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Validating Regulatory Sensory Processing Disorders Using the Sensory Profile and Child Behavior Checklist (CBCL 1½–5)

Ruth Pérez Robles · Ma. Claustre Jané Ballabriga · Eduardo Doval Diéguez · Pedro Caldeira da Silva

Abstract The objective was to validate Regulatory Sensory Processing Disorders' criteria (DC:0-3R, 2005) using empirical data on the presence and severity of sensory modulation deficits and specific psychiatric symptoms in clinical samples. Sixty toddlers who attended a child mental health unit were diagnosed by a clinical team. The following two groups were created: toddlers with RSPD (N = 14) and those with "other diagnoses in Axis I/II of the DC:0-3R"(OD3R) (N = 46). Independently of the clinical process, parents completed the Infant Toddler Sensory Profile (as a checklist for sensory symptoms) and the Achenbach Behavior Checklist for ages 1½–5 (CBCL 1½–5). The scores from the two groups were compared. The results showed the following for the RSPD group: a higher number of affected sensory areas and patterns than in the OD3R group; a higher percentage of sensory deficits in specific sensory categories; and a higher severity of behavioral symptoms such as withdrawal, inattention, other externalizing problems and pervasive developmental problems in CBCL 1½–5. The results confirmed our hypotheses by indicating a higher severity of sensory symptoms and identifying specific behavioral problems in children with RSPD. The results revealed convergent validity between the instruments and the diagnostic criteria for RSPD and supported the validity of RSPD as a unique diagnosis. The findings also suggested the importance of identifying sensory modulation deficits in order to develop an early intervention to enhance the sensory capacities of children who do not fully satisfy the criteria for some DSM-IV-TR disorders.

Keywords Regulatory sensory processing disorders · DC:0-3R · Infant toddler sensory profile · CBCL 1½–5 · Sensory modulation dysfunction

Introduction

Regulatory Sensory Processing Disorders (RSPD) constitute a primary diagnostic category in the *Diagnostic Classification of Mental Health and Development Disorders of Infancy and Early Childhood Revised Edition: DC:0-3R* (Zero To Three 2005). There are five axes that comprise the DC:0-3. Axis I consists of the primary diagnosis (which includes RSPD and seven other broad diagnostic categories), Axis II refers to the parent-infant relationship disorder classification, Axis III covers medical and developmental disorders and conditions, Axis IV refers to psychosocial stressors, and Axis V covers the functional and emotional developmental level.

RSPD are defined by the presence of (1) barely adaptive emotional and/or behavioral patterns in the child and (2) constitutional or maturational difficulties in modulating sensory and motor responses to stimuli. These behaviors occur in multiple relationships and contexts and impact the functioning and/or development of the child. RSPD comprise 3 types and 2 subtypes (Zero to Three 2005).

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The prevalence of these disorders in the general population of children aged 18 months in Denmark was reported to be 7% (Skovgaard et al. 2007). These have also been proposed to constitute the most prevalent diagnostic category of DC:0-3R in children up to 5 years old (Zero to Three 2005).

The diagnostic criteria for these regulatory disorders (RD) (Zero to Three 1994) were initially created based on a consensus of clinical and research experts, including occupational therapists and child psychiatrists (DeGangi et al. 1991, 1993) and served to define the condition characterized by infant difficulties in regulating physiological, sensory, attentional, motor, or affective processes and maintaining a calm, alert, or affectively positive state (Greenspan 1992). RD were renamed RSPD in the DC:0-3R (Zero to Three 2005) in order to draw attention to the difficulties in sensory processing that characterize these disorders included in the *Diagnostic Manual for Infant and Early Childhood* (Interdisciplinary Council on Developmental and Learning Disorders 2005).

During the past 15 years, research has contributed to an increased understanding of the dysfunctional sensory, motor, and behavioral responses that certain infants, toddlers, and young children experience (Reebye and Stalker 2007). Longitudinal studies demonstrated that symptoms of RD during infancy were related to the child's clinical status at 3 years of age. Specifically, 95% of infants with moderate RD had diagnoses that fell into one of the two following diagnostic clusters in early childhood: (1) delays in motor, language, and cognitive development or (2) parent–child relational problems (DeGangi et al. 2000).

In spite of its widespread clinical use in early childhood but due to the lack of validity studies, RSPD (or a similar category such as sensory processing disorders, SPD) were not included in the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-IV-TR: American Psychiatric Association 2000) or the *International and Statistical Classification of Diseases and Related Health Problems* (ICD-10: World Health Organization 2006).

Most of the disorders in Axis I of the DC:0-3 were based on versions of adult DSM-IV diagnoses that were adapted to the clinical criteria for early childhood. On the other hand, RSPD diagnostic criteria were specifically created for infancy and early childhood. Most of those disorders were supported by a greater number of validity studies than were RSPD, e.g. Depressive Disorder (Luby et al. 2002), Posttraumatic Stress Disorder (Scheeringa et al. 1995, 2002), Sleep Onset Protodyssomnia and Night Waking Protodyssomnia (Benoit et al. 1992; Burnham et al. 2002; Halpern et al. 1994; Minde et al. 1993; Sadeh 1994), and Infantile Anorexia (Chatoor et al. 2000, 2001). These disorders were also included in the Research Diagnostic Criteria-Preschool Age (RDC-PA; Task Force on Research

Diagnostic Criteria: Infancy and Preschoolers, 2003) and they were supported by the American Association for Child and Adolescent Psychiatry.

One limitation of the DC:0-3 framework for RSPD diagnoses is that the number of criteria necessary for a diagnosis has not been specified. This limitation has been compensated for by the provision of detailed symptom descriptions that should allow future research to contribute data on these criteria (Zero to Three Task Force 1994).

The types and subtypes of RSPD are based on the sensory threshold of the child (low or high) and the type of self-regulatory response (active or passive). They partially juxtapose the classification proposed by Dunn (1997) regarding Sensory Modulation Dysfunction diagnosis (SMD) in the field of sensory integration practice.

All 3 types of RSPD in the DC:0-3R are characterized by the extreme responses of the child that interfere with self-care, play, and learning activities. Toddlers with diagnoses of Hypersensitive Type (I) are over-reactive to various stimuli, which causes them to be either fearful/cautious or negative/defiant. Children in the Fearful/Cautious Subtype are frequently frightened, anxious, and worried that the sights, sounds, and movements around them will become overpowering. The infants in the Negative/Defiant Subtype are characterized as fussy, difficult, angry, and stubborn when they become older. These children are frequently tactile defensive, are over-reactive to sound, and demonstrate poor auditory processing. Children classified as Hyposensitive/Under-responsive Type (II) are under-reactive to stimuli. They may appear self-absorbed or withdrawn and are difficult to engage. They may also appear inattentive or sad. The sensory stimulation-Seeking/Impulsive Type (III) child presents with impulsive and disorganized behaviors regarding motor responses. These children may be counter-phobic and may lash out at their peers. They are also accident-prone (Reebye and Stalker 2007; Williamsom and Anzalone 2001).

The need to study the validity of this diagnosis has been addressed by various authors such as Rescorla (2005) who noted that the DC:0-3 diagnostic framework diagnoses were not developed using the standard procedures for assessing reliability and validity. These standard procedures use a sample, which includes "cases" with diverse problems as well as "non-cases", to validate diagnoses with data not used in the diagnostic process. However, such data was used in the study of Carter et al. (2010), which analyzed the prevalence of DSM-IV diagnoses in older children.

The prevalence of sensory modulation deficits was found to be between 3.4 and 15.6% in the North American pre-school population (Ahn et al. 2004; Gouze et al. 2009; ICDL 2005). There are no studies that have provided evidence for a greater presence of sensory modulation deficits

associated with RSPD as compared to other Axis I diagnoses that comprise the DC:0-3R to demonstrate that these deficits are a differential diagnosis criterion for the former disorder. These sensory deficits have also been associated with unusual behaviors in children (Davies and Gavin 2007).
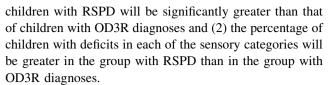
Regarding the behavioral and emotional symptoms in RSPD, it would be important to analyze the boundaries between RSPD and other disorders, such as Anxiety, Depression, Sleep and Feeding Disorders, and Relationship Disorders, because of the phenotypic similarities between them. The only studies that have compared the behavioral symptoms of RSPD with other diagnoses in the DC:0-3 framework did so by comparing them to Multisystem Developmental Disorders (MSDD) (Cesari et al. 2003; DeGangi et al. 2000). The results of these studies found significantly greater avoidance behavior and a greater number of somatic complaints in children with MSDD than in children with RSPD, revealing the discriminative capacity of the instruments and supporting the validity of RSPD as a specific diagnosis.

In the field of early childhood psychiatric epidemiological research, Skovgaard et al. (2004) proposed that assessments should be conducted with existing instruments that have well-established psychometric properties for these age groups, such as the child behavior checklist (CBCL 1½–5) (Achenbach and Rescorla 2000), in conjunction with clinical assessment procedures and the DC:0-3 system. In order to assess sensory modulation deficits in infants and toddlers, Dunn (2001) developed the Infant/Toddler Sensory Profile schedule. Dunn's model has evidence of external validity due to the significant association between the electrodermal responses given by children with and without SMD or different sensory patterns of the short sensory profile (SSP) (McIntosh et al. 1999b; Schaaf 2001) as well as the discriminant capacity of the clinical samples (Dunn 2001).

Taking into account the above-mentioned points, the general objective of the current study was to provide external evidence with empirical data regarding the criteria that postulate sensory modulation deficits as the defining factor of RSPD and the behavioral and emotional characteristic symptoms of RSPD. Thus, the following specific objectives were considered:

To compare the presence and severity of sensory modulation deficits between a group of 18- to 36-month-old children diagnosed with RSPD and another group with a spectrum of a spectrum of Axis I/II diagnoses that comprise the DC:0-3R (OD3R); To compare the severity of the emotional and behavioral symptoms between the two diagnostic groups.

Regarding the first objective, the hypotheses are as follows: (1) the number of affected sensory categories of children with RSPD will be significantly greater than that of children with OD3R diagnoses and (2) the percentage of children with deficits in each of the sensory categories will be greater in the group with RSPD than in the group with OD3R diagnoses.

Regarding the second objective, and taking into account the characteristic symptoms of the condition, such as withdrawal (that characterizes the Hypersensitive and Fearful/Cautious Subtype), attention problems (present in both sensory seeking and hyposensitive types) (Dunn and Bennett 2002) or other externalizing problems (that characterizes the Opposite/Defiant Subtype) (Zero to Three 1994, 2005; Dunn 1997, 2002; Miller et al. 2001), the hypothesis follows that children with RSPD will display greater severity of these symptoms.

Method

Participants

Of the 594 children who attended the Infancy and Early Childhood Unit (UPI) of the Department of Child and Adolescent Psychiatry at a Pediatric Hospital in Lisbon between January 2008 and April 2009, those aged between 18 and 36 months were selected (n = 125). Complete data was gathered for 92% of the 125 children to whom the protocol was applied. Of these children, 55 were excluded due to one or more of the following exclusion criteria: (1) prematurity; (2) any previously detected clinical sensory loss (auditory, visual, etc.); (3) parents with insufficient command of the Portuguese language for the completion of the scales; (4) no diagnosis in Axis I or II of the DC:0-R; (5) specific genetic syndromes; and (6) MSDD. It is known that children with MSDD typically have a more severe disability (including general sensory processing) than those with RSPD. Children with MSDD were excluded from this study because there was not a sufficient number to create a separate MSDD group.

It was obtained a final sample of 60 children (average age = 29.15 months; 55% boys and 45% girls), the majority of whom were of middle class background, according to the Hollingshead Socioeconomic Status Index (1975). Based on the clinical diagnoses, the following two groups were created: group 1 (n = 14) consisting of children diagnosed with RSPD and group 2 (n = 46) consisting of children with a diagnosis within any of the 5 remaining categories within Axis I of the DC :0-3R (OD3R) or with a diagnosis within Axis II (ratings up to 60 on the Parent-Infant Relationship Global Assessment Scale, PIR-GAS) (See Table 1). The group with RSPD diagnoses was comprised of 8 boys and 6 girls, and the group with OD3R diagnoses was comprised of 25 boys and 21 girls. Regarding the organic conditions related to

Table 1 Diagnoses within Axis I and/or II of the DC:0-3R (n = 60) according to category

Axis I			Axis II					
Primary diagnosis	n	%	PIR-GAS	n	%	Relationship disorder classification	n	%
Disorders of affect	13	21.7	11–20 Grossly impaired	3	5.0	Over involved	6	10.0
Adjustment disorders	6	10.0	21–30 Severely disordered	11	18.3	Under involved	23	38.3
Regulatory disorders	14	23.3	31–40 Disordered	8	13.3	Anxious/Tense	9	15.5
Sleep behavior disorder	8	13.3	41–50 Disturbed	9	15.0	Verbally abusive	1	1.7
Eating behavior disorder	2	3.3	51–60 Distressed	7	11.7			
Other disorders	1	1.7						
Subtotal diagnosis Axis I	44	33.3	Subtotal disorder in Axis II	38	63.3	Subtotal disorder in Axis II	38	63.3
Without diagnosis in Axis I	16	26.7	Without disorder in Axis II	21	35.0	Without disorder in Axis II	21	35.0
			Without data in Axis II	1	1.7	Without data in Axis II	1	1.7
Total	60	100.0	Total	60	100.0		60	100.0

development, specific language delays (SLD) or global developmental delays (GDD) appeared in 28.9% of the children with OD3R diagnoses, as compared to 30.8% of children with RSPD, and approximately 14.7% of these corresponded to SLD and 15.5% corresponded to GDD in each group. These differences were not significant.

Instruments

Child Behavior Checklist, CBCL 1½–5 (Achenbach and Rescorla 2000)

It was applied the Portuguese version of the CBCL 1½–5: *Questionário de Comportamentos da Criança* (Gonçalves et al. 2007, unpublished manuscript). This is a multidimensional, standardized 100-item scale that is specific for children aged between 18 months and 5 years and 11 months. These items assess the frequency with which the parents have observed certain behaviors in their children over the past 2 months. The CBCL consisted of three possible responses (0 = "not true"; 1 = "sometimes true"; and 2 = "often true"). The results were grouped according to the following seven symptoms: "emotional reactivity", "anxiety/depression", "somatic complaints", "withdrawn", "sleep problems", "attention problems", and "aggressive behavior". The first four symptoms were regrouped as "internalizing syndromes", and the last two symptoms were grouped as "externalizing syndromes". The scores could also be grouped into five syndromes based on the DSM-IV. These syndromes included those defined by "affective problems", "anxiety problems", "pervasive developmental problems", "attention deficit/hyperactivity problems", and "oppositional defiant problems". Good reliability (internal consistency) indices were demonstrated. In the present study, children with a *T* score of 65 or greater on a CBCL 1½–5 scale were considered to display significant symptoms of problematic behavior (DC:0-3R criteria).

Infant Toddler Sensory Profile, ITSP (Dunn 2002)

It was applied the Portuguese version of ITSP: *Perfil sensorial para bebés e crianças (7–36 meses)* (Robles 2008, unpublished manuscript). This questionnaire includes 48 items that refer to behaviors related to sensory processing in children aged 0–36 months. These items were assessed on a 5-point scale from 1 (almost always) to 5 (hardly ever). This instrument offers the following two types of results: sensory area ("auditory", "visual", "vestibular", "tactile", and "oral") and sensory pattern results ("low registration", "sensation seeking", "sensory sensitivity", and "sensation avoidance"). A "low sensory threshold" was computed as the sum of the "sensory sensitivity" and "sensation avoidance" scores. Cut-off scores for children between 7 and 36 months were determined for each section and quadrant in the following manner: "typical performance" corresponded to scores at or between ±1 SD from the mean for children without disabilities; "probable difference" corresponded to scores within the 1–2 SD range; and "definite difference" corresponded to scores 2 SD outside the mean for children without disabilities. In the study with the original sample, the reliability for the different components ranged between 0.69 and 0.85 (Dunn 2002). Other studies have also contributed satisfactory data on the validity of the content, criteria, and construction of this instrument (Dunn and Daniels 2002). In the current study, scores >1 SD of the mean for the original instrument represented sensory modulation deficit (DC:0-3R criteria).

Diagnostic Classification of Mental Health and Developmental Disorders of Infancy and Early Childhood, Revised Edition: DC:0-3R (Zero to Three 2005)

This classification is organized into 5 axes. Axis I consists of the primary diagnosis and the following 8 broad

diagnostic categories: (1) Posttraumatic Stress Disorder, (2) Deprivation/Maltreatment, (3) Disorders of Affect, (4) RSPD, (5) Sleep Disorders, (6) Feeding Behavior Disorder, (7) Disorders of Relating and Communicating or MSDD, and (8) other disorders. Axis II refers to disorders of the parent–child relationship, and these relationship disorders include several patterns. Each disorder in Axis II highlights a relational pattern that includes descriptors of behavior, affect, and psychological involvement between the caregiver and the child. The relational patterns include the following: Over-involved, Under-involved, Anxious/Tense, Angry/Hostile, Mixed Relationship Disorder, and Abusive (verbal, physical, or sexual). The severity of the disorder was assessed using the Parent-Infant Relationship Global Assessment Scale (PIR-GAS). The PIR-GAS ratings range from well-adapted (91–100) to documented maltreatment (1–10). Ratings below 40 were considered to represent "disorder" in the DC:0-3R. Ratings between 40 and 70 were considered to represent "a tendency". In the current study, we considered ratings up to 60 to be clinically relevant (see Table 1). In addition, Axis III consists of medical and developmental problems, Axis IV consists of psychosocial stressors, and Axis V consists of the levels of emotional and social functioning of the child.

Hollingshead Socioeconomic Status Index (Hollingshead 1975)

This scale categorizes the socioeconomic status (SES) of a family into four categories (low and medium–low; medium; medium–high; and high) according to each parent's maximum level of education and type of employment.

Clinical Adaptation of Strange Situation (UPI's Paradigm)

The objective of "the strange situation" is to identify attachment patterns (secure, insecure, or disorganized) from observations of the child's behavior, especially during the reunion of the child with the mother (Ainsworth 1985). The response of the children at this time, according to the strange situation, is generally accepted to be an indirect indicator of the quality of dyadic interactive history at home (Bretherton 1989). The classification of children according to the strange situation predicts the affective and behavioral quality of the mother towards the child. Children of more supportive and sensitive mothers are classified as having a secure attachment (Lewis and Feiring 1989). The characteristics of behavioral quality, affective tone, and psychological involvement were used to determine the existence of a relationship disorder (PIR-GAS ratings and type of relationship disorder in Axis II of the DC 0-3R). The UPI procedure is recorded as a video, which is used for the clinical assessment of the child and

the interaction between the parents and/or the child during the four episodes. During the first episode (5 min), the parents do not participate as the child explores the environment freely. Then, the observer asks the parents to leave the room for 3 min. In the "separation" episode, one stranger person is placed far away from the child in the same room. Then, the stranger adapts his behavior to that of the child. In the "reunion" episode, the reaction of the parents and the child is registered. In the "play" episode, parents are asked to play as usual with the child for 5 min. Similar adaptations of the strange situation have lead to results that are consistent with those obtained with the complete procedure (Lewis and Feiring 1989).

Procedure

The hospital's ethics committee approved the procedure. The clinical team of the UPI (comprised of three child psychiatrists, a clinical psychologist, two nurses specialized in mental health, and an occupational therapist with an average of 15 years of clinical experience) made the clinical diagnoses using a consensus based on the following information: (a) a written report of the child's interaction during the first consultation at UPI; (b) a video recording of children under 2 years of age in a clinical adaptation of the strange situation; (c) the data collected by a nurse during the intake interview with the parents; and (d) the data gathered by a child psychiatrist during the clinical interview with the parents. Based on whether the child's diagnosis was RSPD or OD3R, the toddler was included into either group 1 or group 2. Independently of the clinic diagnostic process, parents who agreed to participate in the research were asked to complete the ITSP and CBCL 1½–5 assessment scales. None of the clinicians involved in the clinical diagnosis had knowledge of the scale assessment results.

The statistical analysis was performed using SPSS software version 15 with the double entry of data. ITSP scores were analyzed in a categorical form, and scores greater than ±1 SD of the mean from the original instrument were considered extreme scores, according to the following methods:

In order to compare the percentage of children with extreme scores by group, the χ^2 test (Pearson Chi square test) was performed. Alternatively, when the expected values of more than 20% of the cells in the contingency table were below 5, the Fisher's exact test was used.

The differences between groups regarding the number of affected areas were calculated by comparing the percentage of children with extreme scores in 0–5 of the sensory areas. An identical method was used to calculate the differences between groups regarding the number of sensory patterns.

To compare the average ranges associated with the scores obtained in the CBCL 1½–5 for the two groups, the non-parametric Mann–Whitney U test was used. This information was complemented with descriptive analyses of the scores for the central tendency and dispersion of the evaluated symptoms.

Results

The basic characteristics of the two groups did not differ statistically with respect to the studied socio-demographic variables or the presence of medical conditions, as evaluated within Axis III of the DC:0-3R (such as GDD or SLD).

Results for Hypothesis 1, Regarding the Number of Sensory Affected Areas and Patterns by Group

All of the children with RSPD presented sensory modulation problems in at least one sensory area. In the group with OD3R, 21% of the children did not present with any affected sensory areas. Significant differences between the two groups were evidenced when more than two sensory areas were affected ($p = 0.024$); 50% of the children with RSPD versus 19.6% of the children with OD3R had two or more sensory areas with extreme scores (see Table 2). Of the children with RSPD, 7.1% presented sensory modulation problems in the 5 sensory areas, which did not occur for any of the children with OD3R.

Statistically significant differences ($p = 0.018$) were observed between the two groups when comparing children with extreme scores in more than one sensory pattern, as 78.6% of children with RSPD and 37% of children with OD3R presented these scores.

Results for Hypothesis 2, Regarding the Percentage of Sensory Deficits in Each Category by Group Using Comparison Scores of ITSP

A tendency towards statistical significance in the auditory area was observed, as 57.1% of the children with RSPD presented sensory modulation deficits in comparison with

30.4% of the group with OD3R ($p = 0.069$) (see Table 3). In the remaining 4 sensory areas, the differences between the groups did not reach the level of significance.

Two significant differences in the sensory pattern scores were observed between the diagnostic groups (see Table 3). With respect to the low registration pattern, 64.3% of children with RSPD had extreme scores compared to 32.6% of those with OD3R ($p = 0.034$). Regarding the sensory sensitivity pattern, 56.1% of children in the group with RSPD had extreme scores compared to 26.1% of children in the group with OD3R ($p = 0.035$).

Differences between groups were also significant in regards to the low sensory threshold category, for which 64.3% of children with RSPD and 38.3% of those with OD3R diagnoses had extreme scores ($p = 0.014$).

Results for Hypothesis 3 Regarding the Severity of Behavioral Emotional Symptoms by Group Using a Comparison of Scores from the CBCL

Table 4 shows that there were statistically significant inter-group differences in four of the behavior categories, as evaluated by the CBCL 1½–5, and that there was greater severity in the RSPD compared to the OD3R group. These significant differences were associated with the following behavioral categories: withdrawal symptoms ($p = 0.005$), attention deficit/hyperactivity ($p = 0.029$), pervasive developmental problems based on the DSM-IV criteria ($p = 0.005$), and externalizing syndromes ($p = 0.045$).

Discussion

The findings of the present study indicated a greater prevalence and severity of modulation deficits in the RSPD group compared to the OD3R group in terms of the "auditory" area, the "low registration", "sensory sensitivity" and "low sensory threshold" patterns according to ITSP score (Dunn 2001), and a greater severity of "withdrawn" symptoms, "pervasive developmental problems", "attention problems", and other externalizing problems and symptoms according to the CBCL 1½–5 system.

This study has been one of the few studies to address the convergent and divergent validity of RSPD and represents the first exploration into the incidence of sensory and behavioral symptoms in toddlers with RSPD compared to children with other clinical diagnoses.

Regarding the first objective, all toddlers with RSPD showed deficits in at least one sensory category of ITSP, unlike toddlers with OD3R, supporting the diagnosis criteria described in the DC:0-3R (Zero to Three 2005). It is important to note that difficulties in modulating the degree, intensity, and nature of the response to stimuli have been

Table 2 Differences between the diagnostic groups in the number of areas and sensory patterns with extreme scores

		RSPD %	OD3R %	χ^2	p
No of sensory areas affected	≤2	50.0	80.4	5.084	.024*
	>2	50.0	19.6		
No of sensory patterns with extreme scores	≤1	21.4	63.0	5.998	.018*
	>1	78.6	37.0		

* $p < .05$

Table 3 Percentage of children with extreme scores in each area and sensory pattern on the infant toddler sensory profile scale, according to diagnostic group

	RSPD (%)	OD3R (%)	X^2	p
ITSP Sensory areas				
Auditory area	57.1	30.4	3.297	.069
Visual area	35.7	15.2	2.818	.100[a]
Tactile area	64.3	39.1	2.744	.089
Vestibular area	42.9	41.3	.011	.578
Oral area	42.9	28.3	1.057	.239[a]
ITSP Sensory patterns				
Low registration	64.3	32.6	4.488	.034*
Sensation seeking	35.7	21.7	1.118	.309[a]
Sensation avoidance	57.1	37.0	1.799	.180
Sensory sensitivity	57.1	26.1	4.658	.035*[a]
Low sensory threshold	64.3	28.3	5.998	.014*

* $p < 0.05$

[a] When the necessary conditions for the application of the χ^2 test were not met, the p value was calculated using the Fisher exact test

Table 4 Behavioral and emotional symptomatology scores by diagnostic group in CBCL 1½–5

CBCL 1½–5	RSPD		OD3R		p
	Mean (SD)	Mean ranks	Mean (SD)	Mean ranks	
Symptoms					
Emotionally reactive	60.71 (6.54)	30.29	61.11 (8.24)	30.57	.958
Anxious/Depressed	56.71 (7.38)	24.18	60.57 (8.85)	32.42	.119
Somatic complaints	56.86 (6.52)	32.50	56.43 (7.50)	29.89	.613
Withdrawn	65.93 (11.32)	41.79	57.09 (8.41)	27.07	.005**
Sleep problems	61.79 (12.52)	27.14	64.98 (13.73)	31.52	.409
Attention problems	60.93 (6.37)	39.29	57.07 (7.62)	27.83	.029*
Aggressive behavior	64.71 (9.68)	37.14	60.59 (9.84)	28.48	.103
Syndromes (DSM-IV)					
Affective problems	59.71 (7.50)	28.07	60.83 (7.05)	31.24	.549
Anxiety problems	60.29 (8.04)	27.39	62.83 (9.56)	31.45	.444
Pervasive developmental P.	68.14 (10.38)	41.86	59.22 (8.96)	27.04	.005**
Attención déficit/Hyperactivity P.	61.36 (7.13)	35.14	59.13 (8.61)	29.09	.253
Oppositional defiant problems	63.14 (8.53)	36.75	59.48 (8.84)	28.60	.124
Syndromes					
Internalizing	61.21 (7.58)	32.75	59.02 (10.20)	29.82	.581
Externalizing	64.14 (8.04)	38.68	58.93 (10.39)	28.01	.045*
Total	64.00 (6.47)	35.64	60.76 (10.02)	28.93	.208

* $p < .05$; ** $p < .01$

linked in other studies to deficits related to habituation and sensitization mechanisms of the central nervous system (Fisher and Murray 1991; Schaaf 2001; Schaaf et al. 2003). Demonstrating the differential characteristics of OD3R, a high percentage of toddlers with RSPD (78.6%) showed extreme scores in more than one sensory pattern, and 50% also showed more than two sensory areas affected by sensory modulation problems (80.4% of the children with OD3R showed two or less areas affected).

The differences between the groups approached the level of significance in the auditory area, which indicated that auditory modulation deficits could serve as a potential indicator of RSPD for clinical assessment. Auditory defensiveness in infancy was examined by Goldsmith et al. (2006). This study asserted that over-reactivity in the area of auditory defensiveness as well as the tactile area had a greater association with emotional symptoms than other sensory areas (Ben-Sasson et al. 2009). Other studies, which compared sensory modulation deficits between children with SPD and children with no diagnosis (McIntosh et al. 1999b), found the greatest differences between groups in regards to the auditory area. The lack of significant differences in other sensory areas in the current study may be related to sample size and/or the sample origin.

Other studies (Gunn et al. 2009; McIntosh et al. 1999a, b) also observed significant differences in other sensory areas; however, the children who composed the control groups in these studies were not from a clinical sample.

Regarding the differences in sensory patterns between the groups of the present study, toddlers in the RSPD group were approximately twice as likely to exhibit extreme scores in the low registration pattern as those in the OD3R group. According to Dunn's model, this pattern is defined by the child's high sensory threshold and passive strategies. Low-registering toddlers may be described as insensitive or disconnected; they do not pick up on subtle environmental cues and require very clear directives. Most events of daily life are not sufficiently intense to stimulate deep processing for these children, and their passive-reactive self-regulatory stance makes them somewhat oblivious to ongoing activity that does not explicitly engage them. These patterns correspond to the hyporeactive type in the DC:0-3R system.

Toddlers with RSPD also showed higher scores for the sensory sensitivity pattern than toddlers with OD3R. According to Dunn, this pattern is defined by a low threshold and by active strategies. Sensitive toddlers detect more input and notice more sensory events and comment on them regularly rather than attempting to ward them off. They are easily distracted and can be complainers. Structured experiences help them avoid being overwhelmed by unstructured and disruptive inputs. This pattern corresponds to hypersensitive type in the DC:0-3R system. A greater number of children with RSPD showed extreme scores in the low sensory threshold (an ITSP category that results from the sum of two ITSP score patterns and refers to the presence of a low threshold of the child independent of the child's use of active or passive strategies). Characteristic symptoms of all 4 patterns of RSPD were demonstrated in these results.

The presence of deficits in sensory modulation deficits in the group with OD3R (even in a lesser extent than in RSPD group) was also supported by other studies; Specifically sensory modulations deficits showed correlations with Depression, Generalized Anxiety (Gouze et al. 2009) and externalizing problems in preschool children (Gunn et al. 2009). Further research is necessary to analyze the prevalence of sensory modulation deficits in patient samples with different diagnoses within the DC:0-3R system.

Regarding the second objective (i.e., comparing the severity of the emotional and behavioral symptoms between the two diagnostic groups), symptoms such as withdrawal or inattention as well as other externalizing symptomatology (e.g., impulsiveness and aggressive behavior) from the CBCL 1½–5 system were significantly more prevalent in the group of children with RSPD, which supports the hypothesis. In addition to the agreement with most of the characteristic symptoms for various patterns of RSPD in the DC:0-3R, these symptoms were discriminative in the present study. This provided evidence of convergent validity between the measuring instrument and clinical observation.

On the subscale of pervasive developmental problems, the RSPD patient group obtained significantly higher scores than the OD3R group (even, these scores were outside of the clinical range of CBCL 1½–5) ($T \geq 65$). This result is supported by studies that have challenged the differential diagnosis of early regulatory problems for early autism symptoms (Bagnato and Neisworth 1999; DeGangi et al. 2000).

Limitations

Several limitations must be considered when interpreting the results of the present study. The main limitation of this study was the sample size, which although similar to the other existing studies, indicates that the results must be interpreted cautiously. The 0D3R patient group was treated as a homogenous group due to the small sample sizes that would have resulted from separating the 0D3R groups by diagnostic category. Similarly, the bias associated with the non-random nature of the study sample limited the generalization of the results. This study was highly dependent upon the accuracy of the instruments, and the results of this study were based on the parents' reports, which used relatively new measures, such as the ITSP scale, and were influenced by the perception of sensory-related behaviors.

Future Research and Integration

Nevertheless, the results support the usefulness of the ITSP and CBCL 1½–5 instruments as part of future clinical evaluations and have demonstrated the capacity of these instruments to discriminate between clinical signs in early childhood. This preliminary data has offered clues as to the differential diagnosis of RSPD and other similar conditions. Thus, it would be interesting to further analyze the differences between RSPD and the related conditions by separating the 0D3R groups by diagnostic category. The validation of these preliminary data and the development of research into the sensitivity and specificity characteristics of the instruments applied using patient samples similar to those of the current study would be of great importance for the potential inclusion of these results in the DSM-V manual as a differential diagnostic entity in early childhood.

To our knowledge, no research or theoretical revisions have been carried out that describe the relationship between RSPD and the taxonomic classification of SMD. This may be due to their parallel development in the field of sensory integration and in the area of infant mental

health. These studies are nevertheless fundamental, as Miller et al. (2000) have indicated, to clarify potentially similar concepts between SMD and RSPD.

Another actual question is whether sensory deficits represent a risk factor for psychiatric disorders or whether these would constitute a dual diagnosis. In the study of Gouze et al. (2009), 63% of children with deficits in sensory modulation also showed behavioral symptoms. The fact that 37% of the children had only a sensory modulation deficit suggests that sensory modulation dysfunction exists independently of any psychiatric disorder. However, future studies should further analyze this question.

Conclusion

Taking into account the above-mentioned results, we conclude that the criterion postulating the presence of sensory modulation deficits in RSPD is sensitive for the detection of this disorder. The presence of deficits in two or more sensory areas was found to be more discriminative than the presence of these deficits in less than two areas, and this was similar to the presence of extreme scores in more than one sensory ITSP pattern (Dunn 2002). The current findings help characterize the specific sensory problems in toddlers with RSPD and facilitate the identification of RSPD profiles for use in clinical practice. Valid and more broadly recognized early detection measures are necessary to enable and support early intervention services.

The results of this study on the sensory processing of toddlers with RSPD are supported by the early psychophysiological research studies conducted on children with self-regulation difficulties (DeGangi et al. 1991; Porges 1991). In these studies, the psychophysiological profiles of RSPD children were characterized by fluctuations in vagal tone during sensory or cognitive stimulation, which was not the case for children without these problems. These children tended to have higher spontaneous activation of vagal tone and inconsistent vagal reactivity. The findings of the present study suggest that children with RSPD could benefit from clinical interventions with sensory integration techniques that (by reducing or increasing environmental stimuli appropriate for the individual child) would aim to improve the sensory abilities of the individual child and reduce the severity of the behavioral and emotional symptoms.

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