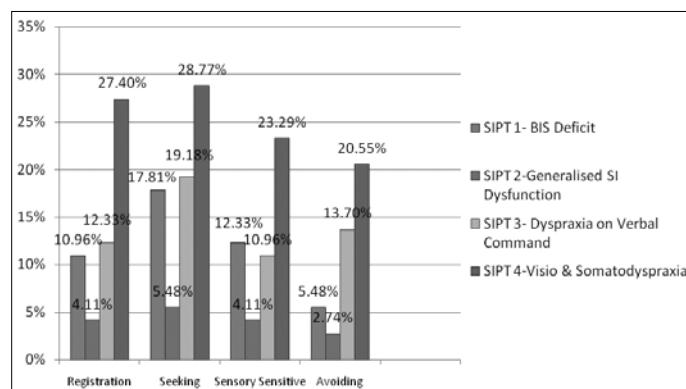


Figure 2

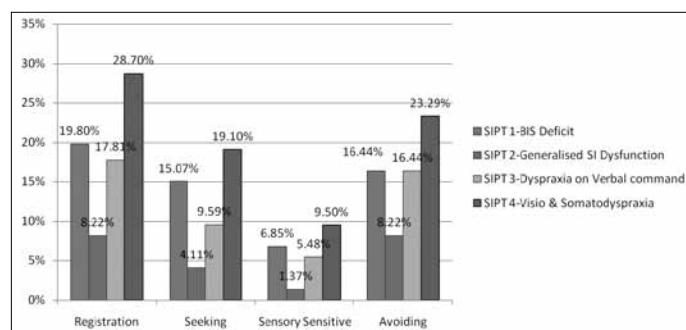


Figure 4

In Figure 5 the quadrants, "registration" and "seeking", are combined to represent SUR and "sensory sensitive" and "avoiding" are combined to represent SOR. The SIPT group distribution is illustrated in terms of SUR and SOR of the Sensory Profile and the Sensory Profile School Companion respectively. Visio- and somatodyspraxia have the highest representation in SUR of both the Sensory Profile (56.17%) and Sensory Profile School Companion (47.95%). Dyspraxia on verbal command has second highest representation in SOR (24.66%) and SUR (31.51%) of the SP, but bilateral integration and sequencing deficit has the second highest representation in SUR (34.87%) and SOR (23.29%) of the SPSC. A contradictory observation is that dyspraxia on verbal command has a higher representation in SUR of the SP (31.51%) than the SPSC (24.66%) which is against expectation as the inability to follow instructions in class should be readily noticed by a teacher and seen as a major contributor to poor task performance. Figures 6 and 7 illustrate the percentage incidence of the SIPT groups in terms of SUR and SOR of the SP and SPSC respectively.

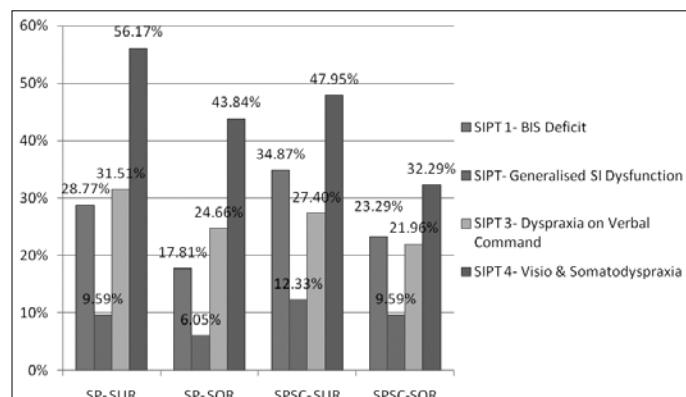


Figure 5

In Figure 6 it is evident that the SIPT groups have a higher representation in the SUR population on the Sensory Profile with

visio- and somatodyspraxia (56.17%) dominating. Dyspraxia on verbal command is better represented in both SUR (31.51%) and SOR (24.66%) on the Sensory Profile than a bilateral integration and sequencing deficit. Generalised SI dysfunction has the lowest representation in the sensory modulation dysfunction population of the SP. Figure 7 also portrays the highest association of SUR with the SIPT groups. Visio- and somatodyspraxia has the highest representation in SUR (47.95%) and SOR (32.88%). In contrast to the SP, BIS deficit has a higher representation in both SUR (34.87%) and SOR (23.29%) on the SPSC than dyspraxia on verbal command.

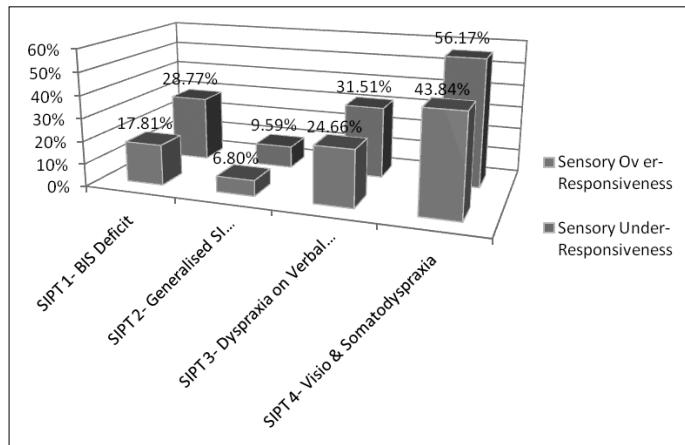


Figure 6

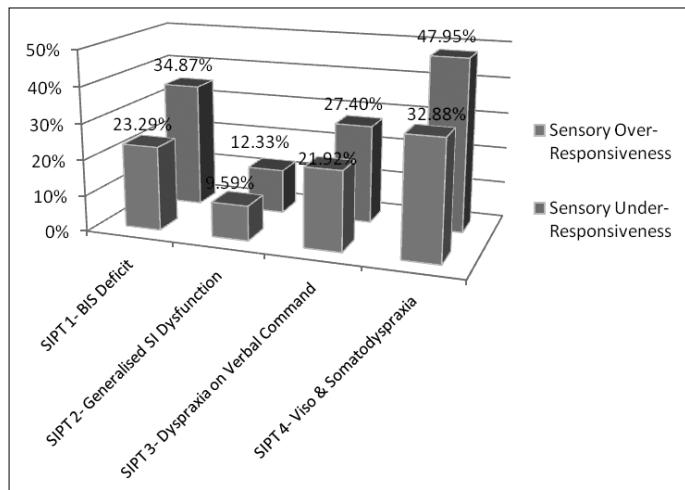


Figure 7

To summarise, the representation of the SIPT groups was highest in the quadrants that represented SUR (seeking and registration) on both the Sensory Profile and Sensory Profile School Companion. Visio- and somatodyspraxia consistently had the highest representation of the four SIPT groups. When grouping the quadrants together to form sensory over-responsiveness (sensory sensitive and avoiding) and sensory under-responsiveness (registration and seeking), SIPT groups again had the highest representation in SUR of both the Sensory Profile and the Sensory Profile School Companion. The SIPT groups bilateral integration and sequencing deficit and dyspraxia on verbal command alternately ranked second and third in SUR of the Sensory Profile and Sensory Profile School Companion. Generalised SI dysfunction had the lowest representation in SUR and SOR of both the Sensory Profile and Sensory Profile School Companion.

Discussion

Distribution of SIPT Groups on the Sensory Profile and Sensory Profile School Companion Quadrants

The general trend observed in terms of SIPT group representation in the four quadrants of the Sensory Profile and Sensory Profile

School Companion is that visio- and somatodyspraxia had the highest representation in all four quadrants (registration=27.4%; seeking=28.77%, sensitive=23.29%; avoiding=20.55%). When examining the quadrants in terms of the SIPT group representation on the SP, the seeking quadrant had the highest representation. The registration quadrant had the second highest representation of SIPT groups which, when grouped together represent sensory under-responsiveness. Dyspraxia on verbal command is the SIPT group with the second highest representation in three quadrants of the SP (registration=12.3%; seeking=19.18%; avoiding=13.70%), except in the sensory sensitive quadrant. BIS deficit had the second highest representation in this quadrant (12.33%).

The Sensory Profile School Companion had the highest representation of SIPT groups in the registration quadrant (BIS deficit=19.80%; generalised SI dysfunction=8.22%; dyspraxia on verbal command=17.81%; visio- and somatodyspraxia=28.77%) with visio- and somatodyspraxia (registration=28.77%; seeking=19.18%; sensitive=9.59%; avoiding=23.29%), again, the best represented in all four quadrants of the Sensory Profile School Companion. In this instance, bilateral integration and sequencing deficits (registration=19.8%; seeking=15.07%; sensitive=6.85%; avoiding=16.44%) had the second highest representation in all four quadrants of the SPSC which may indicate that tasks requiring bilateral function have high priority in the classroom. This observation was against expectation, where the researcher anticipated that dyspraxia on verbal command would feature more prominently on the SPSC due to the demands formal learning places on the ability to follow instructions. However, review of the sample placed the majority of subjects ($n=58$) in the pre-school phase, where development of fine motor function is a priority and children are exposed to activities that require bilateral function.

Distribution of SIPT Groups in SUR and SOR of the Sensory Profile and Sensory Profile School Companion

The SIPT groups were best represented in SUR of both the Sensory Profile and Sensory Profile School Companion with visio- and somatodyspraxia the highest representation across the board. This could indicate a more pronounced possibility of an association between SUR and developmental dyspraxia. Dyspraxia on verbal command was better represented in both SUR (31.51%) and SOR (24.66%) of the Sensory Profile whereas bilateral integration deficits were better represented in SUR (34.87%) and SOR (23.29%) of the Sensory Profile School Companion. This difference in SIPT group representation on the SP and SPSC could be due to demands differing in specific environments, or different skills emphasised. The spread of SIPT groups was more even and less varied on the Sensory Profile School Companion than the Sensory Profile. This could be due to varied degrees of subjectivity of the respondents.

It is therefore likely that in a sample with sensory modulation disorder, visio- and somatodyspraxia is the most common type of dyspraxia to be encountered. Furthermore, the prevalence of visio- and somatodyspraxia in a sample with SUR also questions the influence of SUR on the processing of sensory information.

Discussion- Amalgamating Statistical Analysis and Clinical Analysis

When considering results from both statistical and clinical analysis four significant observations were made:

Firstly, SUR had the highest representation on the Sensory Profile and Sensory Profile School Companion with all types of developmental dyspraxia. This observation supports the weak inverse correlation between SOR and the types of developmental dyspraxia where the closer the fit was to developmental dyspraxia, the smaller the tendency of SOR.

Secondly, dyspraxia on verbal command and visio- and somatodyspraxia are the two types of dyspraxia that warrant further

investigation into their relationship with SUR when considering results from both statistical and clinical analysis to determine if and how sensory detection influences processing of sensory information.

Another interesting observation is the contrast in results obtained from clinical and the statistical analysis when looking at generalised SI dysfunction and SUR or SOR. A positive relation was found between SOR and generalised SI dysfunction through statistical analysis, but clinical analysis offered a higher representation of generalised SI dysfunction in SUR. The author feels that SOR may be mistaken for SUR if a child is in 'shutdown' and blocking out sensory input due to over-responsiveness.

Lastly, the fact that a bilateral integration and sequencing deficit had the most statistical inverse relationship with SOR and yet had the highest representation in SUR on the SP and SPSC, may be considered as a two-fold support for an association of some kind between bilateral integration deficits and SUR. For instance, sensory seeking behaviour which is a quadrant of SUR may interfere with the ability to pay attention to incoming vestibular input whereas registration (also a quadrant of SUR) may impede detection of important proprioceptive input. Fluctuating central nervous system (CNS) arousal levels may therefore impede sensory processing as a person may fluctuate between registration and seeking and a state of CNS over-arousal in response to the seeking of sensory information.

Conclusion

The results from the set of data did not offer evidence of a consistent and unambiguous relationship between developmental dyspraxia and sensory responsivity. Some singular weak inverse correlations and positive relations led to interesting interpretations which were validated by clinical analysis of the set of data. The most prominent being:

- ❖ the role of SUR in developmental dyspraxia, specifically visuo- and somatodyspraxia and dyspraxia on verbal command and the affiliation with the auditory system.
- ❖ SOR and the relation with generalised SI dysfunction as well as the link with the vestibular system and the possible effect on feed-forward. SOR combined with this type of dyspraxia may compound the severity of the dysfunction.
- ❖ inverse correlations between bilateral integration and sequencing deficits and SOR and a high representation of this type of dyspraxia in SUR may be indicative of concomitant relationship between BIS deficits and SUR. From this observation the question arises as to whether it is possible that BIS deficits are fundamentally caused by poor processing of vestibular and proprioceptive input?
- ❖ lastly, the predominantly inverse correlations between the SIPT groups and SOR led to the question whether SOR cannot occur as a single diagnosis?

Limitations

The results from statistical analysis of this research support an evaluation of factors that could have contributed to the research outcome. These factors are:

- ❖ measurement instruments.
- ❖ procedures, namely data analysis and timeframe.

Measurement Instruments: Sensory Profile (SP) and Sensory Profile School Companion (SPSC)

The measurement instruments' (SIPT, SP and SPSC) reliability, validity and suitability are reported in the respective test manuals. The use of the test instruments in measuring change, reporting on differences in populations and construct validity, is well documented in occupational therapy literature^{2,3,4,5,6}.

The use of the SIPT in combination with the SP and SPSC offered challenges in the data collection phase of this research in that there were discrepancies in the responses of the caregivers who completed the SP when compared to those of the teachers (see Figure 8).

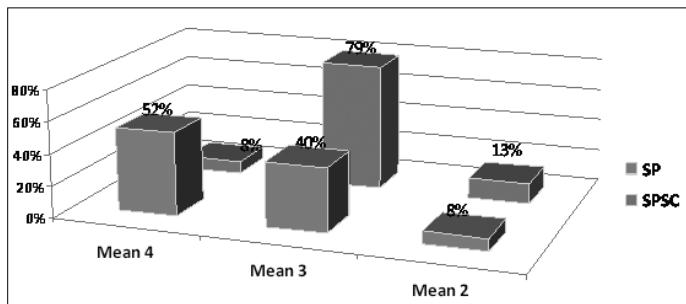


Figure 8

The majority of teachers selected responses 'occasionally' and 'frequently' whereas the majority of caregivers selected responses 'never' or 'seldom'. This contrast in responses was also supported by the results found when analysing the internal consistency of the SP and SPSC using the Cronbach Coefficient Alpha. The alpha value of the Sensory Profile varied between different sections and ranged from acceptable to low while the Sensory Profile School Companion had a good to acceptable alpha value across the whole test.

Possible explanations for caregivers selecting 'never' or 'seldom' include:

- ❖ poor insight on the side of the parent or caregiver.
- ❖ insufficient opportunity by the caregiver to observe behaviour due to time constraints.
- ❖ flawed interpretation of a question or statement.
- ❖ some behaviours constituting a problem being viewed as 'typical' by the caregiver or parent due to their own sensory profile e.g. a parent with a high neurological threshold may not perceive sensory seeking behaviour of a child as problematic.
- ❖ some behaviours representing a problem refer to a tendency, but are interpreted literally and are reported as 'never' observed.

Further, the SP is a parent report method and may be prone to inherent subjective biases as well as restrictions in the number and type of questions included. Another factor to consider is that a parent can adapt to their child's sensory processing problems and thus influence the number and quality of shared experiences in either a positive or negative way⁷. Thus, the contrast in responses between caregivers and teachers due to subjective biases and variance in alpha value may have contributed to the research outcome.

The SIPT

The use of the SIPT in conjunction with other measurements to determine a relationship between constructs is not well documented. Mixed results have been reported in research studies where the SIPT was used in conjunction with other measurement instruments. A favourable result was obtained in a study by Parham⁸ in 1998 where the SIPT was used in conjunction with the Kaufman Assessment Battery for Children to determine the relationship between SI abilities and intelligence. This study was one of a few that produced favourable results as several other studies^{9,10,11} did not show significant relationships.

Even though the use of the SIPT in this research was relevant based on its ability to identify different types of developmental dyspraxia and its inherent good validity, the combination with the SP and SPSC failed to render results that supported the research question. It is proposed therefor that the SIPT, SP and SPSC, when used individually, measure what they are intended to measure, but the research outcomes were affected by the interaction of the measurement instruments used.

Procedures: Data Analysis

This research study was conducted to examine the relationship between types of dyspraxia and sensory systems. Dunn and Brown¹², however stated that it is important to consider not only which sensory systems are implicated, but how a person responds to stimuli. Dunn and Brown's observation was supported by factor analysis of the SP, as factor loadings did not sort by sensory systems, but by the child's responsivity to sensory experiences.

Factor analysis identifies relationships between similarly-performing items and helps to assess dimensionality of constructs. Dunn and Westman¹³ also proposed comparing children with various dysfunctions to identify unique patterns of performance from one dysfunctional group to another as discriminant analysis among groups might assist in identifying a number of items on the SP that could serve as a screening tool. Therefore, doing comparative analysis of measurement tools such as the SP and SIPT could be useful to determine if the SP taps similar or unique factors in performance. A factor analysis of the data used in this study could have been useful if a bigger sample had been used.

Procedures: Timeframe

This type of study requires meticulous collection of data over a period of time. To ensure a big enough sample, enough time is required. Due to time constraints, the sample size was not as big as the researcher would have liked. It is also recommended that data be collected by one person over a longer period of time to ensure uniformity of the data obtained.

Recommendations

The results from the study gave rise to a number of recommendations for future research as well as recommendations for clinical practice:

- ❖ the researcher recommends that the SPSC be used in more research studies. This is based on the fact that the SPSC had better internal consistency and had more correlations with the SIPT than did the SP. In addition, a study which investigates differences in behaviours between the classroom and the home will provide interesting information. Such a study could also examine behaviour changes in the quadrants between one environment and the next.
- ❖ the relationship between SOR and generalised SI dysfunction should be further explored in terms of the severity of generalised SI dysfunction in a population of children with SOR. The prevalence of SOR in children with generalised SI dysfunction should also be investigated.
- ❖ the role that SUR plays in the ideation component of visio- and somatodyspraxia is another suggestion for future research. The inverse correlations of auditory SUR and SOR with this type of dyspraxia, good praxis on verbal command ability and the high representation of viso-and somatodyspraxia in SUR has led the researcher to believe that SUR may play a major role in ideation.
- ❖ it would also be valuable to investigate if SUR of the auditory system impacts on central auditory processing and language when contemplating the inverse correlation of SOR with dyspraxia on verbal command.
- ❖ as previously discussed under limitations, the researcher suggests conducting factor analysis on data obtained from the SIPT, SP and SPSC. A bigger sample will however be required.
- ❖ the role of 'behaviour' in sensory responsivity and developmental dyspraxia is not clarified. The researcher assumed in this study that behaviour as an expression of function would have a correlation with dyspraxia and SOR or SUR. However, no correlation was observed between developmental dyspraxia and behaviour on the SP and SPSC. It is therefore imperative that 'behaviour' be investigated as either a functional, social expression of dyspraxia or conversely as an expression of SUR or SOR.

Clinical Practice

- ❖ The researcher strongly recommends the use of the SP and SPSC in SI evaluations to discern between behaviour tendencies at home and at school.
- ❖ It appears that the self-report or parent- report measures are flawed and that when used in an SI assessment, it is recommended that a top-down approach be followed to allow careful scrutiny of functional performance in order to relate it to sensory modulation behaviour and components of praxis if the SIPT is used.

To conclude, the information obtained from this study is intended to give direction to and provide ideas for future research.

It is the sincere hope of the researcher that this study will alter and add to perceptions of sensory responsiveness and its association with developmental dyspraxia. It has certainly exposed the layers that make up constructs like dyspraxia and sensory responsiveness and how these layers interact with each other. The results of this study will hopefully assist occupational therapists in their interpretation of sensory responsiveness tendencies in the presence of developmental dyspraxia.

It is also hoped that the results will raise awareness of the fact that certain types of dyspraxia have more pronounced links with sensory under- and over-responsiveness and this will consequently assist therapists in promptly and accurately identifying SUR or SOR.

Acknowledgements

I am indebted to following the occupational therapists who contributed data to this study in spite of very busy schedules. Their invaluable contribution facilitated the timeous completion of the research study and I am forever grateful to them: Ingrid Bench, Stefanie Kruger, Anri-Louise Oosthuizen, Eloise de Bruyn, Karen Dietrich, Danielle Hawkins, Elsje Geyser, Hendriette van Rooyen, Elna Jooste, Ninette Visser and last but definitely not the least, Ray Anne Cook.

References

1. Buitendag K, Aronstam MC. The relationship between developmental dyspraxia and sensory responsivity in children aged four through eight years, Part I. *South African Journal of Occupational Therapy*, 2010; 40(3): 16-20.
2. Mulligan S. Cluster analysis of scores of children on the sensory integration and praxis tests. *Occupational Therapy Journal of Research*, 2000; 20: 256-270.
3. Brown T, Leo M, Austin DW. Discriminant validity of the sensory profile in Australian children with autism spectrum disorder. *Physical and Occupational Therapy in Paediatrics*, 2008; Jul 9: 28(3): 253-266.
4. Neuman A. Patterns of response to sensory stimuli encountered in daily activities: A comparison between 3 to 10-year-old Israeli and American children without disabilities. *Occupational Therapy International*, 2006; Jan 25: 13(2): 79-99.
5. Murray EA, Cermak SA, O'Brien V. The relationship between form and space perception, constructional abilities, and clumsiness in children. *American Journal of Occupational Therapy*, 1990; Jul:44(7): 623-628.
6. Bharadwaj SV, Daniel LL, Matzke PL. Sensory-processing disorder in children with cochlear implants. *American Journal of Occupational Therapy*, 2009; 63(2): 208-213.
7. Dickie VA, Baranek GT, Schultz B, Watson LR, McComish CS. Parent reports of sensory experiences of preschool children with and without autism: A qualitative study. *American Journal of Occupational Therapy*, 2009; Mar/Apr: 63(2): 172-181.
8. Parham LD. The relationship of sensory integrative development to achievement in elementary students: four-year longitudinal patterns. *Occupational Therapy Journal of Research*, 1998; 18(3): 105-127.
9. Bundy AC, Shia S, Qi L, Miller LJ. How does sensory processing dysfunction affect play? *American Journal of Occupational Therapy*, 2007; Apr: 61: 201-208.
10. Parush S, Sohmer H, Steinberg A, Kaitz M. Somatosensory function in boys with ADHD and tactile defensiveness. *Physiology and Behavior*, 2007; Nov: 90: 553-558.
11. Walker KF, Burris B. Correlation of sensory integration and praxis test scores with metropolitan achievement test scores in normal children. *Occupational Therapy Journal of Research*, 1991; Oct: 11(5): 307-310.
12. Dunn W, Brown C. Factor analysis on the sensory profile from a national sample of children without disabilities. *American Journal of Occupational Therapy*, 1997; Jul/Aug: 51(7): 490-495.
13. Dunn W, Westman K. The sensory profile: The performance of a national sample of children without disabilities. *American Journal of Occupational Therapy*, 1997; Jan 6: 51(1): 25-34.

Corresponding Author

K Buitendag

k.buitendag@gmail.com

