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Sensory processing abilities and their relation to participation in leisure activities among children with high-functioning autism spectrum disorder (HFASD)

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ABSTRACT

Children with autism may have atypical sensory processing abilities, which are known to impact child's performance and participation. However, lack of information exists regarding the expression of these abilities in specific groups on the spectrum, as children with high-functioning autism spectrum disorder (HFASD). This study aimed to characterize the sensory processing abilities of children with HFASD and examine their relationship to participation in leisure activities. Participants were 50 children aged 6–11 years: 25 children with HFASD and 25 with typical development. Sensory processing abilities were examined by the short sensory profile (SSP). Participation was assessed by the children's assessment of participation and enjoyment (CAPE). Children with HFASD had atypical sensory processing abilities. They also had lower participation in leisure activities expressed in limited range of activities, performed less often, mainly alone and at home. Their atypical sensory processing patterns were correlated with lower participation, specifically in social, physical and informal activities. In conclusion, children with HFASD may have atypical sensory processing abilities and restricted participation. Intervention should refer to each of these parameters and to the relationship between them in order to enable optimal inclusion of children with HFASD in society.

1. Introduction

High-functioning autism (HFASD) refers to individuals with average or above average intelligence with a diagnosis of Autism, Asperger's syndrome, or pervasive developmental disorders not otherwise specified (PDD-NOS). It is distinguished by its relative preservation of linguistic and cognitive development (Klin & Vokmar, 2003; Volkmar & Lord, 2007), so that individuals with HFASD may function well in literal contexts but have difficulty using language in a social context, for example; lack of comprehension of social situations, lack of initiation and sharing with others mutually and reciprocally (Klin, McPartland, & Volkmar, 2005).

Because children in this group are able to use language skills in order to communicate and they are independent in activities of daily living such as self-care and organization in the classroom (Klin & Vokmar, 2003), they are often integrated in regular school and classroom settings. Nonetheless, as mentioned above, these children show signs of diversity in everyday behavior, particularly in the areas of social communication and social interaction when compared to typical children (American Psychiatric Association [APA], 1994).

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Additional characteristics often found among children found on the autistic spectrum refer to their sensory processing abilities. *Sensory processing* refers to the way the nervous system receives, organizes and interprets sensory input. Optimal sensory processing enables a person to respond adaptively to environmental demands and engage meaningfully in daily occupations (Humphry, 2002; Miller & Lane, 2000).

Dunn's model of sensory processing (1997) refers to the relationship between neurological thresholds and self-regulation strategies for adaptive behavior. The neurological thresholds continuum ranges from high thresholds (when high intensity stimuli is necessary in order to respond), to low thresholds (when low intense stimuli provokes a response). The continuity of self-regulation ranges between passive strategy (individuals who do not counter act to unpleasant stimuli), and active strategies (individuals who act to control the amount and type of sensory input) (Dunn, 1997). Based on this interaction, Dunn's model classified patterns of sensory processing into four sub-types. (1) *Sensation Seeking*, which represents high thresholds and an active self-regulation strategy. These individuals energetically engage in actions that add more intense sensations to their bodies and because of these urges have a tendency to being inattentive and unfocused during learning tasks and social interactions (Dunn, 2007). (2) *Sensation Avoiding*, which includes low thresholds and an active self-regulation strategy. These individuals' behavior is characterized by rigid and uncompromising rituality, difficulty in accommodation and transition. They often feel threatened by sensation and therefore tend to adopt avoidance behavior (Dunn, 2007). (3) *Sensation Sensitivity*, which includes low thresholds and a passive self-regulation strategy. These children respond to sensation faster, with more intensity or for a longer duration than those with typical sensory responsiveness. Their behavior may range from active, negative, impulsive or aggressive responses to passive withdrawal or avoidance of sensation (Dunn, 2007). (4) *Low Registration*, which represents a high threshold and a passive self-regulation strategy. These individuals tend to disregard or not respond to sensory stimuli in their environment. They appear not to detect incoming sensory information, and show a lack of responsiveness. Because of this they seem to appear introverted, apathetic or lethargic with a lack of inner drive to initiate exploration (Dunn, 2007).

Among children with ASD, atypical sensory processing may be displayed by sensory over-responsiveness and/or sensory under-responsiveness (e.g. Baranek, David, Poe, Stone, & Watson, 2006; Ben-Sasson et al., 2009; Dunn, Myles, & Orr, 2002; Dunn, 2001; Kientz & Dunn, 1997; Leekam, Nieto, Libby, Wing, & Gould, 2007; Taylay-Ongan & Wood, 2002; Watling, Deitz, & White, 2001). Yet, additional knowledge is needed in regard to the sensory processing abilities of specific groups on the autistic spectrum, such as children with HFASD, who, as mentioned above are usually integrated in regular life settings, for instance regular schools. Moreover, in order to optimize their inclusion in society, studies should further examine how their sensory processing abilities affect their patterns of participation in daily living. This also coincides with the concept of the World Health Organization [WHO] (2001) which emphasized the importance of referring to the relationship between disability, performance and participation in daily living activities. Participation is defined by the WHO as a vital part of human development and life experience through which we acquire skills and competencies and find purpose and meaning in life (2001).

Law et al. (2004) highlighted the need to refer to different dimensions of participation: the range of activities in which the individuals participate in, as well as the context in which these activities are performed—*with whom* do they do the activity (e.g. parent or friend), *where* do they do the activity (e.g. at home or at a friend's house), and how much do they *enjoy* doing the activity. Law et al. (2004) also emphasized the importance of referring to the child's participation in leisure activities. These activities may be divided into formal, which are structured with defined rules and goals such as, youth movements, school clubs and team sports, and informal activities which usually do not require advance planning and are initiated by the child such as playing games or hanging out with friends (King et al., 2004; Law, 2002).

Existing studies show that children with developmental delays participate less in leisure activities compared to typical children (Ashburner, Ziviani, & Rodger, 2008; Hilton, Crouch, & Israel, 2008; King et al., 2003; Potvin, Prelock, & Snider, 2008). Studies also highlighted the relationship between specific abilities and participation. For example, studies which examined the participation of children with physical disabilities, found that cognitive, motor and communication abilities, influence children's participation and enjoyment in activities (Heah, Case, McGuire, & Law, 2007; King et al., 2003; Law et al., 2004, 2006). Wagner et al. (2002), who studies children with disabilities, found that children with autistic spectrum disorders (ASD) showed restricted participation in recreational activities in comparison to peers with other disabilities. Additional studies reported that these children live secluded lives with very little social interaction out of school hours (Hilton et al., 2008; Wagner et al., 2002).

The present study aimed to elaborate the knowledge about the specific sensory processing characteristics of children with HFASD and to their relationship to participation patterns in leisure activities.

2. Materials and methods

2.1. Participants

Participants consisted of 50 children ages 6–11 years (mean = 8.4 ± 1.44). Twenty-five were children with HFASD (17 boys and 8 girls) and 25 were typically developing children (18 boys and 7 girls). All children attended regular education classes, were born full term, and had an IQ of at least 70. This last inclusion criterion was affirmed in the control group by parent report and in the HFASD group by a psychological report. In order to establish that the children in the HFASD group were in fact high-functioning, parents of these children completed the childhood asperger syndrome test (CAST; Scott, Baron-Cohen, Bolton, &

Table 1
Socio-demographic characteristics of participants.

Characteristic	HFASD ($N = 25$) Mean (SD)	Typical children ($N = 25$) Mean (SD)
Boys	17	18
Girls	8	7
Mean age	8.41 (1.44)	8.41 (1.47)
Number of children in family	3.40 (1.32)	4.72 (1.24)
Fathers education in years	15.96 (1.59)	16.04 (1.33)
Mothers education in years	16.60 (1.95)	16.44 (1.82)
Income		
High	88%	84%
Average	12%	16%

Brayne, 2007). Their initial inclusion was based on DSM-IV criteria and was reported by a child neurologist, child psychiatrist or child psychologist evaluations, 6 of which were assessed by the autism diagnostic observation schedule (ADOS: Lord, Rutter, DiLavore, & Risi, 1999). The mean age of diagnosis was 4.0. All children were diagnosed as HFASD, 3 of which were diagnosed specifically with Asperger syndrome. Exclusive criteria in both samples were any major neurological disorder, attention deficit or hyperactivity disorder or children who take medication on a regular basis that affect the nervous system. Table 1 summarizes the socio-demographics of the participants.

2.2. Instruments

2.2.1. A demographic questionnaire which was composed by the researcher to be filled out by the children's parents

The questionnaire included questions related to personal information about the child and his family such as: age, gender, socio–economic status, place of residence. In addition, there were questions related to the health condition of the child.

2.2.2. The childhood Asperger syndrome test (CAST) (Scott, Baron-Cohen, Bolton, & Brayne, 2007)

This questionnaire includes 37 items designed for parents, to be able to identify children between the ages 5–11 years who meet criteria for HFASD. The score used to determine HFASD is a cut-off of 15 (15 items in which the patterns of behavior differ from typical behavior and nevertheless fit the criteria of high performance) to detect this population. In the present study, the use of this tool ensured the inclusion of children with HFASD.

2.2.3. The short sensory profile (SSP) (McIntosh, Miller, Shyu, & Dunn 1999)

This is a shortened version of the diagnostic sensory profile (Dunn, 1999), a parent or caregiver questionnaire, designed for children aged 3–10 years. The SSP evaluates the sensory processing patterns of children in everyday life. It is composed of 38 items divided into seven categories: tactile sensitivity, taste/smell sensitivity, movement sensitivity, under-responsive/seeks sensation, auditory filtering, low energy/weak, and visual/auditory sensitivity. Scoring is on a Likert scale of 1–5. Results determine the classification of the behavior of the child in one of three groups: typical performance (scores at or above the point 1 SD below the mean), ranges 155–190; probable difference (scores at or above the point 2 SD below the mean but lower than 1 SD below the mean), ranges 142–154; definite difference (scores below the point 2 SD below the mean), ranges 38–141. Internal reliability of the test range from .47 to .90. Content and construct validity was established.

2.2.4. Children's assessment of participation and enjoyment (CAPE) (King et al., 2004)

The CAPE is a 55-item questionnaire based on the child's report. It is designed to examine how children and youth aged 6–21 years, participate in everyday activities outside of their school curriculum in five dimensions of participation: diversity (number of activities done), intensity (frequency of participation measured as a function of the number of possible activities within a category), enjoyment of activities, as well as information about the context in which children and youth participate in these activities, i.e. with whom and where they participate. There are three levels of scoring for the CAPE: overall participation scores; scores for two domains (formal activities–structured activities that involve rules or goals and have a formally designated coach, leader, or instructor, and informal activities, which have little or no planning and are often initiated by oneself); scale scores for five types of activities (recreational, active physical, social, skill-based, self-improvement). Test–retest reliability was evaluated on a group of 48 children with disabilities. Overall participation and the formal and informal domains scores ranged from .64 to .86. The diversity and intensity scores for the activity types showed reliabilities ranging from .67 to .81. In Israel, the tool has been translated into Hebrew by the Department of Occupational Therapy at the University of Tel Aviv. Pilot studies have been done with the CAPE which is sensitive in distinguishing between different cultures (Engel-Yeger, Jarus, & Law, 2007) and between typical populations and children with CP (Engel-Yeger, Jarus, Anabi, & Law, 2009). In this study, scoring for the CAPE was as following: for the dimension *with whom*, a score of 0 was recorded if the child participated in the activity on his own. If participation included anyone otherwise himself, a score of 1 was recorded. For the dimension *where*, a score of 0 was recorded if the child participated in the activity in his home. If participation included anywhere outside his home, a score of 1 was recorded.

2.3. Procedure

After obtaining ethical approval from the Israeli Ministry of Education in Jerusalem, to conduct the study, participants were recruited through a voluntary convenience sample from 3 elementary schools with inclusive classes for children with HFASD. Letters of request to participate in the study were sent out to the parents. Each request included an explanation about the aim of the research, a letter of confidentiality and a form of consent. Parents of 27 children with HFASD and 30 typically developing children volunteered to participate in the study and filled the demographic questionnaire. For the HFASD sample, 25 children met the inclusion criteria. Out of the typically developing children, 25 were age and gender matched. The children were invited to an occupational therapy clinic with one or both parents to fill out assessments and questionnaires. While the researcher administered the CAPE with the children, parents filled out the SSP.

2.4. Data analysis

In order to confirm the significance of differences in sensory processing on the total scores of the SSP between HFASD and control groups, a *t*-test was used. A multivariate analysis of variance (MANOVA) was used to examine the differences in sensory processing on the SSP sections. Comparisons between HFASD and control groups for all the CAPE dimensions were completed, using the ANOVA. The correlations between the SSP scores and CAPE scores were explored using the Pearson correlation. The level of significance was set at .05.

3. Results

3.1. Sensory processing abilities of children with HFASD, in comparison to typical children

MANOVA revealed significant group differences on all SSP factor scores ($F_{(1,48)} = 19.3$, $p \leq .0001$). Significant differences between the groups were found in regard to all SSP sections (see Table 2), as well as in SSP total ($t = 19.3$, $p \leq .0001$): participants with HFASD obtained a total mean SSP score of 105.4 (SD = 13.85), which fits the ''definite difference'' range, in comparison to the typically developing group who scored in the ''typical performance'' range with a total mean SSP score of 173.36 (SD = 10.82). In the HFASD group, all 25 children were classified in the ''definite difference'' range.

3.2. Differences between the groups in participation patterns

3.2.1. Diversity

In general, children with HFASD participated in 50% out of the 55 CAPE activities, while the controls participated in 70% of the activities.

3.2.2. Intensity dimension

For intensity, two scores were obtained. One consisted on the total general frequency of all 55 items, and the second referred to the personal intensity and was based only on the number of activities in which the child participated.

Significant differences were seen between the children with HFASD and the control group in the general ($F_{(1,42)} = 6.2$, $p \leq .0001$) and personal ($F_{(1,42)} = 3.2$, $p \leq .002$) intensity scores, meaning that even in the activities in which the HFASD children did participate, the level of intensity was lower. As presented in Table 3, children with HFASD significantly demonstrated lower participation intensity in social activities and in informal domain, compared to controls.

3.2.3. ''With whom'' dimension

Children with HFASD performed significantly more activities on their own compared to controls, in most CAPE scales (see Table 4).

Table 2
Performance classification on the SSP sections in each group.

Factors	HFASD ($N = 25$) Mean (SD)	Typical ($N = 25$) Mean (SD)	$F(1,48)$	(η^2)
Tactile sensitivity	19.28 (5.28)	31.28 (3.51)	89.43***	.65
Taste/smell sensitivity	9.08 (2.67)	17.36 (2.39)	132.86***	.73
Movement sensitivity	11.24 (2.94)	13.80 (1.91)	13.25**	.21
Under-responsive/seeks sensation	19.04 (4.35)	32.84 (2.01)	206.88***	.81
Auditory filtering	14.68 (2.68)	25.36 (2.67)	198.25***	.80
Low energy/weak	19.88 (4.13)	28.16 (2.40)	74.79***	.60
Visual/auditory sensitivity	12.20 (4.02)	24.56 (0.96)	223.47***	.82

** $p < .01$.
*** $p < .0001$.

Table 3
Comparison of CAPE scores between children with HFASD and typical children in "intensity" dimension.

Activities	HFASD ($N = 25$) Mean (SD)	Typical ($N = 25$) Mean (SD)	F, t	η^2
Recreational	4.59 (.58)	4.71 (.56)	$F_{(1,42)} = .503$	.01
Physical	4.49 (.94)	4.01 (1.05)	$F_{(1,42)} = 2.43$	.05
Social	3.22 (.64)	4.12 (.57)	$F_{(1,42)} = 24.14^{***}$	.36
Skill-based	4.32 (1.21)	4.61 (1.02)	$F_{(1,42)} = .77$	.001
Self-improvement	4.79 (.64)	4.71 (.54)	$F_{(1,42)} = .22$	.007
Formal	4.40 (1.01)	4.88(.80)	$F_{(1,42)} = 1.56$	.03
Informal	4.08 (.37)	4.41 (.38)	$F_{(1,42)} = 45.56^{**}$	.48
Total personal intensity	4.14 (.34)	4.48 (.39)	$t_{(1,48)} = 3.25^{**}$	
Total general intensity	2.09 (.53)	3.10 (.60)	$t_{(1,48)} = 6.23^{***}$	

** $p < .01$.
*** $p < .0001$.

Table 4
MANOVA comparison of CAPE scores between children with HFASD and typical children in "with whom" dimension.

Activities	HFASD ($N = 25$) Mean (SD)	Typical ($N = 25$) Mean (SD)	F, t	η^2
Recreational	.41 (.18)	.81 (.16)	$F_{(1,42)} = 60.09^{***}$	.58
Physical	.88 (.17)	.97 (.07)	$F_{(1,42)} = 4.81^{***}$	.10
Social	.67 (.18)	.88 (.13)	$F_{(1,42)} = 18.83^{***}$	.31
Skill-based	.83 (.32)	.96 (.09)	$F_{(1,42)} = 3.67^{***}$	.08
Self-improvement	.71 (.21)	.68 (.16)	$F_{(1,42)} = .30$	.007
Formal	.91 (.15)	.96(.09)	$F_{(1,42)} = 1.56$	.03
Informal	.59 (.13)	.82 (.10)	$F_{(1,42)} = 45.56^{***}$	.48
Total	.64 (.12)	.84 (.08)	$t_{(1,48)} = 6.99^{***}$	

*** $p < .0001$.

3.2.4. "Where" dimension

Children with HFASD tended to perform recreational activities ($F_{(1,42)} = 44.08$, $p \leq .0001$) and Informal activities more at home than the controls (see Table 5).

3.2.5. Enjoyment dimension

As presented in Table 6, children with HFASD, showed significantly less enjoyment when participating in activities as compared to controls. This was presented in total score of this domain and specifically in recreational, physical, social, formal and informal activities.

3.3. Relationship between sensory processing abilities and participation patterns among children with HFASD

Better general sensory processing abilities (presented in higher total SSP score) was significantly correlated with higher general intensity of participation (presented in the total intensity score of the CAPE) ($r = .51$, $p = .05$).

When referring to SSP sections, the higher the tactile sensitivity, the higher the intensity of participation in physical activities ($r = -.54$, $p = .01$). Children with higher taste/smell sensitivity had lower participation intensity ($r = .41$, $p = .05$), they performed more recreational activities with others ($r = -.52$, $p = .01$) and enjoyed them less ($r = .53$, $p = .01$). Children

Table 5
MANOVA comparison of CAPE scores between children with HFASD and typical children in "where" dimension.

Activities	HFASD ($N = 25$) Mean (SD)	Typical ($N = 25$) Mean (SD)	F, t	η^2
Recreational	.59 (.18)	.29 (.08)	$F_{(1,42)} = 44.08^{***}$	.51
Physical	.88 (.11)	.78 (.31)	$F_{(1,42)} = 2.36$	.53
Social	.66 (.09)	.65 (.07)	$F_{(1,42)} = .324$	.00
Skill-based	.96 (.09)	.90 (.23)	$F_{(1,42)} = 1.30$	.03
Self-improvement	.52 (.10)	.51 (.15)	$F_{(1,42)} = .079$	.00
Formal	.97(.05)	.94 (.88)	$F_{(1,42)} = 1.51$	.03
Informal	.63 (.08)	.48 (.07)	$F_{(1,42)} = 39.56^{***}$	.45
Total	.69 (.07)	.55 (.07)	$t_{(1,48)} = 6.65^{***}$	

*** $p < .0001$.

Table 6
MANOVA comparison of CAPE scores between children with HFASD and typical children in enjoyment dimension.

Activities	HFASD ($N = 25$) Mean (SD)	Typical ($N = 25$) Mean (SD)	F, t	η^2
Recreational	4.50 (.36)	4.21 (.39)	$F_{(1,42)} = 6.33^{***}$	.13
Physical	4.54 (.42)	4.30 (.52)	$F_{(1,42)} = 2.91^{***}$	.06
Social	4.61 (.25)	4.20 (.38)	$F_{(1,42)} = 18.0^{***}$	.30
Skill-based	4.56 (.40)	4.37 (.68)	$F_{(1,42)} = 1.27$	.03
Self-improvement	3.77 (.48)	3.70(.54)	$F_{(1,42)} = .19$	.00
Formal	4.41(.34)	3.97 (.61)	$F_{(1,42)} = 9.83^{**}$	.17
Informal	4.38 (.32)	4.14 (.30)	$F_{(1,42)} = 6.88^{***}$	.12
Total	4.38 (.31)	4.13 (.31)	$t_{(1,48)} = 2.83^{**}$	

** $p < .01$.
*** $p < .0001$.

with higher movement sensitivity performed more activities in their home ($r = .44$, $p = .05$) particularly in recreational ($r = .49$, $p = .01$) and informal activities ($r = .42$, $p = .03$). Children with a higher tendency to sensory seeking, performed more activities in their home ($r = .40$, $p = .04$), particularly in self-improvement activities ($r = .41$, $p = .05$). Children with higher visual or auditory sensitivity had a higher tendency to perform self-improvement activities with others ($r = -.48$, $p = .05$). Children with lower energy levels, had a higher tendency to perform activities with others ($r = -.41$, $p = .04$), specifically in self-improvement activities ($r = -.41$, $p = .05$) and informal activities ($r = -.39$, $p = .05$).

4. Discussion

The present study confirmed the existence of atypical sensory processing abilities among the children with HFASD and found that these abilities were related to participation patterns of these children. The atypical sensory processing abilities among children with HFASD, as presented in this study were expressed in the total SSP score as well as in the different sensory modalities. This strengthens the few previous studies in this area (e.g. Dunn et al., 2002; Hilton, Graver, & LaVesser, 2006; Myles et al., 2004).

4.1. Differences in participation patterns between children with HFASD and typical peers

The present study showed that children with HFASD in comparison to typical children participated in a limited range of activities, less often, with a narrower group of other participants. They also participated in activities located mainly in their homes. This was specifically related to social and informal activities. These findings support the recent study of Hilton et al. (2008) which have used the CAPE and assessed the participation in daily life among 52 children with HFASD in similar age range as in the present study. These results may be explained by the diagnostic characteristics of children with HFASD according to which they have difficulties in creating social relationships and promote communication with their peers, difficulties in being flexible and adapt easily to transition. This may be also related to the lower enjoyment level presented among the children with HFASD, which may experience stress and anxiety when participating in leisure activities, which may therefore impact their ability to experience enjoyment (DeGrace, 2004; Larson, 2006).

The results of the present study strengthens previous reports (e.g. Hilton et al., 2008) and represents the CAPE as a sensitive tool for evaluating participation in leisure activities of children with HFASD, by enabling the child to provide his/her direct point of view.

4.2. The relationship between sensory processing abilities and participation patterns among children with HFASD

Recent studies which referred to possible negative impacts of atypical sensory processing on participation of children with HFASD mainly focused on academic performance (e.g. Ashburner et al., 2008; Baker, Angley, & Young, 2008). The present study highlighted the relevance of referring to the impacts of atypical sensory processing on daily leisure participation as well.

In general, the present study depicted that the more severe the sensory processing impairment, the more limited was the diversity and intensity of participation in leisure activities. Specifically, however, children with tactile sensitivity participated more intensely in physical activities. Physical activities also involve intensive proprioceptive and vestibular stimuli. These somatosensory stimuli might provide enjoyment and satisfaction and enhance participation even if tactile sensitivity exists. Moreover, the physical activities included in the CAPE are variable. Thus, children with HFASD enable to choose specific activities in which they feel comfortable, avoid activities such as team sports which involve intensive social and tactile contact between children, but endeavor in activities such as playing on equipment, skateboarding and bicycling. This issue should be further examined in larger samples and also be a challenge for caregivers in finding intervention strategies, in which tactile processing, physical activities and social relationship should be taken into account.

An association was found between smell/taste sensitivity and a reduced amount of participation in activities. This may highlight the vulnerability of children with HFASD to smell/taste stimuli in various activities. In the present study, specific relation was found between this sensitivity and higher number of recreational activities performed with others, as well as with lower enjoyment level. Recreational activities in the CAPE include for example: doing crafts, drawing or coloring, playing with pets, taking care of pets, which may evoke intense stimuli of smell. Although some of these activities are sometimes mandatory, parent reports often describe how their children prefer to avoid recreational activities, mealtime or other activities which require the use of various materials with a strong odor (Rogers, Hepburn, & Wehner, 2003; Leekam et al., 2007). This may explain the lower level of enjoyment when participating in these activities.

An additional finding showed that children with HFASD with higher movement sensitivity preferred to participate more in activities inside the house, especially when participating in recreational activities or informal activities. In regard to recreational activities, the features of some of the activities included in the CAPE such as: doing crafts, watching TV, doing puzzles, playing on the computer, etc., do not involve intensive stimuli to the vestibular system and do not demand extensive movements. When referring to the Informal domain, many of the activities included in it may be performed at home (for example: playing board or card games, writing letters, doing pretend or imaginary play). Participating in activities at home which is a protective, safe and controlled environment lessens the exposure to unpleasant sensory stimulation including movement stimuli. Since the literature indicates that this type of sensory sensitivity may lead to depression and anxiety disorders that affect participation in activities, with an emphasis on the recreational and social domains (Bellini, 2004; Gillott, Furniss, & Walter, 2001; Pfeiffer, Kinnealey, Reed, & Herzberg, 2005), intervention should refer to these results when trying to enhance participation outside home and also encourage the community acceptance of children with HFASD by elaborating the awareness to their sensitivities and vulnerabilities.

Children with HFASD who tended to be sensation seekers, generally preferred to participate in activities inside their home and specifically in self-improvement activities. Ostensibly, this is surprising because it would be expected that these children would desire to be active and to continuously engage in their environments and yet, they demonstrate the opposite—a picture of avoidance. This may result from the characteristics of the self-improvement activities most of which are socially less demanding (such as writing letters; reading; doing homework; doing a chore).

Children with a lower level of energy, i.e. lower muscle strength and endurance, tended to perform informal and self-improving activities in their homes. Green et al. (2002) found that children with HFASD often have motor difficulties on the basis of low muscle tone and display clumsiness, which may cause fatigue and inability to withstand physical and recreational activities. Participation in informal activities such as writing letters, playing with things or toys, gardening, fishing, etc., require less stamina and endurance in comparison to many formal activities such as swimming, team sports, learning to dance. Likewise for self-improvement activities, most of which may be performed at home (e.g. doing puzzles, playing board or card games, collecting things, etc.).

Another finding in this study showed that the higher the visual/auditory sensitivity, the more children with HFASD participated with others in self-improvement activities. In the literature, studies show that visual or auditory sensitivity may lead children and adults with HFASD to be distracted (Adamson, O'Hare, & Graham, 2006; Baker, Lane, Angley, &Young, 2008; Rogers et al., 2003; Tomchek & Dunn, 2007). Activities in the category self-improvement are mainly cognitive (writing a letter/a story, taking lessons, praying, going to the library, reading, doing homework, etc.), and do not involve massive auditory or visual stimuli. These activities may be performed with one other person only and not necessarily with a large group, enabling the child to feel more secure and competent.

In summary, although children with HFASD are frequently included in regular settings and schools with their typical peers, their participation in these settings may be accompanied by high demands and emotional efforts, also contributed by their unique sensory processing abilities. Thus, as mentioned before, inclusion should be performed in specific settings (Ashburner et al., 2008; Dunn, Myles, & Orr, 2002) which will enable children with HFASD to feel secure and competent. For that, clinicians should also supervise parents, teachers and relevant persons in the community to create adaptations towards structured and expected environment and use behavioral strategies that may assist the child to deal with the unpleasant sensations in daily environments. In conclusion, children with HFASD may be at risk for limited participation in leisure activities. The unique atypical sensory processing abilities known to characterize children with HFASD may contribute to their limited participation. The fact, that children with HFASD are often included in regular classroom settings and are expected to participate in activities with their peers, elucidates the need to evaluate their participation patterns as early as possible as well as the impacts of possible limitations, as in sensory processing, on their participation. Including the assessment of sensory processing abilities and identifying their impacts on the activities in which the child participates, avoids, does not enjoy or feel comfortable with, may assist in incorporating sensory friendly environment into the child's daily lives in ways that meet the child's needs. Intervention should also include supervision for the families, teachers and the community in regard to options that may increase the optimal inclusion of children with HFASD in society and elevate their self-esteem and well being.

This study has some limitations: it was based on a small convenience sample recruited from a specific area of the country and had little ethnic or socioeconomic diversity. Future studies should include children with HFASD from different ethnicities and socioeconomic backgrounds. Further studies should investigate the relationship between sensory processing and participation in this population, and specifically examine how the inclusion of sensory processing abilities in intervention programs for children with HFASD impacts their participation patterns in different life settings as school, home and community.

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