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Assessing Sensory Processing Difficulties beyond Autism Spectrum Disorder

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Abstract **Original Research Article**

Introduction: Sensory processing generally refers to the handling of sensory information by neural systems, including the functions of receptor organs and the peripheral and central nervous systems. Sensory processing difficulties occur in a host of neurodevelopmental problems like Autism Spectrum Disorder (ASD), and Attention Deficit Hyperactivity Disorder (ADHD) among several others. These can also occur in children considered otherwise normal. ***Aim:*** To assess prevalence and distribution of Sensory Processing Difficulties among children attending the Child Guidance Clinic (excluding ASD) in a tertiary care hospital in Kolkata. ***Methodology:*** All new cases attending the child Guidance Clinic during study period were included. Serious comorbid physical illness requiring admission, refusal to give consent and cases diagnosed with Autism Spectrum Disorder, learning disorder, Intellectual Disabilities and Psychiatric sequelae of serious physical illness were exclusion factors. All children who were referred to the Child Guidance Clinic were routinely administered the Child symptom Inventory (CSI), followed by detail evaluation. Cases were selected as per inclusion and exclusion criteria. Final diagnosis regarding psychopathology has been made on the basis of DSM-V criteria. Following this, another researcher (Occupational therapist) who is blind to the diagnosis screened the patient for Sensory Processing Difficulties using the validated tools Winnie Dunn Short Sensory Profile (SSP). ***Results:*** Difference of mean SSP score between two groups, externalizing behavior problem i.e. ADHD/ODD/CD (mean score –131.73) and others (mean score-149.69) is statistically significant. ***Conclusion:*** Clinicians should be aware that children with externalizing behaviors may also have underlying sensory processing difficulties which may be masked. Hence evaluation of sensory processing difficulties should form an integral part of the assessment process in such conditions.

Key word: Externalizing Behavior, Autism Spectrum Disorder, Sensory Processing Difficulties, ADHD, Occupational therapy.

INTRODUCTION

Sensory processing generally refers to the handling of sensory information by neural systems, including the functions of receptor organs and the peripheral and central nervous systems. Problems with sensory processing have been noted in the literature since the 1960's and 70's [1]. The term sensory integration dysfunction was coined by the occupational therapist Jean Ayres to describe atypical social, emotional, motor and functional patterns of behavior related to poor processing of sensory stimuli [2].

Sensory integration (SI) is the ability to organize sensory information to make an adaptive response [3]. Some authors have suggested that SI should be referred to as multisensory integration [4]. Behaviors associated with sensory processing are not necessarily symptoms or abnormalities; these are differences and often abilities, such as enhanced perception [5]. Hence apparently normal individuals may have such sensory processing differences too which may or may not affect their daily functioning skills. Sensory processing disorder (SPD) "affects the way the brain interprets the information that comes in and the response that follows, causing emotional, motor, and other reactions that are inappropriate and extreme[6]".

Sensory processing problem are of three types - sensory modulation disorder (SMD), sensory based motor disorder and sensory discrimination disorder. SMD is of 3 types namely Sensory hypersensitivity, sensory hyposensitivity and sensory seeking. Sensory hypersensitivity means that individuals respond to

sensory stimuli in the way that is faster, longer, or more intense than what is expected [9].

Individuals with under-responsivity are unaware or they are slow to respond to sensory input. The third type is sensory-seeking, where individuals crave or display interest in sensory experiences [11]. Sensory discrimination problems are another type of sensory processing problem characterized by difficulty interpreting the specific characteristics of sensory stimuli [12].

The etiology of sensory processing is unknown. Genetic and familial factors have been suggested [12]. Others suggest other risk factors such as pre-, peri- and post-natal birth factors such as maternal stress during pregnancy, jaundice, and allergies [13].

Michael First [14], editor of the DSM-IV TR, notes that three options for adding sensory processing disorders to the DSM-V have been discussed: 1) adding it as a new disorder; 2) adding it as a subtype that would apply to disorders such as Autistic Disorder or Attention-Deficit / Hyperactivity Disorder; or 3) adding a dimensional definition to the DSM-V appendix for "criteria sets and axes needing further study" in order to stimulate additional research. He further notes that the type of data that would be required include 1) evidence that sensory processing disorder describes a condition that is not adequately covered by an existing DSM-IV disorder; 2) evidence supporting its diagnostic validity; 3) evidence supporting its clinical utility; and 4) evidence supporting that there is a low risk of false positive diagnoses that might result if sensory processing disorder were to be added.

Sensory processing difficulties occur in a host of neuro-developmental problems like Autism Spectrum Disorder (ASD), Learning Disorders, and Attention Deficit Hyperactivity Disorder (ADHD) and among several others. These can also occur in children considered otherwise normal. Sensory processing problems seem to overlap numerous conditions, and there is uncertainty about whether it constitutes a distinct disorder or not. Estimated rates of sensory processing dysfunction for children with various disabilities have ranged as high as 40–88% [15, 16]. The prevalence and types of sensory processing impairments in children with ASD and ADHD are well documented in the literature [17-20].

Compared with children without disabilities, children with ADHD exhibited greater difficulties in the sensorimotor domain, including visual and tactile processing [21, 22]. From a sensory processing perspective, children with ADHD may not be receiving and processing sensory information properly and therefore may have difficulty producing appropriate responses at both school and home and in the community[17]. Neu reported that more activity, less adaptability, and lower thresholds for sensory stimuli in infancy are related to a higher rate of diagnosis of ADHD in later stages [23]. Researchers have further identified vestibular sensory differences in children with attentional difficulties; moreover, these difficulties interfere with the children's performance in movement and skills development [2, 24]. The literature supports the observations that children with ADHD have behavioral and conduct difficulties and disruptive behavior disorders, particularly oppositional deviant disorder and conduct disorder, as well as others [17, 25, 26].

It is clear that there is an alteration in the neural networks and a possible central role of dopamine for sensory problems that cannot be linked to specific cerebral lesions in children with ADHD [27]. One of the prominent neuroanatomical markers for children and adolescents with ADHD is widespread cortical thickness reductions [28]. Activities in resting state in sensory and sensory-related cortices in ADHD is significantly more than those of the control group [29]. Moreover, there is a connection between perception and action that is impaired in ADHD [30].

There is also some evidence of an association between sensory processing difficulties and externalisingbehaviour disorders other than ADHD i.e Oppositional Defiant Disorder (ODD) and Conduct Disorder (CD) [31, 32]. However, there has been minimal research into the specific association between sensory processing difficulties and behavioural problems, in the absence of a diagnosis of these disorders. Children with conduct disturbances come to the attention of service providers by virtue of their key handicapping condition, i.e. externalisingbehaviours; however, when more closely examined, they often have other, co-morbid but undiagnosed disorders [33]. Knowledge of such co-morbidities may contribute not only to improved theoretical models of developmental disability, but also to the design of tailored inventions.

The identification of an association between sensory processing difficulties and behavioural problems may have significant implications for clinical practice. Currently, sensory processing is not routinely assessed in children with disruptive behavior [34]. However, the identification of sensory processing difficulties may stand to strengthen the early management of children with behaviour problems, by highlighting everyday management approaches which promote optimal development, socially and academically.

Hence, this study aims to assess prevalence and distribution of Sensory Processing Difficulties among children attending the Child Guidance Clinic (excluding ASD) in a tertiary care hospital in Kolkata and to find out the association between perinatal factors and Sensory Processing Difficulties.

MATERIALS AND METHODS

- Study design: Cross-sectional observational study
- Study period: 3months from date of commencement of the study
- Study setting: Child Guidance Clinic (Department of Psychiatry) and Occupational therapy unit (Department of Physical Medicine, Regional Artificial Limb Fitting Centre), NRS Medical College, Kolkata
- Selection criteria

All new cases attending the child Guidance Clinic during study period were included. Patients having serious comorbid physical illness requiring admission, refusal to give consent for this study and patients with Autism Spectrum Disorder, Intellectual Disabilities, Learning Disorder and Psychiatric sequelae of serious physical illness were excluded.

Study tools

- **Short Sensory Profile by Winnie Dunn**

The primary variable in this study was reported behavioral sensory processing as measured by the SSP [35]. The SSP is a 38-item caregiver report measure comprising the items that demonstrated the highest discriminative power of atypical sensory processing among all the items from the long version, the Sensory Profile [36]. The full SP, from which the norms were established, was standardized on 1,200 children. Items are scored on a 1-point to 5-point scale. One parent of each participant completed the SSP [35], a reliable and valid parent-report measure of functional behaviors associated with abnormal responses to sensory stimuli. The seven SSP subtests are: (1) Tactile Sensitivity, (2) Movement Sensitivity, (3) Visual/Auditory Sensitivity, (4) Taste/Smell Sensitivity, (5) Auditory Filtering, (6) Low Energy/ Weak, and (7) Under-responsive/Seeks Sensation. The possible range of raw scores on the total scale is 38 to 190, with higher scores reflecting more normal performance. A score in the 'typical performance' range indicates that the child does not have sensory processing difficulties, while scores in the 'probable difference' or 'definite difference' ranges indicate that the child might have or does have sensory processing difficulties in that subscale.

The Total Score is the most sensitive indicator of sensory dysfunction. In this study, the SSP is most appropriate because in the early phase of its development the social–communication and motor items in the SP were eliminated. Thus, the SSP isolates sensory processing that is less confounded by items overlapping with the diagnostic features of autism. Initial studies of the validity of the SSP have demonstrated discriminate validity of > 95% inidentifying children with and without sensory modulation difficulties [35]. Miller and colleagues also correlated dysfunctional sensory processing scores with abnormal psychophysiological responses to a series of sensory challenges [37]. Together, these findings provide initial support for use of the SSP as a valid measure of sensory processing.

- **Child Symptom Inventory (CSI)- 4**

The CSI-4 is a behavior rating scale whose items correspond to the symptoms of disorders defined by the Diagnostic and Statistical Manual of Mental Disorders (4th ed. [DSM-IV]; American Psychiatric Association [38].

The CSI–4 contains symptom categories for the following DSM–IV disorders: ADHD, Inattentive type (ADHD:I; 9 items); ADHD, Hyperactive–Impulsive type (ADHD:HI; 9 items); ADHD, Combined type (ADHD:C; 18 items); ODD (8 items); CD (15 items); GAD (8 items); social phobia (3 items); SAD (8 items); MDD (10 items); dysthymic disorder (8 items); schizophrenia (5 items); and two PDDs, autistic disorder (12 items) and Asperger's disorder (8 items). The CSI–4 also contains single items to screen for simple phobias, obsessions, compulsions, motor tics, vocal tics, enuresis, and encopresis. Administration time is between 10 and 15 min.

There are two scoring procedures: Symptom Count (categorical) scores, which use scores of 0 (never/sometimes) or 1 (often/very often), and Symptom Severity (dimensional) scores, which use scores of 0 (never), 1 (sometimes), 2 (often), or 3 (very often). Symptom Severity scores are simply the sum of the item scores for a particular symptom category. For Symptom Count Scores, a specific symptom is generally considered to be a clinically relevant problem if it is rated as occurring "often" or "very often." When the Symptom Count score is equal to or greater than the number of symptoms specified by DSM–IV as being necessary for a diagnosis, the child receives a Screening Cutoff score of "yes" for the disorder. Although the CSI–4 contains the behavioral symptoms of disorders, it does not include additional diagnostic criteria (e.g., age of onset of symptoms, impairment of functioning). For this and other reasons, Screening Cutoff scores do not signify a clinical diagnosis.

DSM- 5

The Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) is the 2013 update to the Diagnostic and Statistical Manual of Mental Disorders, the taxonomic and diagnostic tool published by the American Psychiatric Association (APA).

Sampling method

Consecutive new patients have been taken attending the clinic within the study period and who met the inclusion criteria.

Method of Data collection

Ethical clearance from the Institutional Ethics Committee has been obtained. Informed consent has been taken from the parents or guardian accompanying the child. After initial height, weight measurements and basic physical examination, all children were referred to the Child Guidance Clinic and all of them have been routinely administered the Child symptom Inventory(CSI)-4, followed by detailed history, mental status examination and psychological assessment. 72 cases, whofulfilled the inclusion criteria have been selected. Final diagnosis regarding psychopathology was made on the basis of DSM-V criteria (10). Following this, another researcher (Occupational therapist) who is blind to the DSM-V diagnosis will screen the patient for SSP using the validated tools Winnie Dunn Short Sensory Profile.

ANALYSIS: Data has been entered in MS Excel Sheet and subsequently analyzed using SPSS version 24.

- Descriptive analysis has been computed in terms of mean and standard deviation with range for continuous variables and frequency with percentage for ordinal and nominal variables.
- Association between variables has been assessed by Independent Sample T test and Chi-square test.
- Variables which has not fulfilled the cut-off level ($p>0.05$) has not been considered to be reliable predictors of the dependent variable in the statistical model and has been hence not entered for further analysis.

RESULTS AND DISCUSSION

We screened 123 new cases of age between 3 to 15 years attending the child guidance clinic of NRS medical college during the study period and 51 cases were excluded after taking detailed history, mental status examination and psychological assessment. All the cases were routinely administered CSI. 72 cases were selected who fulfilled exclusion criteria. Among them 53 cases were male child and 19 were female child. 27 cases had history of perinatal complications (ecclampsia, seizure, any infections, prolonged labour, instrumental delivery, low birth weight, cord neck, birth asphyxia, early onset sepsis, poor Apgar Score etc). 49 cases were diagnosed as ADHD, Oppositional Defiant Disorder (ODD) or Conduct Disorder (CD) as per DSM-5 criteria. 23 cases were diagnosed other disorder like communication disorder, motor disorder, separation anxiety disorder, disruptive mood dysregulation disorder etc(Table 1).

Table-1

SEX		PERINATAL COMPLICATION		PSYCHIATRIC DIAGNOSIS	
MALE	FEMALE	PRESENT	ABSENT	ADHD/ODD/CD	OTHERS
53	19	27	45	49	23

Table-2: Distribution of the severity of sensory dysfunction

Frequency	Percent	Valid Percent	Cumulative Percent	
DEFINITE	38	52.8	52.8	52.8
PROBABLE	19	26.4	26.4	79.2
TYPICAL	15	20.8	20.8	100.0
Total	72	100.0	100.0	

The mean SSP score is 137.472 with standard deviation of 19.0129. The frequency distribution of the severity of sensory dysfunction shows (table -3) 38 cases (52.8%) has definite problem of sensory dysfunction. 19 cases are within probable difference range and 15 cases are typical i.e. apparently normal sensory function.

Table-3: Distribution of sex of the patient and mean SSP score

sex		N	Mean	Std. Deviation	Std. Error Mean
SSP	1	53	137.679	18.3374	2.5188
	2	19	136.895	21.3070	4.8882

Independent sample t test

T	.153
Df	70
p-value	.879

TABLE 4 shows no overall gender difference in the short sensory score profile. The result of independent sample T test shows no significant association (p-value .879) between sexes of the child and mean SSP score. 53 male children cases has mean SSP score 137.67(±18.33) and 19 female children has mean SSP score 136.89 (±21.30).

Table-4: Distribution of perinatal complication and mean SSP score

Perinatal complication	N	Mean	Std. Deviation	Std. Error Mean
1. present	27	121.926	16.2503	3.1274
2. absent	45	146.800	13.7834	2.0547

Independent sample t test

T	-6.928
Df	70
p-value	<0.001

Table 5 shows the association of perinatal complication and sensory dysfunction. The result of independent sample T test shows a significant association (p-value <0.001) between perinatal complication and mean SSP score. 27 cases with history of perinatal complication has mean SSP score 121.926 (±16.25) and 49 cases with no history of any complication has mean SSP score 146.8 (±13.78).

Table-5: Distribution of psychiatric diagnosis and sensory dysfunction

Diagnosis	Mean	Std. Deviation	Std. Error Mean
1.ADHD/ODD/CD	131.735	16.9875	2.4268
2. OTHERS	149.696	17.5355	3.6564

Independent sample t test

T	-4.141
Df	70
p-value	<0.001

Table 6 shows the association of psychiatric diagnosis and sensory dysfunction. The result of independent sample T test shows a significant association (p-value <0.001) between

psychiatricdiagnosis and mean SSP score. In this study 49 cases are diagnosed as ADHD/ODD/CD the mean SSP score of this group is 131.73 (±16.98) and the mean score of the group with other psychiatric diagnosis is 149.69 (±17.53). Here the difference between these two groups is 70 which are statistically significant.

Table-6: Distribution of psychiatric diagnosis in each category of short sensory profile

		1	2	3	Total
		Definite	Proba le	Typical	
Diagnosis	1. ADHD/ODD/CD	34	12	3	49
	2. OTHERS	4	7	12	23
Total		38	19	15	72

Chi-Square Tests			
	Value	df	p-value
Pearson Chi-Square	24.162[a]	2	<0.001

Table 7 shows the distribution of psychiatric diagnosis in each category of short sensory profile. It shows 35 cases diagnosed as ADHD/ODD/CD has definite difficulties whether only 4 cases with other diagnosis has definite difficulties. But only 3cases of group 1 are typical i.e. apparently normal sensory function and 12 cases with other psychiatric diagnosis has normal sensory function. Chi-Square test shows association between psychiatric diagnosis and severity of sensory dysfunction is statistically significant. (Chi-Square Value 24.162 and p-Value <0.001).

DISCUSSION

This study aimed to find the association between Sensory Processing Difficulties (SPD) among children attending the Child Guidance Clinic (excluding those diagnosed as Autism Spectrum Disorder) in a tertiary care hospital in Kolkata. 72 new cases were selected who fulfilled inclusion criteria. Within the field of occupational therapy there is a prominent school of thought that suggests that some children can be clearly identified as having SPD either as part of or, in some cases independently of any other diagnoses [9].

There is evidence to show that certain children experience difficulties in the processing of sensory information compared to typical children [8,11,15,18,19,26,35,39,40,41,42]. In addition sensory difficulties are so well recognized in relation to ASD [8, 19, 40, 41, 42] that sensory sensitivities were included as a diagnostic feature of ASD in DSM V published in May 2013.

Other than ASD, sensory processing problems seem to be present in numerous other conditions, and there is uncertainty about whether it constitutes a distinct disorder or not. Estimated rates of sensory processing dysfunction for children with various disabilities have ranged as high as 40–88% [15, 16].

In this study we excluded the children diagnosed as ASD and divided the selected cases into two groups. First group was the children with diagnosis of ADHD, ODD and CD (i.e. Externalizing Disorder) and Second group was of communication disorder, motor disorder, separation anxiety disorder, Disruptive Mood Dysregulation Disorder etc.

In this sample of children, a high proportion of participants appeared to have sensory processing difficulties. 52.8 % of them had definite difference than typical consistent with previous study [43] done by Fox .et.al (the proportion of children with sensory processing disorders in the study was 55.2%). The only study of the prevalence of sensory processing difficulties in the community estimated a prevalence of 5.3–13.7%, using a deliberately conservative cut-off [15].

One of possible explanations for a high prevalence of sensory processing difficulties in this sample is higher number of cases of externalizing behavioral disorder who may be more likely to have sensory processing difficulties. As in previous research

[44], this study also finds no meaningful gender differences on the Sensory Profile. Due to the predominance of male children (only 19 female and 53 male) in our sample the findings cannot be generalized.

In the current study significant association (p-value <0.001) was found between presence of perinatal complications and sensory profile score. The mean SSP score of 27 cases with history of perinatal complication had definite difficulties in comparison with the other group. This finding is consistent with previous studies [13] done by May- Benson which conclude with the first report on a large group of children with SPD showing the consistent association of unfavorable events in pregnancy, delivery, neonatal and infant phases and SPD and it seems prudent to consider watching for possible signs of SPD in a young child when there is a history of major maternal stresses during pregnancy, assisted delivery, fetal distress, jaundice etc.

The current results suggest a significant difference of sensory processing difficulties in the two groups of study population aged 3–15 years. These findings are consistent with the study that has explored this relationship in children without identified disabilities Gunn *et al*. [34] found a significant correlation between scores on the SSP and the 'ODD' (Oppositional defiant disorder) and 'externalising' scales of the Child Behaviour Checklist CBCL; Achenbach 1978 in Latino preschool children. The study done by Fox et al also found a significant association between sensory processing difficulties and severity of behavioural problems in children aged 5–9 who have been identified as at risk of conduct disorder.

The current findings suggest that sensory processing difficulties may coexist with and possibly contribute to behavioural problems, although this would need to be examined longitudinally in order for any cause–effect relationships to be established. It may also be that a common neurological factor underlies the development of both externalizing behaviour and sensory processing difficulties. Behaviour problems have been linked with dysfunction of the prefrontal cortex and the amygdala [45, 46] and EEGs in children with sensory processing difficulties suggest impaired sensory gating (the brain's ability to filter sensory information). However, the neural mechanisms underlying these phenomena remain unknown [39].

Though the present study has not emphasized on different areas of sensory dysfunction (tactile, taste and smell, movement, under-responsive/seek sensation, auditory filtering, low energy/weak and visual/auditory sensitivity) it was found in previous studies that children with ADHD have more difficulties in tactile processing [21]. Tactile dysfunction comprises three types of tactile dysfunction including hypersensitivity to touch (tactile defensiveness), hyposensitivity to touch (under-responsive), and poor tactile perception and discrimination [32]. "Might not be aware that his/her face or hands are dirty or even his/her runny nose" and "may not be aware that he/she has been touched, except that when he/she has been touched forcefully" two examples for hyposensitivity to touch. Two examples of tactile defensiveness are "doesn't like to brush his/her hair or is easily annoyed by it" and "react excessively to small cuts, or bites".

Certain behavior of hyperactive children like impulsivity, accident proneness could be explained on the basis of sensation seeking behavior. The symptoms of oppositional defiant disorder are predictors in hypersensitivity scores of tactile sensory function in ADHD. The subtypes of ADHD are not different regarding auditory processing problems. However, the co-morbidity of ODD in children with ADHD is a risk factor for auditory processing problems [47].

ADHD children with sensory oversensitivity usually suffer from other problems such as anxiety[48].To manage the comorbidity present with ADHD and also ODD and CD treatment plan should include sensory integration therapy to correct the sensory processing difficulties. Just as parents of children are educated about ADHD symptoms [49], considering the co-morbidity of ADHD and sensory processing problems, they should also be educated about the symptoms and behavioral management of sensory processing problems [50].

The significant association between sensory processing difficulties and behavioral problems has important implications for clinical practice. Clinicians should be aware that many children who present with externalizing behaviors may have underlying sensory processing difficulties. Evaluation of sensory processing difficulties should form part of the assessment process, and consultation with an occupational therapist that has completed accredited training in sensory integration practice should be considered.

Limitations

- Sample size of this study was less.
- Most of the children scored in the high ranges because of the higher number of study population in measures of externalizing behaviour.
- The assessment of sensory processing could have been strengthened by the addition of the teacher-rated SSP.
- Prevalence of sensory processing difficulties among apparently normal children could have been assessed as a comparator arm.
- Different areas of sensory processing difficulties have not been addressed in this study.

CONCLUSION

Very few Indian studies have explored the association between sensory processing difficulties and externalizing behaviours in children. It was hypothesized that the prevalence of sensory processing difficulties in this sample would be higher in the group of externalizing disorder and the results bore this out. Based on the SSP scores, the difference between two groups are significant. The findings suggest that further research into this association is warranted, as it may illuminate important management approaches for such children.

DECLARATION

This work is original, not plagiarized. The manuscript has not been submitted elsewhere for review before publication. I take full responsibility for the work submitted here. There is no conflict of interest.

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