Short sensory profile and its relation with repetitive behavior and anxiety symptoms in children with autistic spectrum disorder

Heba E. Abou El Wafa, Soha A. El Latif Ghobashy, Amira K. Zakaria

Department of Psychiatry, Alexandria University, Alexandria, Egypt

Correspondence to Heba E. Abou El Wafa, MD, Department of Psychiatry, Alexandria University, Alexandria, Egypt.
Tel: 01018455515; fax: 033594830;
E-mail: heba_essam3@yahoo.com

Received: 11 April 2021
Revised: 2 May 2021
Accepted: 24 May 2021
Published: 26 February 2022

Egyptian Journal of Psychiatry 2022, 43:14–22

Background
Sensory processing abnormalities have been reported in 42%–88% of children with autism. Atypical sensory features are thought to result from aberrant sensory processing, and may be evident across all sensory modalities, including auditory, tactile, vestibular, oral, olfactory, movement, and visual domains. Several studies have shown a high prevalence of anxiety in autistic children, although they have difficulties expressing their emotions. In this study, the relation between abnormal sensory profile, repetitive behavior, and anxiety symptoms in children with autism spectrum disorder (ASD) will be elucidated.
Results
Those with the definite difference in short sensory profile (SSP) represented 63.3% of the cases. As for the SSP domains, Under-responsiveness/Seeks sensation was the domain with the highest percentage of those with the definite difference (65%) followed by Auditory sensitivity (46.7%) and then Low energy (40%), whereas Visual/Auditory sensitivity was the domain with least cases showing definite difference (11.7%).
Sensory abnormality is more evident in older children. Autism severity is related to the severity of the sensory abnormality. The total score of SSP showed a significant correlation with the total Repetitive Behavior Scale-Revised score. Anxiety Scale for Children with Autism Spectrum Disorder – Parent Version showed a significant correlation with the total score of SSP.
Conclusion
Sensory processing abnormalities are common among children with ASD and it is related to the severity of ASD, repetitive behaviors, and anxiety symptoms. Therefore, using these scales for individualization of the characteristics of sensory profile and their behavioral response and anxiety symptoms in basic assessment and follow-up is recommended, as well as promoting changes in therapeutic intervention through the possibility of choosing and designing the most appropriate intervention based on the individualized profile of the patients.

Keywords:
anxiety, autism, repetitive behavior, sensory processing, short sensory profile

Egypt J Psychiatr 43:14–22

1110-1105

Background

Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterized by social interaction impairment, repetitive behavior, and sensory abnormalities (Geschwind, 2009; Silver and Rapin, 2012).

The clinical phenotype of ASD can present in a variety of combinations that can range from a nonverbal child with mental retardation to those who possess a superior intelligence quotient (IQ) with inadequate social skills (Gadad *et al*., 2013; Masi *et al*., 2017).

Atypical sensory features that have been reported in 42%–88% of children with the disorder are thought to result from aberrant sensory processing, and may be evident across all sensory modalities, with specific affection of the tactile and taste/smell sensitivity, the auditory filtering and the sensory seeking (Tomchek and Dunn, 2007; Brock *et al*., 2012) (Watling *et al*., 2001).

Repetitive and restricted behaviors (RRB) represent a common problem in ASD, where they constitute the second dimension of diagnostic criteria (Matuschek *et al*., 2016).

Children with autism have difficulties in communicating their emotions; however, several

studies have shown a high prevalence of anxiety in those participants. Among the functions hypothesized for RRB, they are thought to be coping strategies that allow autistic participants to avoid or reduce the high level of anxiety resulting from being overwhelmed by the surrounding environment (van Steensel *et al.*, 2011; Gaye Ambler *et al.*, 2015).

A high rate of sensory processing difficulties exists in children with ASD who have more sensory-related behavioral symptoms than typically developing controls. Classification of sensory processing difficulties has been proposed by the Interdisciplinary Council on Developmental and Learning Disorders (ICDL Work Groups, 2005). ICDL proposed that it can be classified into: (a) sensory over-responsivity; (b) sensory under-responsivity; and (c) sensory seeking (Burns *et al.*, 2017).

The relation between abnormal sensory profile, repetitive behavior, and anxiety symptoms in children with ASD remains to be elucidated. Therefore, we set this study to clarify such relation in Egyptian children with ASD.

Method

A cross-sectional survey design was used on a selected sample of 60 children with ASD recruited from Child and Adolescent Psychiatry Clinic at El-Hadara University Hospital and Mamoura Psychiatric Hospital over a period of one and a half year from 2018 to 2019. Ethical approval from the institutional ethics committee and verbal consent from parents and/or caregivers of all the participants were obtained.

All cases were subjected to the following:

(1) History taking.
(2) Full psychiatric interview using the Kiddie Schedule for Affective Disorders and Schizophrenia-Present and Lifetime Version 2013 (Advanced Center for Intervention and Services Research ACISR, 2016).
(3) Thorough clinical examination with emphasis on neurological examination.
(4) Short sensory profile (SSP), a standardized parent questionnaire that measures children's responses to sensory events in everyday life (McIntosh*et al.*, 1999).
(5) The Repetitive Behavior Scale-Revised (RBS-R) (Lam and Aman, 2007).
(6) Anxiety Scale for Children with Autism Spectrum Disorder (ASC-ASD) Arabic – Parent Version (Rodgers*et al.*, 2016).
(7) Childhood Autism Rating Scale (CARS-2): the standardized Arabic edition for an established assessment for ASD among Arabic-speaking children (Akoury-Diran*et al.*, 2013).

Results

Short sensory profile (SSP) aspects

The total score mean was 135.9±18.76 (i.e., in the range of definite sensory impairment). Those with "Definite difference" in sensory processing represented 63.3% of the cases, 23.3% were having a "Probable difference," and 13.3% had a "Typical performance."

As for the domains, Figure 1 shows that Under-responsiveness/Seeks sensation was the domain with the highest percentage of those with the definite difference in 40 cases (65%) followed by Auditory filtering domain in 28 cases (46.7%) and then Low energy in 24 cases (40%), Taste/smell sensitivity in 20 cases (33.3%), Tactile sensitivity in 19 cases (31.7%), whereas Visual sensitivity was the domain with least cases showing the definite difference in 7 cases (11.7%).

Repetitive Behavior Scale-Revised (RBS-R)

For the RBS-R, the total score for the cases showed a mean of 32.62±18.80. All the cases showed at least one form of repetitive behavior at the time of assessment.

Anxiety Scale for Children with Autism Spectrum Disorder Arabic – Parent Version (ASC-ASD-P)

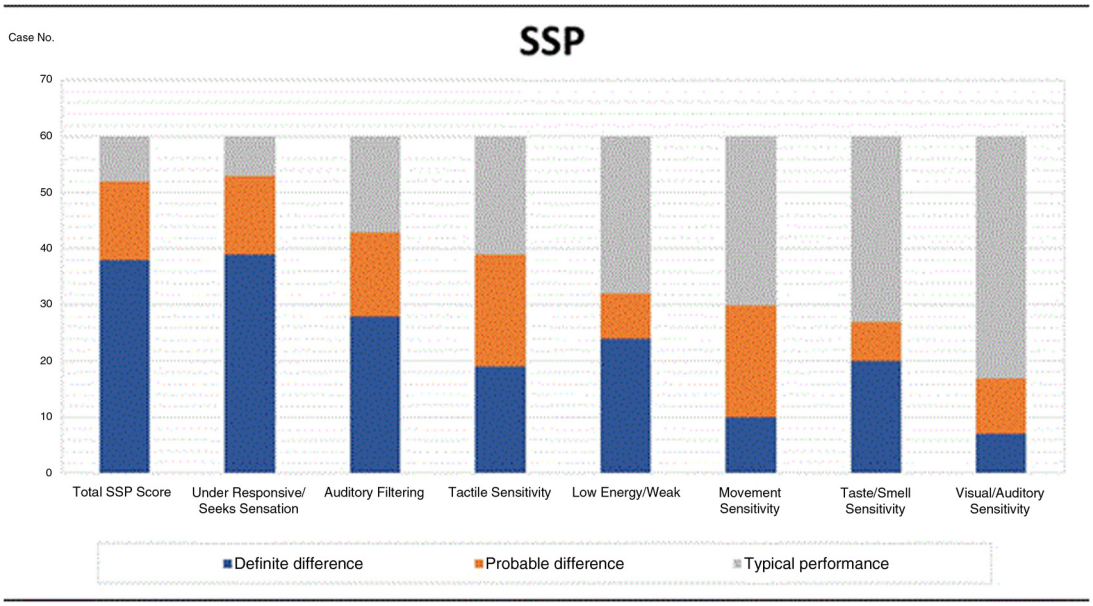
Parent version of the ASC-ASD scores had a mean of 15.62. Only 30% of the studied sample showed significant anxiety scores (score ≥20) (Table 1).

The age of the child at the time of assessment showed a significant negative correlation with SSP score (P=0.015) and significant positive correlations with both of RBS-R (P<0.001) and ASC-ASD-P (P=0.014) scores. Thus, with increasing age, the severity of the sensory abnormality, repetitive behavior, and anxiety symptoms increase (Table 2).

There was a statistically significant difference between the two groups according to SSP score (P=0.032), where the severe group had significantly lower scores, that is, the definite difference in sensory processing.

There is a significant negative correlation between the total score of SSP and CARS 2 (P value =0.001), total

Figure 1



Demonstrates the SSP Score in children with autism. The total score mean was 135.9±18.76 (i.e in the range of definite sensory impairment). Those with "Definite difference" in sensory processing represented 63.3 % of the cases, 23.3% were having a "Probable difference", and 13.3% had a "Typical performance". As for the domains, the figure shows that Under responsiveness/Seeks Sensation was the domain with highest percentage of those with definite difference 40 cases (65%) followed by Auditory Filtering domain 28 cases (46.7%) and then Low Energy 24 cases (40%), Taste/smell sensitivity 20 cases (33.3%), Tactile Sensitivity 19 cases (31.7%), while Visual sensitivity was the domain with least cases showing definite difference 7 (11.7%).

Table 1 Correlation between age and psychometric data (*n*=60)

	CARS-2	SSP total	RBS-R total	ASC-ASD-P
Child age at assessment				
r	−0.026	−0.312*	0.468*	0.317*
P	0.846	0.015*	<0.001*	0.014*

ASC-ASD-P, Anxiety Scale for Children with Autism Spectrum Disorder – Parent Version; CARS2, Childhood Autism Rating Scale, second edition; RBS-R, Repetitive Behavior Scale-Revised; SSP, short sensory profile.

Table 2 The relation between severity of ASD and the other psychometric data (*n*=60)

	CARS		Test of Sig.	*P*
	Mild to moderate (<36) (*n*=36)	Severe (≥36) (*n*=24)		
Total SSP score				
Min.–Max.	65.0–180.0	109.0–153.0	*t*=2.194*	0.032*
Median	140.1±20.93	129.5±12.93		
Anxiety score				
Min.–Max.	1.0–42.0	1.0–27.0	U=448.500	0.803
Median	13.0	16.0		
RBS-R total				
Min.–Max.	1.0–89.0	11.0–71.0	U=557.000	0.059
Mean ± SD	25.0	31.50		

ASD, autism spectrum disorder; CARS, Childhood Autism Rating Scale; RBS-R, Repetitive Behavior Scale-Revised; SSP, short sensory profile.

RBS-R (*P* value <0.001), and ASC-ASD-P Anxiety score (*P* value <0.001). Thus, the more severe ASD had a lower SSP score denoting a more definite difference in sensory processing. This also denotes that, with the severity of sensory impairment (lower SSP score), the repetitive behavior and anxiety symptoms are more frequent.

Also, Table 3 shows that there was a statistically significant positive correlation between RBS-R and ASC-ASD-P score (*P* value <0.001) (Table 4).

A multivariate regression analysis that included all parameters with significant univariate correlations showed that sensory impairment (lower SSP score)

was mostly associated with the severity of ASD (CARS-2 score) (Table 5).

The higher RBS-R was associated with the higher anxiety score ASC-ASD-P ($P<0.001$) and older age ($P=0.012$) (Table 6).

As for the ASC-ASD-P score, the most significant correlation was that with the RBS-R ($P<0.001$).

Discussion

The purpose of the present study was to investigate the relation between sensory characteristics, repetitive behavior, and anxiety symptoms on a sample of 60 children with ASD measured with the SSP (McIntosh *et al.*, 1999) RBS-R, and ASC-ASD-P (Rodgers *et al.*, 2016). The severity of the disorder was measured by CARS2 (Akoury-Dirani *et al.*, 2013).

Sensory processing and autism severity

Although the measurement instruments used to evaluate the severity of the disorder have been quite varied among previous studies, most of them found that severity is directly related to the degree of sensory impairments (Henshall, 2008). Studies have reported associations between overall autism severity and the presence of more sensory problems (Ben-Sasson *et al.*, 2008). Using the CARS as a measure of autism severity, Kern *et al.* (2006) found that total sensory profile scores correlated with autism severity in children with autism (Watson *et al.*, 2011). Our

Table 3 Correlations between psychometric data (*n*=60)

	CARS2	SSP	RBS-R
SSP			
r	–0.421*		
P	0.001*		
RBS-R			
r	0.263*	–0.600*	
P	0.043*	<0.001*	
ASC-ASD-P			
r	0.005	–0.555*	0.644*
P	0.970	<0.001*	<0.001*

ASC-ASD-P, Anxiety Scale for Children with Autism Spectrum Disorder – Parent Version; CARS2, Childhood Autism Rating Scale, second edition; RBS-R, Repetitive Behavior Scale-Revised; SSP, short sensory profile.

Table 4 Univariate and multivariate analysis for the parameters affecting total SSP score (*n*=60)

Total SSP score	Univariate		Multivariate[#]	
	r	*P*	B (95% CI)	*P*
Age	–0.312*	0.015*	–0.437 (–3.496–2.622)	0.770
Residence (urban=0, rural=1)	–0.255*	0.049*	–4.706 (–19.911–10.498)	0.528
Socioeconomic status	0.315*	0.014*	6.471 (–3.316–16.258)	0.185
CARS-2	–0.421*	0.001*	–0.981 (–1.800 – –0.162)	0.021*
ASC-ASD-P score	–0.555*	<0.001*	–0.550 (–1.187–0.086)	0.087
RBS-R total	–0.600*	<0.001*	–0.090 (–0.486–0.307)	0.644

ASC-ASD-P, Anxiety Scale for Children with Autism Spectrum Disorder – Parent Version; B, standardized coefficients; CARS2, Childhood Autism Rating Scale, second edition; CI, confidence interval; RBS-R, Repetitive Behavior Scale-Revised; SSP, short sensory profile. [#]All variables with $P<0.05$ were included in the multivariate. *Statistically significant at $P\leq0.05$.

Table 5 Univariate and multivariate analysis for the parameters affecting total RBS-R score (*n*=60)

RBS-R total	Univariate		Multivariate[#]	
	r	*P*	B (95% CI)	*P*
Age	0.468*	<0.001*	2.482 (0.568–4.396)	0.012*
CARS-2	0.263*	0.043*	0.538 (–0.021–1.097)	0.059
SSP score	–0.600*	<0.001*	–0.102 (–0.601 – 0.396)	0.682
ASC-ASD-P score	0.644*	<0.001*	0.970 (0.494–1.446)	<0.001*

ASC-ASD-P, Anxiety Scale for Children with Autism Spectrum Disorder – Parent Version; B, standardized coefficients; CARS2, Childhood Autism Rating Scale, second edition; CI, confidence interval; RBS-R, Repetitive Behavior Scale-Revised; SSP, short sensory profile. [#]All variables with $P<0.05$ were included in the multivariate. *Statistically significant at $P\leq0.05$.

Table 6 Univariate and multivariate analysis for the parameters affecting ASC-ASD-P score (*n*=60)

ASC-ASD-P score	Univariate		Multivariate[#]	
	r	*P*	B (95% CI)	*P*
Age	0.322*	0.012*	0.083 (–1.009–1.174)	0.880
SSP score	–0.555*	<0.001*	–0.002 (–0.290–0.286)	0.988
RBS total	0.644*	<0.001*	0.273 (0.133–0.413)	<0.001*

ASC-ASD-P, Anxiety Scale for Children with Autism Spectrum Disorder – Parent Version; B, standardized coefficients; CI, confidence interval; RBS, Repetitive Behavior Scale; SSP, short sensory profile. [#]All variables with $P<0.05$ were included in the multivariate.
*Statistically significant at $P\leq0.05$.

study results came in concordance with previous ones, where the sensory profile showed a significantly lower score in the severe group (P=0.032).

This is clarified in the effect of sensory processing on core autism symptoms. In a matter of fact, in confirmation of the importance of the role played by the sensory aspects even in the diagnosis, the fifth edition of the DSM, among the criteria for ASD, includes atypical sensory behaviors, thus introducing the "hyper- or hypo-reactivity to sensory input or unusual interest in sensory aspects of environment" (American Psychiatric Association APA, 2013). This role of sensory processing has been investigated in scarce yet elaborative studies on the neurobiological bases of sensory processing in ASD using functional MRI and electrophysiological and behavioral data (Gomot *et al*., 2002). It was also explained by Dunn (1997) in his proposed sensory processing model that was similar to another proposal by ICDL workgroups in 2005 (Greenspan and Wieder, 2008).

Results of SSP from the current study showed that those with "Definite difference" in sensory processing represented 63.3% of the cases, 23.3% were having a "Probable difference," and 13.3% had a "Typical performance." Notably, when probable and definite difference classifications were summed as an indicator of some degree of sensory processing differences, 86.6% of the sample of children with ASD was rated as having some degree of difference in sensory processing based on the SSP total score.

These results coincided with many previous research works that reported sensory processing abnormalities in 42%–88% of children with autism disorder. In a study with similar results, overall SSP results showed that most participants in this sample (82%) exhibited some degree of sensory processing difficulty (Baker *et al*., 2007). It is assumed that atypical sensory features are thought to result from aberrant sensory processing, and may be evident across all sensory spectrum (Brock *et al*., 2012).

Sensory profile distribution

In the current study, the SSP showed that Under-responsiveness/Seeks sensation was the domain with the highest percentage of those with the definite difference (65%) followed by Auditory filtering domain (46.7%), and then Low energy (40%), Taste/smell sensitivity (33.3%), and Tactile sensitivity (31.7%), whereas Visual/Auditory sensitivity was the domain with least cases showing definite difference (11.7%).

It agrees with the sensory processing sections of the SSP done by Tomchek and Dunn (2007) demonstrating that the highest reported definite differences in the ASD group included Under-responsiveness/Seeks sensation (86.1%), Auditory filtering (77.6%), Tactile sensitivity (60.9%), and Taste/smell sensitivity (54.1%).

These findings are in contrast to the Ermer and Dunn (1998) study where a low incidence of behaviors was reported within the sensory seeking. The difference between our results and this study could be attributed to different age groups as the patterns of the sensory abnormalities in children with autism are pervasive and multimodal and may change across age (Rogers and Ozonoff, 2006).

Similar to our study, a study, examining the different types of sensory-processing issues with the SSP, found that children with ASD consistently showed more sensory atypicality compared with typically developed (TD) group across all modalities. However, the strongest group differences were noted in the Under-responsiveness/Seeks sensation and Auditory-filtering sections (Kojovic *et al*., 2019). Watling *et al*. (2001) reported affection of all sensory modalities with specific affection of the tactile and taste/smell sensitivity, the auditory filtering, and the sensory seeking.

In addition, other previous studies reported that more than 98% of the ASD sample had significant differences in the Under-responsiveness/Seeks

Sensation section (Kern *et al.*, 2006). Analysis of section items indicated that the sample appeared to seek sensory input from multiple sensory systems (e.g., auditory, vestibular, tactile, proprioception). The sensory processing findings noted in this study reflect a pattern of dysfunctional sensory modulation; that is, children with ASD demonstrate difficulty with filtering and changing to sensory stimuli to develop an adaptive response. Sensory modulation has been defined as the capacity to regulate and organize the degree, intensity, and nature of responses to sensory input in a graded and adaptive manner. This supports findings of previous research in this domain (Tomchek and Dunn, 2007).

In view of these evidence, the specificity of sensory problems in the population with autism usually does not take into consideration the fact that several studies have found that individuals with autism tended to show a mixed type of sensory responsiveness; in other words, an individual would show atypical scores across all sensory profile quadrants, that is, sensory hyper-, hypo-sensitivity, seeking, and avoidance (Baranek *et al.*, 2006). It was hypothesized in previous research that, like repetitive behaviors, it is the frequency of sensory impairment rather than the systematic form that distinguishes individuals with autism from both typically developed individuals and other clinical groups (Uljarević, 2013).

Sensory processing and repetitive behaviors

In the present study, total SSP and RBS-R scores had a significant negative correlation, where repetitive and restricted behaviors are more severe in those with severe sensory dysfunction. These results are consistent with previous research describing the co-occurrence of repetitive behaviors and sensory response abnormalities in the ASD population (Uljarevic, 2013).

Di Renzo *et al.* (2017) studied the relation between sensory characteristics and repetitive behaviors using the same scales used in our studies on a sample of 50 preschoolers and their results were similar to ours.

Several other studies have addressed the relationship between sensory problems and repetitive behaviors. For example, Boyd *et al.* (2009) used RBS-R and Sensory Questionnaire to examine repetitive behaviors and sensory processing in 61 children with high functioning autism (HFA) aged 6–17 years with 64 typically developing children. Not surprisingly, children with HFA had more repetitive behaviors and sensory problems than individuals in the TD group (Uljarević, 2013).

Furthermore, a significant, positive association was found between the total repetitive behaviors scores and overall sensory problems, and this relationship remained significant after controlling for IQ. This was in studies by Boyd *et al.* (2009), Gabriels *et al.* (2013), and Chen *et al.* (2008).

It was hypothesized in literature that sensory problems are related to the stereotypic or repetitive behaviors displayed by children with ASD, and that the stereotypic behaviors reflect the child's attempt to lower arousal (self-calm) or increase arousal (sensory-seeking) (Henshall, 2008; Posar and Visconti, 2018).

In other words, it was proposed that repetitive behaviors might function as a soothing or stimulating mechanism for children with sensory dysfunction and this explains their relation with the severity of the sensory abnormality (Jussila *et al.*, 2020).

As for the relation between repetitive behaviors and severity of the disorder, RBS-R score was significantly related to CARS-2 score in our study. It coincides with many other studies investigating repetitive behaviors in children with ASD. This may reflect sound psychometric characteristics of both scales where their results about frequency and severity of a core feature of ASD correlated (Lam and Aman, 2007).

Repetitive behavior and anxiety

In previous studies, RRBs have been related to the presence of anxiety in individuals with ASD (Scahill *et al.*, 2015).

In a previous study, 58% of children with severe restricted/repetitive behavior at enrollment had elevated anxiety symptoms by age 11, compared with 41% of those with moderate, and 20% of those with mild restricted/repetitive behavior, respectively. Moderate and severe restricted/repetitive behavior were both associated with increased odds of elevated anxiety (moderate aOR: 2.5 [1.2–5.3]; severe aOR: 3.2 [1.4–7.5]). They proposed that restricted/repetitive behavior severity at the time of ASD diagnosis indicates risk for future anxiety symptoms (Uljarević, 2013).

In cross-sectional samples, scores on anxiety measures and scores on repetitive behavior measures show low-to-moderate correlations (i.e., r=0.15–0.45). In other studies, this association appeared stronger (Scahill *et al.*, 2015).

In our study, results showed a strong positive correlation between anxiety and repetitive behavior (r=0.644 and P value<0.001).

This could be explained by the hypothesis proposed in literature that RRBs are thought to be coping strategies that allow autistic participants to avoid or reduce the high level of anxiety resulting from being overwhelmed by the surrounding environment (van Steensel *et al*., 2011).

Anxiety in ASD and its relation with sensory processing

In the present study, 30% of the cases had significant anxiety symptoms based on ASC-ASD-P scores. Anxiety is a common co-occurring symptom in ASD. Studies report that between 22% and 84% of children are reported by parents to experience impairing anxiety (White *et al*., 2009).

In a meta-analysis, the prevalence of anxiety disorders (conceptualized as persistently elevated anxiety symptoms leading to significant distress or impairment) was estimated at 40% in ASD by middle childhood (van Steensel *et al*., 2011).

The extent to which anxiety disorder estimates in children with ASD are biased by the inconsistent differentiation of anxiety and ASD symptoms is unclear (Ginsburg *et al*., 2011).

This wide range could be explained by more than one factor. First, the fact that participants with ASD have difficulties in communicating their emotional states; however, several studies have shown a high prevalence of anxiety in those participants (Szatmari *et al*., 2006).

Second, as evidenced through the study of Kerns *et al.* (2014) who examined anxiety presentations in young people with ASD and concluded that there was evidence for varied manifestations of anxiety in ASD. In their sample, 17% of children presented with "traditional" anxiety, 15% presented with anxiety altered in its presentation by its interaction with ASD-related characteristics, and 31% presented with a combined profile (Kerns *et al*., 2014).

White *et al.* (2015) examined the metric and latent factor equivalence of the Multidimensional Anxiety Scale for Children across three groups: young people with an anxiety disorder, young people with ASD, and a healthy control group, and concluded that the factor structure was different in the ASD group, further supporting the notion of the varied manifestations of anxiety in ASD.

Lecavalier *et al*. (2014) systematically reviewed 10 anxiety measures for use in clinical trials in ASD and concluded that using measures developed for use with typically developing children "may be less than satisfactory" with children with ASD. This was a third explanation to the contradictory and very wide range of anxiety level in individuals with ASD reported in literature. What explains our results where only 30% had significant anxiety symptoms is that we used a scale that was adapted to be used for children with ASD, making the measurement more specific. Yet it was not that satisfactory with younger nonverbal children (Rodgers *et al*., 2016).

As for the relation with sensory abnormality in our study, the ASC-ASD-P score was significantly correlated with the SSP score (P<0.001). This was in agreement with many studies that reported that anxiety in ASD appears to be associated with sensory processing abnormalities (Green and Ben-Sasson, 2010).

To sum up, the causes of anxiety in ASD could be explained by having problems in understanding of emotional states and intentions of others, together with over-reaction and inability to block-out insignificant environmental sensory stimuli, so that individuals with autism might experience their world as highly unpredictable, making even the most simple situations and events uncertain and difficult (Magiati *et al*., 2017).

Conclusion

We concluded from our study that sensory processing is common among children with ASD and is more evident in older ones. Furthermore, it is significantly related to the severity of ASD, repetitive behaviors, and anxiety symptoms. The use of sensory profile as a trait marker for autism is recommended as well as using these scales for individualization of the characteristics of sensory profile and the behavioral response and anxiety symptoms in basic assessment and follow-up. Finally, we promote changes in therapeutic intervention through the possibility of choosing and designing the most appropriate intervention based on the individualized profile of the child.

Aknoweldgements

The authors would like to express gratitude to the whole staff of Alexandria University Clinic for being cooperative with the research team.

Ethics approval and consent to participate

A verbal consent (as this is more preferred by our community and this was approved by the ethical committee) to participate in the study was obtained from parents of all children as well as approval of the current research from ethical committee of lexandria University (reference number is not applicable).

Consent for publications

All authors are accepting publications.

Availability of data and materials

All data were accessible by the internet as shown in details of references section.

Funding

This study was not funded by any organizations nor individuals.

Authors contributions

HA revised the work and she attributed to the conception of this work and interpretation of data. SG played an important role in the conception of this work and study design also in interpretation of data. AZ played a major role in the acquisition of data and drafted the work. All authors have read and approved the manuscript.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

Abbreviations: ASC-ASD-P, Anxiety scale for children with autism spectrum disorder – parent version; ASD, Autism Spectrum Disorder; CARS2, Childhood Autism Rating Scale, second edition; RBS-R, Repetitive Behavior Scale-Revised; RRB, Repetitive and restricted behaviors; SSP, Short Sensory Profile; TD, Typically Developing.

References

Advanced Center for Intervention and Services Research (ACISR) (2016). K-SADS-PL DSM-5. Child and Adolescent Research and Education (CARE) Program, Yale University.

Akoury-Dirani L, Alameddine M, Salamoun M (2013). Validation of the Lebanese Childhood Autism Rating Scale-Second Edition-Standard Version. Res Autism Spectr Disord 7:1097–1103.

American Psychiatric Association (APA) (2013). Diagnostic and statistical manual of mental disorders (DSM). 5th ed. Washington: APA.

Baker A, Lane A, Angley M, Young R (2007). The relationship between sensory processing patterns and behavioural responsiveness in autistic disorder: a pilot study. J Autism Dev Disord 38:867–875.

Baranek GT, David FJ, Poe MD, Stone WL, Watson LR (2006). Sensory Experiences Questionnaire: Discriminating sensory features in young children with autism, developmental delays, and typical development. J Child Psychol Psychiatry Allied Discip 47:591–601.

Ben-Sasson A, Cermak S, Orsmond G, Tager-Flusberg H, Kadlec MB, Carter A (2008). Sensory clusters of toddlers with autism spectrum disorders: differences in affective symptoms. J Child Psychol Psychiatry 49:817–825.

Boyd BA, McBee M, Holtzclaw T, Baranek GT, Bodfish JW (2009). Relationships among repetitive behaviors, sensory features, and executive functions in high functioning autism. Res Autism Spectr Dis 3:959–966. doi:10. 1016/j. rasd.2009.05.003

Brock M, Freuler A, Baranek G, Watson L, Poe M, Sabatino DiCriscio A (2012). Temperament and sensory features of children with autism. J Autism Dev Disord 42:2271–2284.

Burns CO, Dixon DR, Novack M, Granpeesheh D (2017). A systematic review of assessments for sensory processing abnormalities in autism spectrum disorder. Rev J Autism Dev Disord 4:209–224.

Chen YH, Rodgers J, McConachie H (2008). Restricted and repetitive behaviours, sensory processing and cognitive style in children with autism spectrum disorders. J Autism Dev Disord 39:635–642.

Di Renzo M, Bianchi di Castelbianco F, Vanadia E, Petrillo M, Racinaro L, Rea M (2017). Sensory processing and repetitive behaviors in clinical assessment of preschool children with autism spectrum disorder. J Child Adolesc Behav 5:342.

Dunn W (1997). The impact of sensory processing abilities on the daily lives of young children and their families: A conceptual model. Infants Young Child 9:23–35.

Ermer J, Dunn W (1998). The sensory profile: a discriminant analysis of children with and without disabilities. Am J Occup Ther 52:283–290.

Gabriels RL, Agnew JA, Pan Z, Holta KD, Reynoldsa A, Laudenslagerb ML (2013). Biol Psychol 9:262–268.

Gadad B, Hewitson L, Young K, German D (2013). Neuropathology and animal models of autism: genetic and environmental factors. Autism Res Treat 2013:731935.

Gaye Ambler P, Eidels A, Gregory C (2015). Anxiety and aggression in adolescents with autism spectrum disorders attending mainstream schools. Res Autism Spectr Disord 18:97–109.

Geschwind DH (2009). Advances in autism. Annu Rev Med 60:367–380.

Ginsburg G, Kendall P, Sakolsky D, Compton S, Piacentini J, Albano A, *et al.* (2011). Remission after acute treatment in children and adolescents with anxiety disorders: findings from the CAMS. J Consult Clin Psychol 79:806–813.

Gomot M, Giard MH, Adrien JL, Barthélémy C, Bruneau N (2002). Hypersensitivity to acoustic change in children with autism: electrophysiological evidence of left frontal cortex dysfunctioning. Psychophysiology 39:577–584.

Green SA, Ben-Sasson A (2010). Anxiety disorders and sensory over-responsivity in children with autism spectrum disorders: is there a causal relationship? J Autism Dev Disord 40:1495–1504.

Greenspan S, Wieder S (2008). Diagnostic classification in infancy and early childhood. In: Tasman A, Kay J, Lieberman J editors. Psychiatry. 3rd ed. USA: Wiley Online Library. 679–688.

Henshall C (2008). Unusual sensory experiences in people on the autism spectrum. PhD Thesis. University of Warwick publication service.

ICDL (2005). Diagnostic manual for infancy and early childhood. Bethesda: ICDL.

Jussila K, Mattila ML, Moilanen I, Ebeling H, Joskitt L, Kielinen M (2020). Sensory abnormality and quantitative autism traits in children with and without autism spectrum disorder in an epidemiological population. J Autism Dev Disord 50:180–188.

Kern J, Trivedi M, Garver C, Grannemann B, Andrews A, Savla J, *et al.* (2006). The pattern of sensory processing abnormalities in autism. Autism 10:480–494.

Kerns C, Kendall P, Berry L, Souders M, Franklin M, Schultz R, *et al.* (2014). Traditional and atypical presentations of anxiety in youth with autism spectrum disorder. J Autism Dev Disord 44:2851–2861.

Kojovic N, Ben Hadid L, Franchini M, Schaer M(2019). Sensory processing issues and their association with social difficulties in children with autism spectrum disorders. J Clin Med 8:E1508.

Lam KS, Aman MG (2007). The repetitive behavior scale-revised: independent validation in individuals with autism spectrum disorders. J Autism Dev Disord 37:855–866.

Lecavalier L, Wood J, Halladay A, Jones N, Aman M, Cook E, *et al.* (2014). Measuring anxiety as a treatment endpoint in youth with autism spectrum disorder. J Autism Dev Disord 44:1128–1143.

Magiati I, Lerh JW, Hollocks MJ, Uljarevic M, Rodgers J, McConachie H, *et al.* (2017). The measurement properties of the Spence Children's Anxiety Scale–Parent Version in a large international pooled sample of young people with autism spectrum disorder. Autism Res 10:1629–1652.

Masi A, DeMayo MM, Glozier N, Guastella AJ (2017). An overview of autism spectrum disorder, heterogeneity and treatment options. Neurosci Bull Neurosci Bull 33:183–193.

Matuschek T, Jaeger S, Stadelmann S, Dölling K, Grunewald M, Weis S, *et al.* (2016). Implementing the K-SADS-PL as a standard diagnostic tool: effects on clinical diagnoses. Psychiatry Res 236:119–124.

McIntosh DN, Miller LJ, Shyu V, Dunn V (1999). Overview of the short sensory profile (SSP). In: Dunn W editor. The sensory profile. San Antonio, TX: Psychological Corporation. 59–74.

Posar A, Visconti P (2018). Sensory abnormalities in children with autism spectrum disorder. J Pediatr (Rio J) 94:342–350.

Rodgers J, Wigham S, McConachie H, Freeston M, Honey E, Parr JR (2016). Development of the Anxiety Scale for Children with Autism Spectrum Disorder (ASC-ASD). Autism Res 9:1205–1215.

Rogers S, Ozonoff S (2006). Annotation: what do we know about sensory dysfunction in autism? A critical review of the empirical evidence. J Child Psychol Psychiatry 46:1255–1268.

Scahill L, Aman MG, Lecavalier L, Halladay AK, Bishop SL, Bodfish JW, *et al.* (2015). Measuring repetitive behaviors as a treatment endpoint in youth with autism spectrum disorder. Autism 19:38–52.

Silver WG, Rapin I (2012). Neurobiological basis of autism. Pediatr Clin North Am 59:45–61.

Szatmari P, Georgiades S, Bryson S, Zwaigenbaum L, Roberts W, Mahoney W, *et al.* (2006). Investigating the structure of the restricted, repetitive behaviours and interests domain of autism. J Child Psychol Psychiatry Allied Discip 47:582–590.

Tomchek SD, Dunn W (2007). Sensory processing in children with and without autism: a comparative study using the short sensory profile. Am J Occup Ther 61:190–200.

Uljarevic M (2013). Instruments for measuring repetitive behaviours. J Chem Inf Model 53:1689–1699.

Uljarević M (2013). Repetitive behaviours, anxiety and sensory problems in children with autism and correlates of anxiety in their parents. PhD Thesis. Cardiff University: Cardiff, Wales.

van Steensel FJA, Bögels SM, Perrin S (2011). Anxiety disorders in children and adolescents with autistic spectrum disorders: a meta-analysis. Clin Child Fam Psychol Rev 14:302–317

Watling R, Deitz J, White O (2001). Comparison of sensory profile scores of young children with and without autism spectrum disorders. Am J Occup Ther 55:416–423.

Watson L, Patten E, Baranek G, Poe M, Boyd B, Freuler A, *et al.* (2011). Differential associations between sensory response patterns and language, social, and communication measures in children with autism or other developmental disabilities. J Speech Lang Hear Res 54:1562–1576.

White S, Oswald D, Ollendick T, Scahill L (2009). Anxiety in children and adolescents with autism spectrum disorders. Clin Psychol Rev 29:216–229.

White S, Lerner M, McLeod B, Wood J, Ginsburg G, Kerns C, *et al.* (2015). Anxiety in youth with and without autism spectrum disorder: examination of factorial equivalence. Behav Ther 46:40–53.