Abnormal Sensory Information Processing in Symptoms of Autism Spectrum Disorder

Leonie van der Veen

Master Thesis – Clinical Neuropsychology

S3335178
04-2021
Department of Psychology
University of Groningen
Examiner/Daily supervisor:
Dr. Y. Groen
Second reviewer:
Dr. G.F. Gaastra

Abstract

Sensory processing abnormalities, including both hyper- and hyposensitivity are common in autism spectrum disorders (ASD). ASD is characterized by restricted and repetitive patterns of behavior, interests and activities (RRB), as well as impairments in social communication and interaction (SCI). Females with ASD are underdiagnosed and may express ASD traits differently compared to males. The present study explored the relationship between sensory processing abnormalities and both domains of ASD: RRB and SCI. Adults (N = 243) were recruited from the general population and administered the Autism Quotient (AQ-NL) along with the Autism Quotient Feminine (AQf-NL) and the Adolescent/Adult Sensory Profile (AASP-NL). Results showed a significant positive correlation between the number of ASD traits for the RRB and SCI domains and hyper- and hyposensitivity. However, participants who showed more ASD traits showed less sensation seeking. Furthermore, female sensitive ASD traits was associated with less hyper- and hyposensitivity. These data suggest sensory processing abnormalities to be related to both domains of ASD and further research should determine if sensory processing abnormalities relate differently to female sensitive ASD traits.

Keywords: autism spectrum disorder, sensory processing abnormalities, repetitive behaviors and interests, social and communication and interaction, females

Abnormal Sensory Information Processing in Symptoms of Autism Spectrum Disorder

Autism Spectrum Disorder (ASD) is a neurodevelopmental condition characterized by the existence of restricted and repetitive patterns of behavior, interests and activities (RRB), as well as impairments in social communication and interaction (SCI) (American Psychiatric Association, 2013). In addition, it is confirmed that ASD traits can be observed in the general population (Constantino & Todd, 2003). Furthermore, females with ASD are underdiagnosed and may express ASD traits differently compared to males (Halladay et al., 2015; Hull, Petrides, & Mandy, 2020). For example, this includes differences in social difficulties regarding the maintenance of social relationships (Head, McGillivray & Stokes, 2014; Sedgewick, & Pellicano, 2019) and interests which tend to be more relational in nature (Grove, Hoekstra, Wierda, & Begeer, 2018).

Despite being reported in early descriptions of ASD (Kanner, 1943), only the most recent edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5: American Psychiatric Association, 2013) included abnormal sensitivity to sensory stimuli as a symptom of ASD. These processing abnormalities have been reported, via self-reports and observations, in visual, auditory, tactile, oral, gustatory, and olfactory sensory processing in children and adults (Baum, Stevenson & Wallace, 2015; Robertson & Baron-Cohen, 2017; kern et al., 2006). More than 90% of the children with ASD exhibit these abnormalities, suggesting them to be global in nature (Kern et al., 2006; Tomchek & Dunn, 2007). These symptoms continue to be present in adults, but perhaps to a lesser extent (Crane & Pring, 2009; Kern et al., 2006). Not being properly attuned to the relevant information from the environment as a result of abnormal sensory processing, can be detrimental for an individual's ability to engage adequately in everyday life.

The DSM-5 distinguishes sensory processing abnormalities in two categories: hyper- or hyposensitivity. The difference between these two responses to sensory stimuli could best be explained as stated in Dunn's Model of Sensory Processing (Brown, Tollefson, Dunn, Cromwell & Filion, 2001; Dunn, 2001). According to this model, adults that require a low intensity of sensory stimuli for neurons to fire and for the individual to react indicates that the individual has a low neurological threshold. This corresponds with hypersensitivity and manifests itself in a strong and quick response to sensory stimuli or in avoiding sensory stimuli because they are overwhelming. For example, Germani et al (2014) showed via questionnaires and interviews

with parents that infants with a high risk for ASD experienced more auditory processing difficulties which were shown by the child trying to escape noisy environments. On the other hand, Dunn's model explains hyposensitivity by a high neurological threshold. This indicates that the individual requires high intensity of sensory stimuli for neurons to fire and for the individual to react and manifests itself in missing stimuli, taking longer to respond to stimuli or actively seeking stimuli as an attempt to meet the threshold. For example, in an olfactory assessment, Muratori et al (2017) showed that children with ASD exhibit a higher threshold to odors, resulting in difficulties with recognizing odors.

In the current diagnostic criteria, sensory processing abnormalities are a subdomain of the RRB criterion of ASD (American Psychiatric Association, 2013). Indeed, Schulz and Stevenson (2019) found a strong link between RRB and sensory processing abnormalities in each sensory modality using self-report tools filled out by the parents. This implies that the children and adolescents who reported these abnormalities showed an increase in RRB. Boyd, McBee, Holtzclaw, Baranek and Bodfish (2009) shared the same conclusion for children with ASD using both observational and parent report measures. The abnormal neurological threshold may result in an overwhelming feeling for the individual with ASD. The RRB's such as adherence to a routine, restricted interests or motor movements may act as a homeostatic mechanism to gain control over the sensory input (Green et al., 2013). This implies that the individual could use RRB as an approach to manage their sensory processing abnormalities (Baker, Lane, Angley, & Young, 2008). However, Baron-Cohen & Belmonte (2005) suggested the opposite direction in their review and laid the emphasis on the characteristics of RRB. They concluded a detail-focused manner of information processing to be an important feature of RRB for children and adults, which may hamper effectively processing sensory information. Nonetheless, no conclusion about causality between RRB and sensory processing abnormalities can be made.

The causality of the relationship between RRB and sensory processing abnormalities remains unclear, as well as the evidence for the type of sensory processing abnormality. Using self-report tools filled out by parents, Schulz and Stevenson (2019) suggested that as the sensitivity to sensory stimuli increases, the occurrence and severity of RRB also increases. This hypersensitivity occurred across all sensory modalities in children with ASD. Boyd et al (2009) also confirmed this relationship using self-report tools filled out by parents and specifically found no evidence for an association regarding hyposensitivity. This means that even though

hyposensitivity is a symptom of ASD, it seems to not be related to the distinct RRB domain of ASD. A specific example of sensory processing abnormalities in relation to RRB was given by Baranek, Foster and Berkson (1997). They found via self-report measures and observations that children who showed hypersensitivity to touch exhibited more stereotypical behaviors. Schulz and Stevenson (2020) suggest that this positive relationship also holds for the visual modality. In their study using adults with ASD, RRB's increased along with increasing sensory sensitivity in a visual detection test. However, even though the relationship between hypersensitivity and RRB seems clear, hyposensitivity may still be of essence in RRB for children and adults (Gabriels et al., 2008). For example, children and adolescents with ASD may be hyposensitive to pain and cause self-injury by insisting on engaging in RRB, such as biting or head banging (Gal, Cermak & Ben-Sasson, 2007). The individual experiencing hyposensitivity may use self-stimulation to compensate for restricted sensory input (Smith, Press, Koenig, & Kinnealey, 2005).

Even though sensory processing abnormalities are a subdomain of RRB, new theoretical and empirical evidence suggests a strong positive relationship between sensory processing abnormalities and the SCI domain of ASD (Ronconi, Molteni & Casartelli, 2016). They proposed a perspective shift from the explanation of the impaired "Social Brain" as the cause of SCI to an explanation concerning abnormal responses to sensory input. Moreover, Ewing and Rhodes (2013) also questioned the "Social Brain" view. Using a memory and discrimination task, they showed that in comparison to the general population, children and adolescents with ASD displayed sensory processing abnormalities. However, these abnormalities were not specific for social sensory stimuli. This raises the proposal that the SCI domain of ASD does not rise from a social specific problem, but a more general sensory processing abnormality. The same conclusion has been drawn by Järvinen-Pasley and Heaton (2007) concerning the auditory modality, where similar sensory processing abnormalities were shown for speech and non-speech stimuli in a pitch sequence discrimination task for children. Not only for the auditory modality, also the sensory processing abnormalities across all modalities could have an impact on social functioning in children and adults (Hellendoorn, Wijnroks, & Leseman, 2014; Thye, Bednarz, Herringshaw, Sartin & Kana, 2018). In addition, Thye et al (2018) proposed that the relationship between these two aspects of ASD may be bidirectional and interdependent for children and adults. For example, an individual who is overwhelmed by the auditory stimuli of multiple

people talking may withdraw from these social scenarios, leading to less social practice and ultimately may result in a breakdown of successful social interaction.

It appears that sensory processing abnormalities and the SCI domain of ASD should not be considered separately from each other. Moreover, like the RRB domain, the type of sensory processing abnormality does not seem to be consistent. The following literature suggests that individuals with ASD can be hypo- and hypersensitive to social sensory stimuli. In children with ASD, Hilton, Graver and LaVesser (2006) found a strong positive relationship between self-reported social difficulties and being hypersensitive to sensory stimuli, including the tendency to avoid sensory stimuli. A specific example concerning children is the hypersensitivity to individual parts of social auditory information, which is at the expense of the global auditory message in, for example, speech (Foster et al., 2016). Contrastingly, social difficulties in ASD are also related to hyposensitivity to sensory stimuli. Muratori et al (2017) demonstrated male children with ASD to be hyposensitive to odors, meaning that their olfactory system needs a higher concentration of the stimulus for it to be detected. This phenomenon related positively to social and problems with aggression. Next to odors, adolescents and children with ASD exhibit hyposensitivity to touch according to Kaiser et al (2016). This was expressed by the hypoactivation of brain regions involved in social-emotional information processing during the touch.

The aim of the present study is to explore the relationship between sensory processing abnormalities and both domains of ASD: restricted and repetitive patterns of behaviors (RRB), as well as social communication and interaction (SCI). To reach this aim, self-report measure The Autism Spectrum Quotient (AQ-NL: Hoekstra, Bartels, Cath, & Boomsma, 2008) will be used to measure ASD traits. Considering the discrepancy between the female and male ASD, The Autism Spectrum Quotient Feminine (AQf-NL: Wouters, 2021) will also be used to measure female sensitive ASD traits. Lastly, The Adult Sensory Profile (AASP-NL: Brown et al., 2001), which is a self-report measure, will be used to measure sensory processing abnormalities. Comparisons will be made between the score on both measures of ASD traits and the measure of sensory processing abnormalities. Based on the literature concerning the RRB domain, the first hypothesis states the expectation that there will be a positive relationship between the scores on the measure of the RRB and the scores on both measures of sensory processing abnormality: hyper- and hyposensitivity. Based on the literature concerning the SCI domain, the second

hypothesis states the expectation that there will be a positive relationship between the scores on the measure of the SCI and the scores on both measures of sensory processing abnormality: hyper- and hyposensitivity. A better understanding of how sensory processing abnormalities are related to ASD traits could be implicated with the affirmation of these hypotheses. This is important considering the recency of the addition of sensory processing abnormalities in ASD to the DSM-5.

Method

Participants. Participants were recruited via advertisements on various social media and via personal invitation. The participants did not receive a reward for completion of the questionnaire. Furthermore, the participants provided their informed consent. The questionnaires used in this study require a minimum age of 16. Participants who disclosed having an impairment which interferes with one or more of their sensory modalities were excluded from further analysis (n = 38 were excluded). Furthermore, participants who indicated not to have filled out the questionnaire truthfully or did not respond correctly to specific questions controlling for this matter were excluded from further analysis (n = 9 were excluded). After exclusion, the data of 243 Dutch speaking participants were analyzed. The mean age of the participants was 34.15 (*SD* = 14.19) ranging from 16 to 76 years old. Of the participants 74.8% were female, 24.4% males, 0.4% other and 0.4% did not want to disclose this information.

Materials

The Autism Spectrum Quotient and the AQ-Feminine. The Autism Spectrum Quotient-NL (AQ-NL: (Hoekstra et al., 2008) is a self-report tool that is used to identify ASD related traits in the absence of intellectual disability in young people and adults. Hoekstra et al (2008) stated to have found satisfactory internal consistency (a = .81 in student sample, a = .71 in general population sample) and test– retest reliability (r = .78). The AQ-NL consists of 50 items organized into five subscales: “Social Skill” (item numbers = 1, 11, 13, 15, 22, 36, 44, 45, 47, 48), “Attention Switching” (item numbers = 2, 4, 10, 16, 25, 32, 34, 37, 43, 46), “Attention to Detail” (item numbers = 5, 6, 9, 12, 19, 23, 28, 29, 30, 49), “Communication” (item numbers = 7, 17, 18, 26, 27, 31, 33, 35, 38, 39) and “Imagination” (item numbers = 3, 8, 14, 20, 21, 24, 40, 41, 42, 50). Example item from the “Social Skill” subscale: ‘‘I find it hard to make new friends.’’ Example item from the “Attention to Detail” subscale: “I notice patterns in things all the time.”

In addition to the AQ-NL, an add-on questionnaire has been developed by the EmFASiS team (www.emfasisonderzoek.org) which is expected to be sensitive to females with ASD: The Autism Spectrum Quotient-feminine-NL (AQf-NL: Wouters, 2021). The validity and reliability have not been determined yet. The AQf-NL consists of 57 items organized into six subscales. The subscales "Attention to Detail" (item numbers = 6, 9, 12, 19, 23, 28, 29, 49), "Attention Switching" (item numbers = 2, 4, 10, 16, 25, 32, 34, 37, 43, 46) and "Imagination" (item numbers = 3, 8, 14, 20, 21, 40, 42, 50) contain items deriving from the AQ-NL. The subscales "Social Skill" (item numbers = 2, 15, 17, 19, 28, 32, 33, 41), "Communication" (item numbers = 1, 21, 27, 31, 34, 44, 49, 50), and "Sensory Processing" (item numbers = 4, 7, 9, 11, 12, 14, 16, 22, 23, 24, 26, 29, 36, 37, 45) contain newly developed items (see appendix table 1). Example item form "Social Skill": "I often think out a social event completely in advance". Example item form "Communication": "I usually consciously look at others for what to say".

For the AQ-NL and AQf-NL, each item asks how often the participant performs a particular behavior with answers using a 4-point Likert Scale in which 1 = ''Definitely Agree'' up to 4 = ''Definitely Disagree''. For some items, the scoring was reversed in which 1 = "Definitely Disagree" up to 4 = "Definitely Agree". One point is awarded to answer types 1 and 2 and zero points are awarded to answer types 3 and 4. A low overall score on the AQ-NL and AQf-NL indicates that this individual shows a low degree of ASD traits and a high overall score indicates that this individual shows a high degree of ASD traits. Furthermore, for the AQ-NL, a score can range from 0 to 50 and a score higher than 32 can be a cutoff for distinguishing individuals who have clinically significant levels of autistic traits (Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001). A score classification has not been developed for the AQf-NL.

The Adolescent/Adult Sensory Profile. The Adolescent/Adult Sensory Profile (AASP-NL: Brown et al., 2001) is a 60 item self-report tool to determine sensory processing patterns and their influence on performance. Brown et al (2001) stated the questionnaire to provide construct validity (F (3, 17) = 8.38, p = .001) and item reliability ("Sensory Sensitivity" α = .81, "Sensation Avoiding" α = .66, "Low Registration" α = .82, and "Sensation Seeking" α = .79). This measure is based on the four quadrants of Dunn's Model of Sensory Processing (Dunn, 1997). The four tendencies are described as "Sensory Sensitivity" (item numbers = 7, 9, 13, 16, 20, 22, 25, 27, 31, 33, 34, 48, 51, 54, 60), "Sensation Avoiding" (item numbers = 1, 5,

11, 18, 24, 26, 29, 35, 38, 43, 46, 49, 53, 56, 57), “Low Registration” (item numbers = 3, 6, 12, 15, 21, 23, 36, 37, 39, 41, 44, 45, 52, 55, 59) and “Sensation Seeking” (item numbers = 2, 4, 8, 10, 14, 17, 19, 28, 30, 32, 40, 42, 47, 50, 58). Each of the sensory modalities is addressed in the questionnaire. Example item from “Sensory Sensitivity: “I don’t like particular food textures.” Example item from “Low Registration”: “I don’t seem to notice when someone touches me.”

Further, each item asks how often the participant performs a particular behavior with answers using a 5-point Likert Scale in which 1 = ‘‘Almost Never’’, 2 = ‘‘Seldom’’, 3 = ‘‘Occasionally’’, 4 = ‘‘Frequently’’ and 5 = ‘‘Almost Always’’. An overall score can be determined for each quadrant, ranging from 15 till 75. A low overall score on the AASP-NL indicates that this individual shows a low degree of sensory processing abnormalities and a high overall score indicates that this individual shows a high degree of sensory processing abnormalities. Table 1 displays the classification system that can be used to classify the score on each quadrant of the AASP-NL.

Table 1

A Classification for the Score on Each Quadrant of the AASP-NL (Brown, Dunn, & Rietman, 2001)

	AASP-NL Quadrant			
Classification	Sensory Sensitivity	Sensation Avoiding	Low Registration	Sensation Seeking
High	49 – 75	50 – 75	45 – 75	63 – 75
Above Average	42 – 48	42 – 49	36 – 44	57 – 62
Average	26 – 41	27 – 41	24 – 35	43 – 56
Below Average	19 – 25	20 – 26	19 – 23	36 – 42
Low	15 – 18	15 – 19	15 – 18	15 – 35

Note: These classifications are based on individuals without disorders and are used in the population aged 18 till 64

Procedure. Ethical permission from the Ethical Committee Psychology of the University of Groningen was granted prior to recruitment commencing (PSY-2021-S-0093). Using Qualtrics (2020), the questionnaire was administered online and participants completed this at their own convenience. The duration to complete the questionnaire was approximately thirty minutes. Participants received information about the study, which stated the topic of interest to be the processing of sensory information and the linkage to personality. Participants were not informed about the actual topic under investigation, namely traits of ASD. This method was chosen to maximize participant quantity and minimize the social desirability bias. First of all, participants gave informed consent. Then, they answered 15 questions concerning demographic information and the presence of sensory disorders. After that, participants filled out the AQ-NL, the AQF-NL, the Adult Sensory Profile-NL and one additional questionnaire for the purpose of another study. In addition, three control items were added evenly throughout the questionnaire. These items asked the participants to select the answer that was specifically asked for in the question. After finishing the questionnaire, the participants received questions concerning the diagnosis of ASD, a neurological condition, a psychological or psychiatric condition. The participants received a final question asking them if they filled out the questionnaire truthfully. Finally, the participants were given a debriefing discussing the actual topic under investigation and were thanked for their participation.

Data Analysis. The analyses were conducted in SPSS (26.00.01). The analyses aimed to determine the relationship between the sensory processing abnormalities, namely hyper- and hyposensitivity, and both domains of ASD: SCI and RRB. To investigate the first hypothesis, bivariate correlation coefficients were calculated between the RRB domain of ADS and both manners of sensory processing: hyper- and hyposensitivity. For RRB, the subscales “Attention to Detail” and “Attention Switching” from the AQ-NL and AQf-NL were used. For hypersensitivity, the quadrants from the AASP-NL “Sensory Sensitivity” and “Sensation Avoiding” were used. Lastly, for hyposensitivity the quadrants from the AASP-NL “Low Registration” and “Sensation Seeking” were used. Moreover, visual inspection suggests no outliers to influence the bivariate correlations mentioned (see appendix figure 1 to 4).

To investigate the second hypothesis, bivariate correlation coefficients were calculated between the SCI domain and both manners of sensory processing tendencies: hyper- and hyposensitivity. For SCI, the subscales “Social Skill” and “Communication” from the AQ-NL

and AQf-NL were used. For hyper- and hyposensitivity, the equivalent quadrants from the first hypothesis were used. Moreover, visual inspection suggests no outliers to influence the bivariate correlations mentioned (see appendix figure 5 to 8).

Furthermore, the Kolmogorov-Smirnov test indicated the normality assumption to be violated for the variable “Social Skill”, “Communication”, “Attention to Detail” and “Attention Switching” for the AQ-NL and the AQf-NL (see appendix table 2). For this reason, Spearman's rho was used to calculate the bivariate correlation coefficients using a significance level of $\alpha = .05$. Cohen's guidelines (1988) were applied to indicate the magnitude of the bivariate correlation coefficients, according to which a bivariate correlation coefficient between 0.10 and 0.30 is small, between 0.30 and 0.50 medium and from 0.50 large.

Results

Descriptive statistics. Table 3 shows the descriptive statistics for the AQ-NL per subscale. As this table indicates, the subscale “Attention to Detail” had the highest mean. According to the classification system from the AQ-NL, the mean for the total score on the AQ-NL is considered average. The maximum total score is considered high and the minimum total score is considered low. Furthermore, table 3 shows the descriptive statistics for the AQf-NL per subscale. As this table indicates, the subscale “Sensory Processing” had the highest mean and the subscale “Imagination” had the lowest mean. However, the subscales differ in their number of items, so their maximum of scores differs. A classification system has yet to be developed. Moreover, table 3 shows the descriptive statistics for the AASP-NL per quadrant. The quadrant “Sensation Seeking” had the highest mean and the quadrant “Low Registration” had the lowest mean. According to the classification system from the AASP-NL, the means from all the four quadrants are considered average. The maximum scores from all the four quadrants are considered high. The minimum scores from the quadrants are considered low except for the quadrant “Sensory Sensitivity” which is considered average.

Table 3

Means (and Standard Deviations) and Range from the AQ-NL and AQf-NL per Subscale and the AASP-NL per Quadrant

		Mean(*SD*)	Maximum	Minimum
AQ-NL				
	Social Skill	2.20*(2.14)*	10	0
	Communication	2.49*(2.04)*	10	0
	Attention to Detail	4.97*(2.30)*	10	1
	Attention Switching	4.14*(2.35)*	10	1
	Imagination	2.63*(1.91)*	9	0
	Total	16.42*(7.67)*	43	2
AQf-NL				
	Social Skill	5.66*(2.30)*	8	0
	Communication	4.87*(2.33)*	8	0
	Attention to Detail	3.57*(2.01)*	8	0
	Attention Switching	4.14*(2.35)*	10	0
	Imagination	1.93*(1.65)*	8	0
	Sensory Processing	9.23*(3.76)*	15	0
	Total	29.40*(5.70)*	44	15
AASP-NL				
	Sensory Sensitivity	37.46*(9.85)*	67	29
	Sensation Avoiding	37.55*(10.02)*	67	19
	Low Registration	30.79*(7.26)*	52	16
	Sensation Seeking	46.40*(7.74)*	67	26
	Total	152.19*(22.11)*	227	101

Note: $N = 243$

Restricted and Repetitive Patterns of Behavior. As displayed in table 4 and appendix 1 to 4, the subscale “Attention Switching” and “Attention to Detail” from the AQ-NL and AQf-NL showed a significant positive correlation with the AASP-NL quadrants “Sensory Sensitivity”, “Sensation avoiding” and “Low registration”. Furthermore, the strength of these correlations was medium concerning the subscale “Attention Switching” and small concerning the subscale “Attention to Detail”. This means that the participants who scored higher on both subscales showed more hypersensitivity and hyposensitivity. However, on the subscale “Attention Switching”, a medium negative correlation was present with the hyposensitivity quadrant “Sensation Seeking” on the AQ-NL and AQf-NL. This means that the participants who scored higher on this subscale showed less sensation seeking. Furthermore, the subscale “Attention to Detail” presented a nonsignificant correlation with the “Sensation Seeking” quadrant. Taken together, this means that the hypothesis is confirmed for hypersensitivity, but only partly confirmed for hyposensitivity.

Social Communication and Interaction. As displayed in table 4 and appendix 5 to 8, the opposite relationships were shown for the AQ-NL and AQf-NL concerning the SCI subscales. Focusing on the AQ-NL, the subscales “Social Skill” and “Communication” presented a significant positive correlation with the AASP-NL quadrants “Sensory Sensitivity”, “Sensation Avoiding” and “Low Registration”. Moreover, the strength of these correlations were medium, however the strength of the correlation between the “Social Skill” subscale and the “Sensation Avoiding” quadrant was large. This means that the participants who scored higher on these SCI subscales showed more hypersensitivity and hyposensitivity. However, the hyposensitivity quadrant “Sensation Seeking” presented a significant, negative correlation for both SCI subscales. These correlations were of medium strength for the “Social Skill” subscale and of small strength for “Communication” subscale. This means that the participants who scored higher on these SCI subscales showed less sensation seeking.

On the other hand, as displayed in table 4 and appendix 6 and 8, the subscales “Social Skill” and “Communication” from the AQf-NL presented a significant negative correlation with the AASP-NL quadrants “Sensory Sensitivity”, “Sensation Avoiding” and “Low Registration”. Furthermore, these correlations were of medium strengths. This means that the participants who scored higher on “Social Skill” and “Communication” showed less hypersensitivity. However, the hyposensitivity quadrant “Sensation Seeking” presented a significant, positive correlation of

medium strength for the "Social Skill" and "Communication" subscales. This means that the participants who scored higher on these SCI subscales showed more sensation seeking. Collectively, the hypothesis for hypersensitivity as well as hyposensitivity are partly confirmed.

Table 4

Bivariate Correlation Coefficients Between the Two RRB Subscales and the Two SCI Subscales From the AQ-NL and AQf-NL and the Four Quadrants of the AASP-NL

		Sensory Sensitivity	Sensation Avoiding	Low Registration	Sensation Seeking
RRB AQ-NL					
	Attention Switching	.479*	.485*	.419*	-.402*
	Attention to Detail	.225*	.251*	.183*	-.071
RRB AQf-NL					
	Attention Switching	.479*	.485*	.419*	-.402*
	Attention to Detail	.182*	.228*	.158*	-.076
SCI AQ-NL					
	Social Skill	.413*	.530*	.346*	-.428*
	Communication	.360*	.382*	.433*	-.199*
SCI AQf-NL					
	Social Skill	-.418*	-.494*	-.376*	.322*
	Communication	-.416*	-.427*	-.457*	.344*

Note: $N = 243$
* $p < .05$

Discussion

The aim of the present study was to explore the strength of the relationship between sensory processing abnormalities and both domains of ASD: restricted and repetitive patterns of behaviors (RRB), as well as social communication and interaction (SCI). Results showed that sensory processing abnormalities (including both hyper- and hyposensitivity), as measured by the AASP-NL, were related to more RRB and SCI, as measured by the AQ-NL and AQf-NL.

Based on previous research, it was hypothesized that participants who reported more ASD traits in the RRB and SCI domains would also experience more hypersensitivity (Baranek et al., 1997; Boyd et al., 2010; Foster et al., 2016; Hilton et al., 2006; Schulz & Stevenson, 2019; Schulz and Stevenson, 2020). The results of the present study are in line with these previous findings. Participants who experienced a high amount of RRB and SCI also experienced more hypersensitivity, however these correlations were only of medium or small strength. Concerning

RRB, these results are in line with the findings of Schulz and Stevenson (2019) and Boyd et al (2009), stating sensory processing abnormalities to be strongly linked to RRB. Moreover, these results correspond with studies in which RRB increased along with hypersensitivity in specific modalities (touch and vision) (Baranek et al., 1997; Schulz and Stevenson, 2020). Concerning SCI, these results support the findings of Ronconi et al (2016) who argue for the abnormal responses to sensory input as an explanation for social difficulties in ASD. Furthermore, given the present study included adults, these findings add on to Hilton et al (2006) who stated hypersensitivity to increase as SCI increased in children.

Furthermore, in line with previous research, it was hypothesized that participants who reported more ASD traits in the RRB and SCI domains would also experience hyposensitivity (Gabriels et al., 2008; Gal et al., 2007; Kaiser et al., 2016; Muratori et al., 2017; Smith et al., 2005). The results of the present study are partly in line with these previous findings. Particularly, participants who experienced more low registration of stimuli also experienced more RRB and SCI, however these correlations were only of medium or small strength. Concerning RRB, these results are in line with Gabriels et al (2008) who stated that hyposensitivity might be of essence in RRB. Furthermore, these results provide evidence that hyposensitivity is related to SCI. This gives an additional insight into the previous research on this relationship which is modality specific for touch and odors (Kaiser et al., 2016; Muratori et al., 2017). So, the RRB and SCI domains both demonstrated medium and small correlation strengths for sensory processing abnormalities. This means that even though sensory processing abnormalities is listed as a subdomain of RRB in the DSM-5 (American Psychiatric Association, 2013), the present study indicates that sensory processing abnormalities are similarly represented in the SCI domain.

However, in the present study, participants who reported more RRB and SCI showed less sensation seeking. This is not in accordance with the hypotheses stating hyposensitivity to be related to more ASD traits in both domains. However, Hedger, Dubey and Chakrabarti (2020) may provide an explanation for this via their meta-analysis. They point out that individuals with ASD find social stimuli less gratifying compared to non-ASD individuals. On the behavioral level, this can manifest itself in a reduction of social orienting, including directing less attention towards social stimuli, and a reduction of social sensation seeking. Furthermore, this contrast from the hypotheses might be explained through infancy research. In a meta-analysis, Ben-

Sasson et al (2009) stated that infants with ASD are less likely to eagerly examine their environment and show interest in seeking sensations compared to typically developing infants. Furthermore, Ben-Sasson et al (2007) implicated that The Sensory Profile self-report tool might not capture the atypical types of sensation seeking that are specific for ASD infants. Subsequently, these results may also translate to adults with ASD, yet this must be explored in a different study.

Furthermore, in the present study, the AQf-NL, which is sensitive to female typical ASD traits, presented different results from the AQ-NL concerning the SCI domain. The results showed that when female sensitive ASD traits increase, the number of sensory processing difficulties decrease. This is contradictory to the non-feminine sensitive SCI domain, so the hypothesis arises that female sensitive SCI traits are associated with less sensory processing difficulties in ASD. Subsequently, this hypothesis is supported by social gender differences in ASD. In an eye-tracking paradigm, Harrop et al (2018) demonstrated females age 6 till 10 with ASD to show more typical social attention compared to males with ASD. They showed more prioritization of social stimuli suggesting them to present a broader social phenotype. Furthermore, Cook, Ogden and Winstone (2018) indicated using interviews that adolescent females with ASD showed motivation for friendships similar to their non-ASD peers. Also, through written accounts and interviews, Vine Foggoa and Webster (2017) revealed that female adolescents with ASD showed mature understanding of the aspects of friendships. So, it might be that females developed better social and communication skills, because they experience less sensory processing difficulties compared to males. However, more research on this topic is needed to confirm this.

Based on the new hypothesis mentioned above, the differences between the scores on the AASP for females and males for the present sample have been explored using an independent-sample t-test. Females score significantly higher on the “Sensory Sensitivity” ($t(239) = -6.02$, $p = .007$) and the “Sensation Avoiding” ($t(239) = -3.97$, $p = .001$) quadrant from the AASP, compared to males. However, no significant difference between males and females was found for “Low Registration” ($t(239) = -3.02$, $p = .161$) and “Sensation Seeking” ($t(239) = .92$, $p = .443$) quadrants. This could mean that there is a gender difference for hypersensitivity, but not for hyposensitivity. However, previous research using the self-report tool Sensory Profile revealed that males and females aged 6 till 18 only differed in movement flexibility (Bitsikaa,

Sharpley & Mills, 2018). Furthermore, Frazier and Hardan (2017) found no difference between males and females aged 4 till 17 for sensory processing abnormalities using parent ratings and interviews. Nonetheless, these previous studies are based on children and adolescents and do not use female sensitive ASD traits. Thus, further research on gender differences in sensory processing abnormalities is needed.

The present study has strengths and limitations. First of all, the AQ-NL and AASP-NL revealed good reliability and validity (BaronCohen et al., 2001; Brown et al., 2001). Also, the questionnaire used in this study optimized the reliability by including control questions and not disclosing the topic of the study. Concerning the limitations, this study relied on self-report questionnaires as measures of sensory processing abnormalities and ASD traits. Although this is a common practice in studies of adults (Crane & Pring, 2009; Grove et al., 2018; Kern et al., 2006), it does depend on the participants having reliable judgement of their own experiences and being able to verbalize them. In contrast, studies in children have generally used self-report tools filled out by the parents (Boyd et al., 2009; Boyd et al., 2010; Schulz and Stevenson, 2019). This may provide a more complete measure of ASD traits and sensory processing abnormality behaviors, yet it cannot directly reveal subjective experiences. Therefore, an objective measurement should be considered (Schulz & Stevenson, 2020). A second limitation of the study is that the validity of the AQf-NL has not been assessed, nor has the reliability been determined. However, the items have been analyzed and adjusted to be as reliable as possible in the current phase of the composition of this self-report tool (Wouters, 2021). A third limitation concerns the homogeneity of the sample. The present study made use of a convenience sampling method which led to the inclusion of a majority of females. Considering the observed difference between female and male ASD symptom presentation (Halladay et al., 2015; Head, et al., 2014; Hull, et al., 2020; Sedgewick, & Pellicano, 2019), the present sample might give a misrepresentation of the relationships under investigation. However, it must be noted that the present study has a large sample size (N = 243) resulting in a reasonable number of male participants (N = 59). Finally, it is unsure if the correlations found in the present study are applicable to individuals with many ASD traits. If the study would be repeated, a clinical sample would be preferred.

To conclude, this study provides evidence for the positive relationship in the general population between hyper- and hyposensitivity and both domains of ASD: RRB and SCI. These results suggest that sensory processing abnormalities may be intertwined with both domains of

ASD and thus of central importance. Moreover, this study gives the indication that less sensation seeking is related to more ASD traits in both domains. Furthermore, this study provides evidence for a different direction between sensory processing abnormalities and the SCI domain for female sensitive ASD traits. However, it must be noted that the present study did not make use of a clinical sample and replication in a clinical sample is needed to confirm the results for ASD. Furthermore, one interesting direction for future research would be to compare the sensory processing abnormalities between males and females with ASD. This could be done using the AASP-NL, but adding an objective measuring method of sensory processing abnormalities might be of essence. These objective measurements might have to be specified per sensory modality and could for example exist of a visual detection task (Schulz & Stevenson, 2020) or an olfactory assessment (Muratori et al., 2017). In this way, comparisons can be made between the subjective experiences and the objective measurements of sensory processing abnormalities.

References

American Psychiatric Association. (2013). Diagnostic and statistical manual of mental disorders : dsm-5 (5th ed.). *American Psychiatric Association*.

Baker, A., Lane, A., Angley, M., & Young, R. (2008). The relationship between sensory processing patterns and behavioural responsiveness in autistic disorder : a pilot study. *Journal of Autism and Developmental Disorders*, *38*(5), 867–875.

Baranek, G. T., Foster, L. G., & Berkson, G. (1997). Tactile defensiveness and stereotyped behaviors. *The American Journal of Occupational Therapy: Official Publication of the American Occupational Therapy Association*, *51*(2), 91–5.

Baron-Cohen, S., & Belmonte, M. K. (2005). Autism: a window onto the development of the social and the analytic brain. *Annual Review of Neuroscience*, *28*(1), 109–126. https://doi.org/10.1146/annurev.neuro.27.070203.144137

Baron-Cohen, S., Wheelwright, S., Skinner, R., Martin, J., & Clubley, E. (2001). The Autism-Spectrum Quotient (AQ): Evidence from Asperger syndrome/high-functioning autism, males and females, scientists and mathematicians. *Journal of Autism and Developmental Disorders*, *31*, 5–17.

Baum, S. H., Stevenson, R. A., & Wallace, M. T. (2015). Behavioral, perceptual, and neural alterations in sensory and multisensory function in autism spectrum disorder. *Progress in Neurobiology*, *134*, 140–60. https://doi.org/10.1016/j.pneurobio.2015.09.007

Ben-Sasson, A., Cermak, S. A., Orsmond, G. I., Tager-Flusberg, H., Carter, A. S., Kadlec, M. B., & Dunn, W. (2007). Extreme sensory modulation behaviors in toddlers with autism spectrum disorders. *The American Journal of Occupational Therapy : Official Publication of the American Occupational Therapy Association*, *61*(5), 584–92.

Ben-Sasson, A., Hen, L., Fluss, R., Cermak, S. A., Engel-Yeger, B., & Gal, E. (2009). A meta-analysis of sensory modulation symptoms in individuals with autism spectrum disorders. *Journal of Autism and Developmental Disorders*, *39*(1), 1–11.

Bitsika, V., Sharpley, C. F., & Mills, R. (2018). Sex differences in sensory features between boys and girls with autism spectrum disorder. *Research in Autism Spectrum Disorders*, *51*, 49–55. https://doi.org/10.1016/j.rasd.2018.04.002

Boyd, B. A., McBee, M., Holtzclaw, T., Baranek, G. T., & Bodfish, J. W. (2009). Relationships among repetitive behaviors, sensory features, and executive functions in high functioning

autism. *Research in Autism Spectrum Disorders*, *3*(4), 959–966. https://doi.org/10.1016/j.rasd.2009.05.003

Brown, C., Tollefson, N., Dunn, W., Cromwell, R., & Filion, D. (2001). The Adult Sensory Profile: Measuring patterns of sensory processing. *American Journal of Occupational Therapy*, *55*, 75–82.

Brown, C., Dunn, C., & Rietman, A. (2001). Adolescent Adult Sensory Profile-NL Handleiding AASP voor het meten van het effect van sensorische prikkelverwerking bij adolescenten en volwassenen.

Cohen, J. (1988). Statistical power analysis for the behavioral sciences (2nd ed.). Lawrence Erlbaum Associates.

Cook, A., Ogden, J., & Winstone, N. (2018). Friendship motivations, challenges and the role of masking for girls with autism in contrasting school settings. *European Journal of Special Needs Education*, *33*(3), 302–315. https://doi.org/10.1080/08856257.2017.1312797

Constantino, J. N., & Todd, R. D. (2003). Autistic traits in the general population: a twin study. *Archives of General Psychiatry*, *60*(5), 524–30.

Crane, L., Goddard, L., & Pring, L. (2009). Sensory processing in adults with autism spectrum disorders. *Autism*, *13*(3), 215–228.

Dunn, W., & Brown, C. (1997). Factor analysis on the Sensory Profile from a national sample of children without disabilities. *American Journal of Occupational Therapy*, *51*, 490–495.

Ewing, L., Pellicano, E., & Rhodes, G. (2013). Reevaluating the selectivity of face-processing difficulties in children and adolescents with autism. *Journal of Experimental Child Psychology*, *115*(2), 342–55. https://doi.org/10.1016/j.jecp.2013.01.009

Foster, N. E., Ouimet, T., Tryfon, A., Doyle-Thomas, K., Anagnostou, E., & Hyde, K. L. (2016). Effects of age and attention on auditory global-local processing in children with autism spectrum disorder. *Journal of Autism and Developmental Disorders*, *46*(4), 1415–28. https://doi.org/10.1007/s10803-015-2684-2

Frazier, T. W., & Hardan, A. Y. (2017). Equivalence of symptom dimensions in females and males with autism. *Autism : The International Journal of Research and Practice*, *21*(6), 749–759. https://doi.org/10.1177/1362361316660066

Gabriels, R. L., Agnew, J. A., Miller, L. J., Gralla, J., Pan, Z., Goldson, E., … Hooks, E. (2008). Is there a relationship between restricted, repetitive, stereotyped behaviors and interests

and abnormal sensory response in children with autism spectrum disorders? *Research in Autism Spectrum Disorders*, *2*(4), 660–670. https://doi.org/10.1016/j.rasd.2008.02.002

Gal, E., Cermak, S., & Ben-Sasson, A. (2007). Sensory processing disorders in children with autism. In R. L. Gabriels & D. E. Hill (Eds.), Growing up with autism: Working with school-age children and adolescents. *New York: Guilford Press*.

Germani, T., Zwaigenbaum, L., Bryson, S., Brian, J., Smith, I., Roberts, W., … Vaillancourt, T. (2014). Brief report: assessment of early sensory processing in infants at high-risk of autism spectrum disorder. *Journal of Autism and Developmental Disorders*, *44*(12), 3264–70. https://doi.org/10.1007/s10803-014-2175-x

Green, S. A., Rudie, J. D., Colich, N. L., Wood, J. J., Shirinyan, D., Hernandez, L., … Bookheimer, S. Y. (2013). Overreactive brain responses to sensory stimuli in youth with autism spectrum disorders. *Journal of the American Academy of Child & Adolescent Psychiatry*, *52*(11), 1158–1172. https://doi.org/10.1016/j.jaac.2013.08.004

Grove, R., Hoekstra, R. A., Wierda, M., & Begeer, S. (2018). Special interests and subjective wellbeing in autistic adults. *Autism Research*, *11*(5), 766–775. https://doi.org/10.1002/aur.1931

Halladay, A. K., Bishop, S., Constantino, J. N., Daniels, A. M., Koenig, K., Palmer, K., … Szatmari, P. (2015). Sex and gender differences in autism spectrum disorder: summarizing evidence gaps and identifying emerging areas of priority. *Molecular Autism*, *6*, 36–36. https://doi.org/10.1186/s13229-015-0019-y

Harrop, C., Jones, D., Zheng, S., Nowell, S. W., Boyd, B. A., & Sasson, N. (2018). Sex differences in social attention in autism spectrum disorder. *Autism Research*, *11*(9), 1264–1275. https://doi.org/10.1002/aur.1997

Head, A. M., McGillivray, J. A., & Stokes, M. A. (2014). Gender differences in emotionality and sociability in children with autism spectrum disorders. *Molecular Autism*, *5*(1), 19–19. https://doi.org/10.1186/2040-2392-5-19

Hedger, N., Dubey, I., & Chakrabarti, B. (2020). Social orienting and social seeking behaviors in asd. a meta analytic investigation. *Neuroscience and Biobehavioral Reviews*, *119*, 376–395. https://doi.org/10.1016/j.neubiorev.2020.10.003

Hellendoorn, A., Wijnroks, L., & Leseman, P. (2014). The relationship between atypical visual processing and social skills in young children with autism. *Research in Developmental Disabilities*, *35*(2).

Hilton, C., Graver, K., & LaVesser, P. (2007). Relationship between social competence and sensory processing in children with high functioning autism spectrum disorders. *Research in Autism Spectrum Disorders*, *1*(2), 164–173. https://doi.org/10.1016/j.rasd.2006.10.002

Hull, L., Petrides, K. V., & Mandy, W. (2020). The female autism phenotype and camouflaging: a narrative review. *Review Journal of Autism and Developmental Disorders*, *7*(4), 306–317. https://doi.org/10.1007/s40489-020-00197-9

Järvinen-Pasley, A., & Heaton, P. (2007). Evidence for reduced domain-specificity in auditory processing in autism. *Developmental Science*, *10*(6), 786–793.

Hoekstra, R. A., Bartels, M., Cath, D. C., & Boomsma, D. I. (2008). Factor structure, reliability and criterion validity of the autism-spectrum quotient (aq): a study in dutch population and patient groups. Journal of Autism and Developmental Disorders, 38(8), 1555–1566. https://doi.org/10.1007/s10803-008-0538-x

Kaiser, M. D., Yang, D. Y., Voos, A. C., Bennett, R. H., Gordon, I., Pretzsch, C., … Pelphrey, K. A. (2016). Brain mechanisms for processing affective (and nonaffective) touch are atypical in autism. *Cerebral Cortex (New York, N.y. : 1991)*, *26*(6), 2705–14. https://doi.org/10.1093/cercor/bhv125

Kanner, L., 1943. Autistic disturbances of affective contact. *Nervous Child 2*, 217–250

Kern, J. K., Trivedi, M. H., Garver, C. R., Grannemann, B. D., Andrews, A. A., Savla, J. S., … Schroeder, J. L. (2006). The pattern of sensory processing abnormalities in autism. *Autism : The International Journal of Research and Practice*, *10*(5), 480–94

Muratori, F., Tonacci, A., Billeci, L., Catalucci, T., Igliozzi, R., Calderoni, S., & Narzisi, A. (2017). Olfactory processing in male children with autism: Atypical odor threshold and identification. *Journal of Autism and Developmental Disorders*, *47*(10), 3243–3251. https://doi-org.proxy-ub.rug.nl/10.1007/s10803-017-3250-x

Qualtrics. (2020). Provo, Utah, USA: Qualtrics. Retrieved from https://www.qualtrics.com

Robertson, C. E., & Baron-Cohen, S. (2017). Sensory perception in autism. *Nature Reviews. Neuroscience*, *18*(11), 671–684. https://doi.org/10.1038/nrn.2017.112

Ronconi, L., Molteni, M., & Casartelli, L. (2016). Building blocks of others' understanding: a perspective shift in investigating social-communicative deficit in autism. *Frontiers in Human Neuroscience*, *10*, 144–144. https://doi.org/10.3389/fnhum.2016.00144

Schulz, S. E., & Stevenson, R. A. (2019). Sensory hypersensitivity predicts repetitive behaviours in autistic and typically-developing children. *Autism : The International Journal of Research and Practice*, *23*(4), 1028–1041. https://doi.org/10.1177/1362361318774559

Schulz, S. E., & Stevenson, R. A. (2020). Differentiating between sensory sensitivity and sensory reactivity in relation to restricted interests and repetitive behaviours. *Autism : The International Journal of Research and Practice*, *24*(1), 121–134. https://doi.org/10.1177/1362361319850402

Sedgewick, F., Hill, V., & Pellicano, E. (2019). 'it's different for girls': gender differences in the friendships and conflict of autistic and neurotypical adolescents. *Autism : The International Journal of Research and Practice*, *23*(5), 1119–1132. https://doi.org/10.1177/1362361318794930

Smith, S. A., Press, B., Koenig, K. P., & Kinnealey, M. (2005). Effects of Sensory Integration Intervention on Self-Stimulating and Self-Injurious Behaviors. American Journal of Occupational Therapy, 59(4), 418–425. https://doi-org.proxy-ub.rug.nl/10.5014/ajot.59.4.418

Thye, M. D., Bednarz, H. M., Herringshaw, A. J., Sartin, E. B., & Kana, R. K. (2018). The impact of atypical sensory processing on social impairments in autism spectrum disorder. *Developmental Cognitive Neuroscience.* https://nls.ldls.org.uk/welcome.html?ark:/81055/vdc_100058470136.0x00000a.

Tomchek, S. D., & Dunn, W. (2007). Sensory processing in children with and without autism: a comparative study using the short sensory profile. *The American Journal of Occupational Therapy : Official Publication of the American Occupational Therapy Association*, *61*(2), 190–200.

Van, W.-C. P. J. M., Van, E. E., Groen, W. B., Van, D. P. A., Oosterling, I. J., & Van, D. G. R. J. (2014). Gender and age differences in the core triad of impairments in autism spectrum disorders: a systematic review and meta-analysis. *Journal of Autism and Developmental Disorders*, *44*(3), 627–635. https://doi.org/10.1007/s10803-013-1913-9

Vine Foggo, R. S., & Webster, A. A. (2017). Understanding the social experiences of adolescent females on the autism spectrum. *Research in Autism Spectrum Disorders, 35*, 74–85. https://doi.org/10.1016/j.rasd.2016.11.006

Wouters, D (2021). De verschillen tussen mannen en vrouwen op de AQ en AQ-f.

Appendix

Table 1

The items from the AQf-NL in Dutch that are included in the revised version from Wouters (2021)

Sociaal Inzicht	
	2. Ik ga tegen mijn zin in naar sociale gebeurtenissen, omdat dat van mij verwacht wordt
	15. Andere mensen zeggen dat ik in het eerste contact sociaal overkom, maar dat gaat echt niet vanzelf
	17. Ik kan goed vriendschappen onderhouden
	19. In een gesprek voel ik me er vaak buiten staan
	28. Ik ga tegen mijn zin in naar sociale gebeurtenissen, omdat ik bang ben dat ik er anders niet bij hoor
	32. Ik voel geen connectie met anderen in een gesprek
	33. Ik doe al jaren alsof ik sociaal ben, maar dat ben ik eigenlijk niet
	41. Ik vind het gemakkelijk om mijn problemen met vrienden te delen
Communicatie	
	1. Andere mensen snappen vaak niet wat ik bedoel te zeggen
	21. Ik zoek bewust uit hoe ik mijn gevoelens moet uiten
	27. Om mezelf een houding te geven kijk ik continue bewust wat anderen doen
	31. Ik denk na afloop van een gesprek vaak lang na over wat iemand eigenlijk bedoelde
	34. Ik heb mezelf bewust aangeleerd welke zinnen ik het beste kan gebruiken in een gesprek
	44. In een gesprek met meerdere mensen val ik stil
	49. Ik kijk meestal bewust bij anderen af wat ik moet zeggen

	50. Ik denk een gesprek van tevoren vaak helemaal uit
Sensorische Prikkelverwerking	
	4. Contact met anderen geeft mij energie
	7. Als ik teveel aan mijn hoofd heb, dan barst ik in huilen uit
	9. De gewone dagelijkse activiteiten zijn voor mij heel vermoeiend
	11. Ik vind het lastig om mijn lijf goed te voelen
	12. Na een drukke dag moet ik een paar dagen niks doen
	14. Ik vergeet vaak te eten of te drinken
	16. Contact met andere mensen is voor mij heel vermoeiend
	22. Ik eet veel dingen niet, omdat ze niet lekker voelen, proeven of smaken
	23. Ik heb periodes met lichamelijke pijn en/of klachten zonder duidelijke oorzaak
	24. Ik raak van slag als de sfeer in een groep niet goed is
	26. Ik merk uitputting en overbelasting veel te laat op
	29. Ik raak van slag als de stemming van een ander niet goed is
	36. Ik doe mijn hele leven al meer dan ik eigenlijk aankan
	37. Ik voel me niet prettig in een drukke omgeving met veel geluid, licht en/of geur
	45. Ik voel niet goed of ik dorst of honger heb

Table 2

Test of Normality for Subscales of the AQ-NL and AQf-NL Using the Kolmogorov-Smirnov

	AQ-NL		AQf-NL	
AASP-NL Quadrant	Statistic	Significance	Statistic	Significance
Social Skill	.212	.00	.205	.00
Communication	.155	.00	.158	.00
Attention to Detail	.124	.00	.139	.00
Attention Switching	.155	.00	.155	.00

Note: $N = 243$

$P < .01$

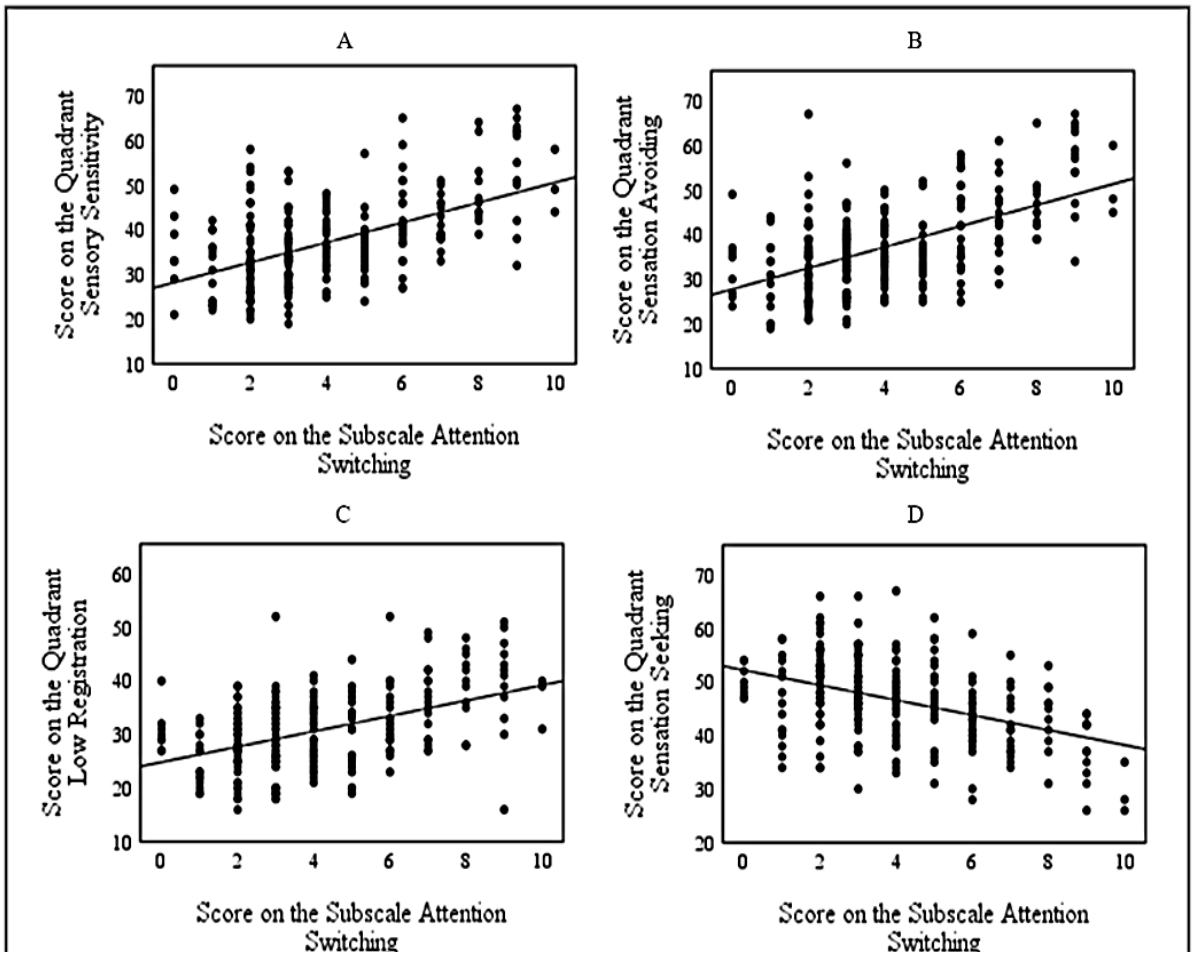

Figure 1. Scatter diagrams showing the relation between the AQ-NL subscale "Attention Switching" and the Sensory Profile-NL quadrants A) "Sensory Sensitivity", B) "Sensation Avoiding", C) "Low Registration" and D) "Sensation Seeking".

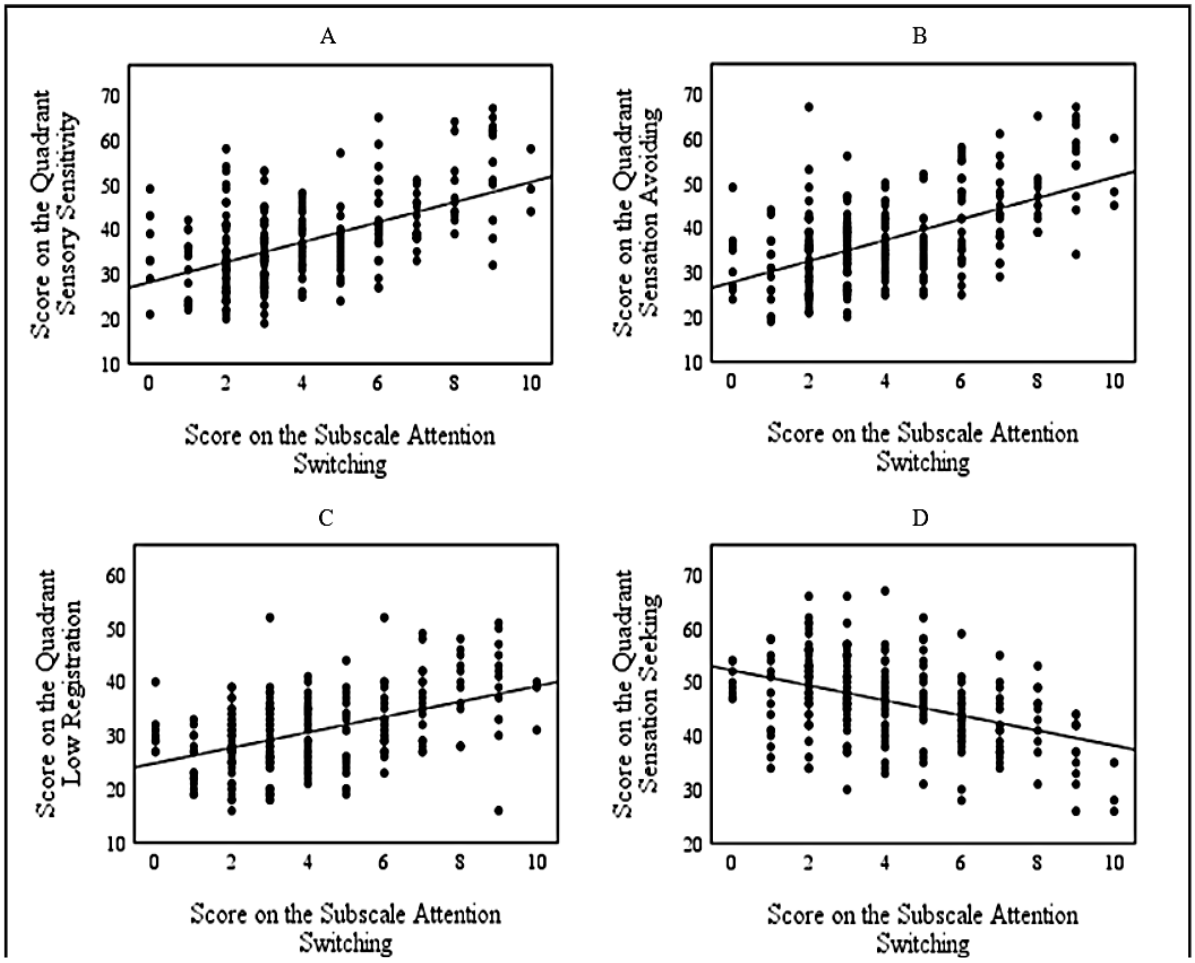

Figure 2. Scatter diagrams showing the relation between the AQf-NL subscale "Attention Switching" and the Sensory Profile-NL quadrants A) "Sensory Sensitivity", B) "Sensation Avoiding", C) "Low Registration" and D) "Sensation Seeking".

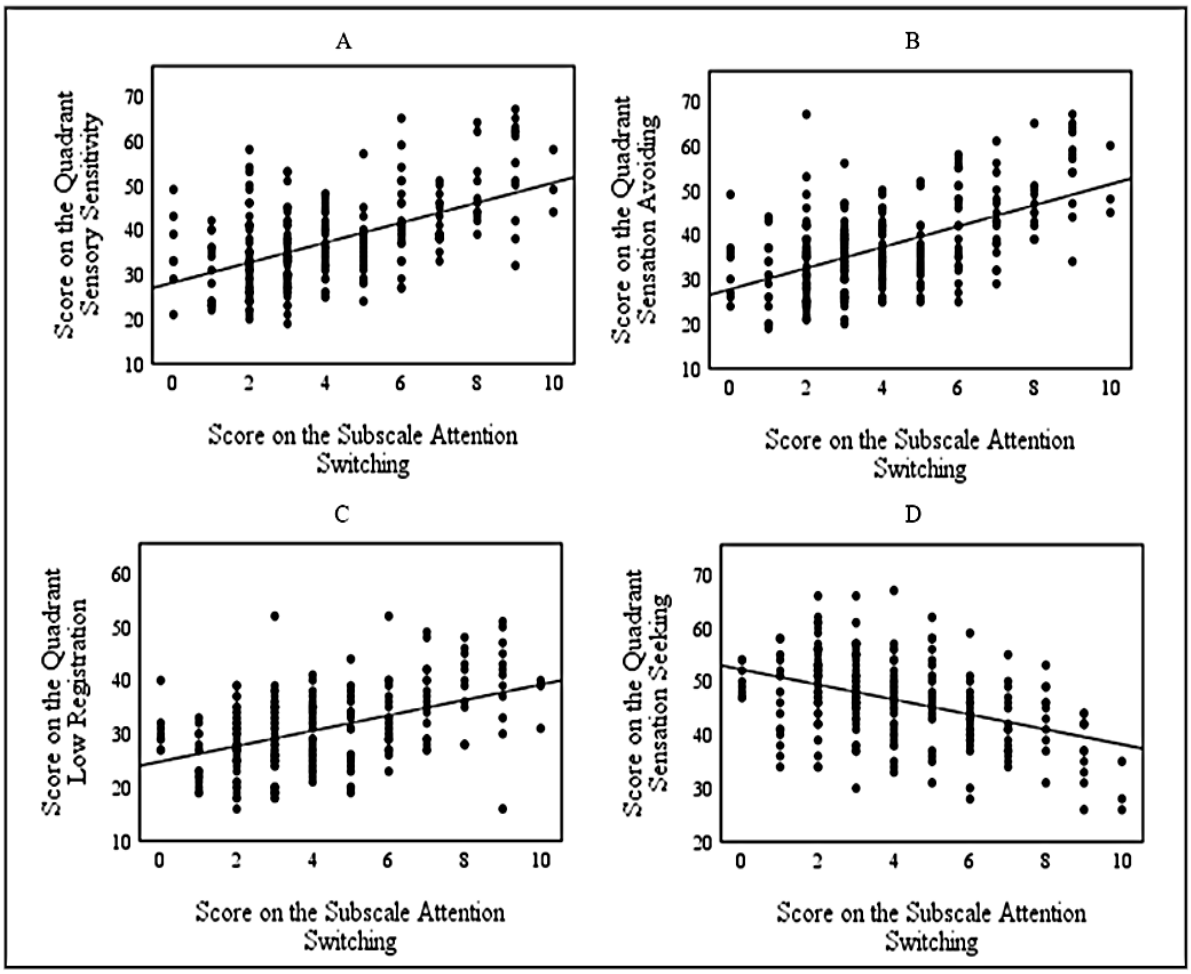

Figure 3. Scatter diagrams showing the relation between the AQ-NL subscale "Attention to Detail" and the Sensory Profile-NL quadrants A) "Sensory Sensitivity", B) "Sensation Avoiding", C) "Low Registration" and D) "Sensation Seeking".

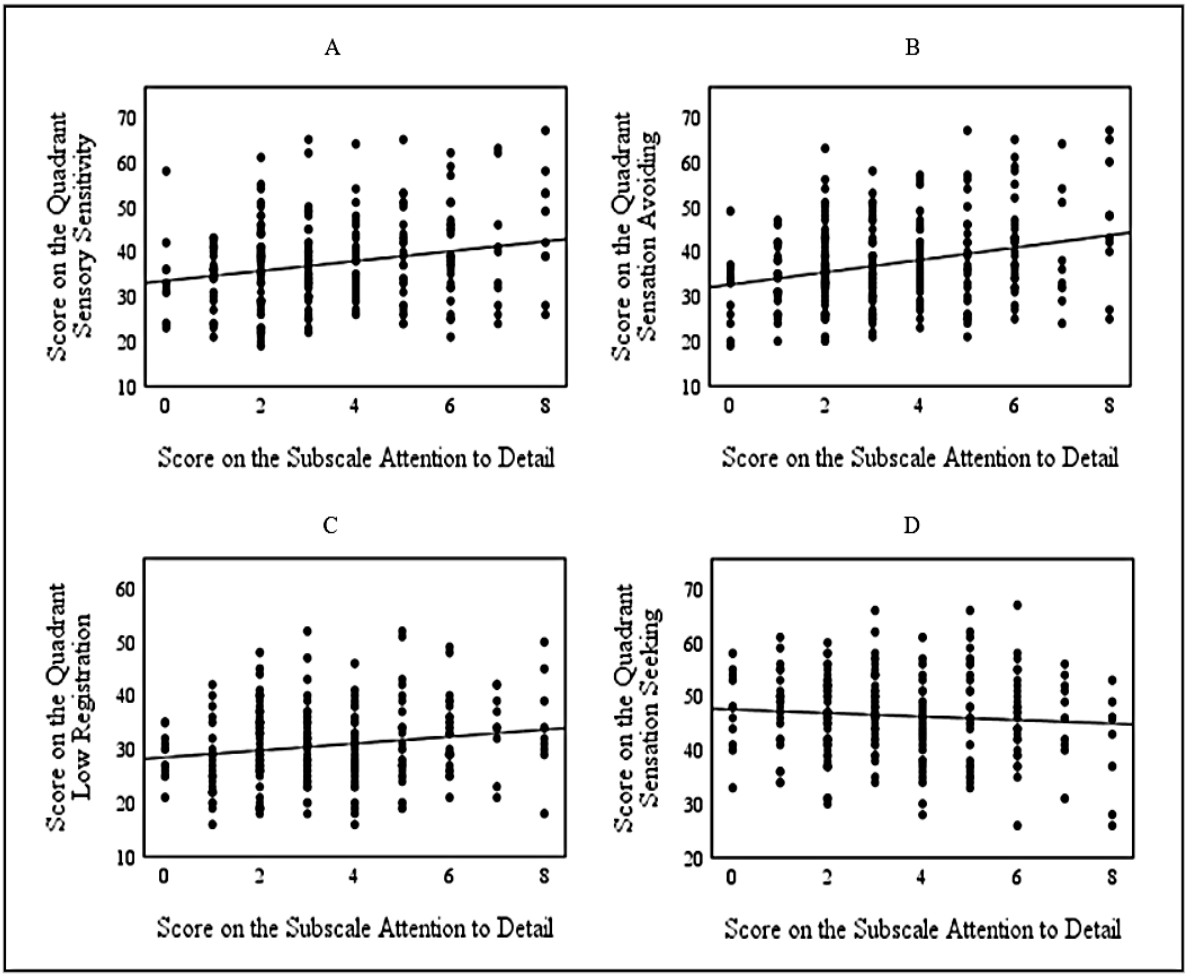

Figure 4. Scatter diagrams showing the relation between the AQf-NL subscale "Attention to Detail" and the Sensory Profile-NL quadrants A) "Sensory Sensitivity", B) "Sensation Avoiding", C) "Low Registration" and D) "Sensation Seeking".

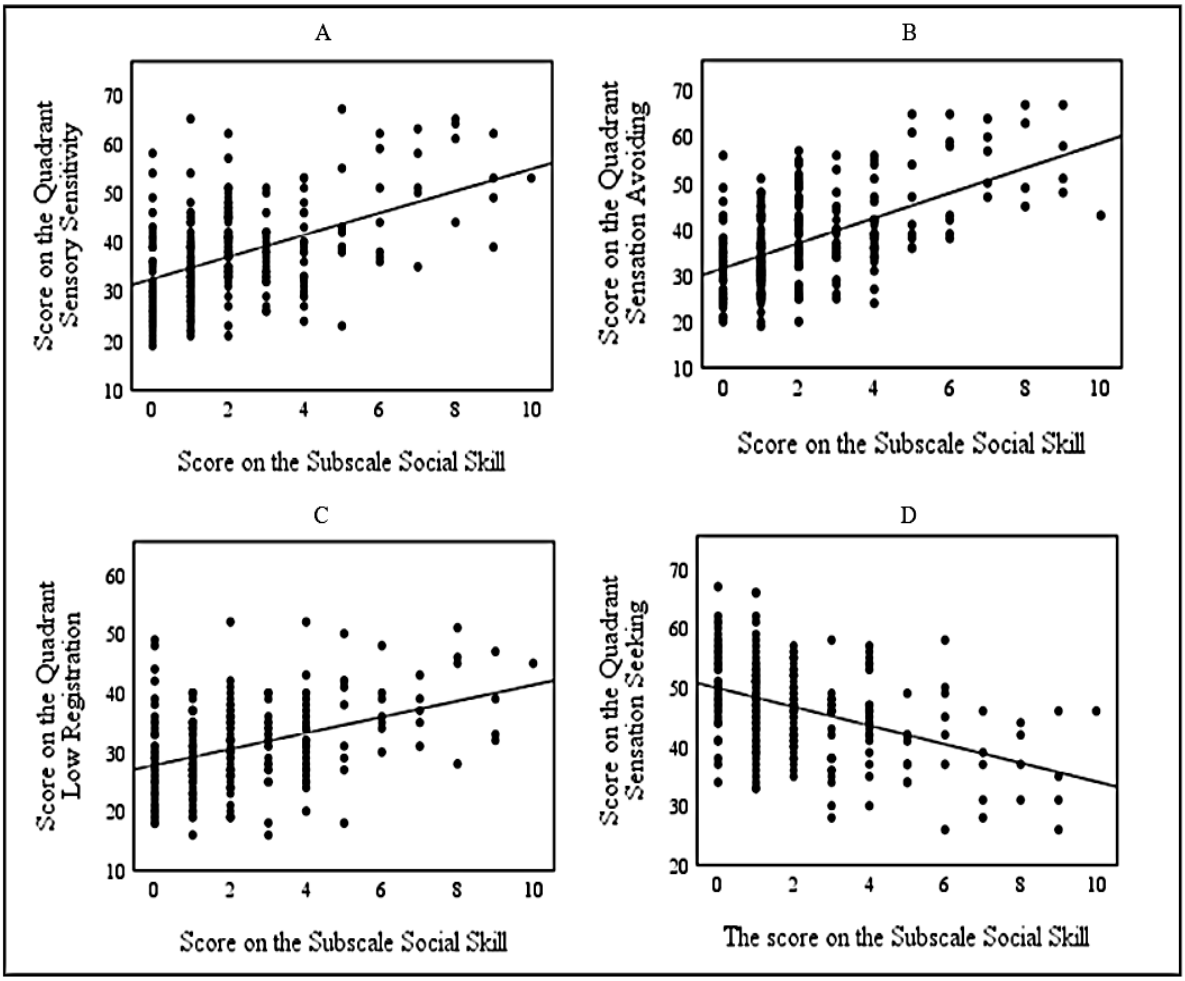

Figure 5. Scatter diagrams showing the relation between the AQ-NL subscale "Social Skill" and the Sensory Profile-NL quadrants A) "Sensory Sensitivity", B) "Sensation Avoiding", C) "Low Registration" and D) "Sensation Seeking".

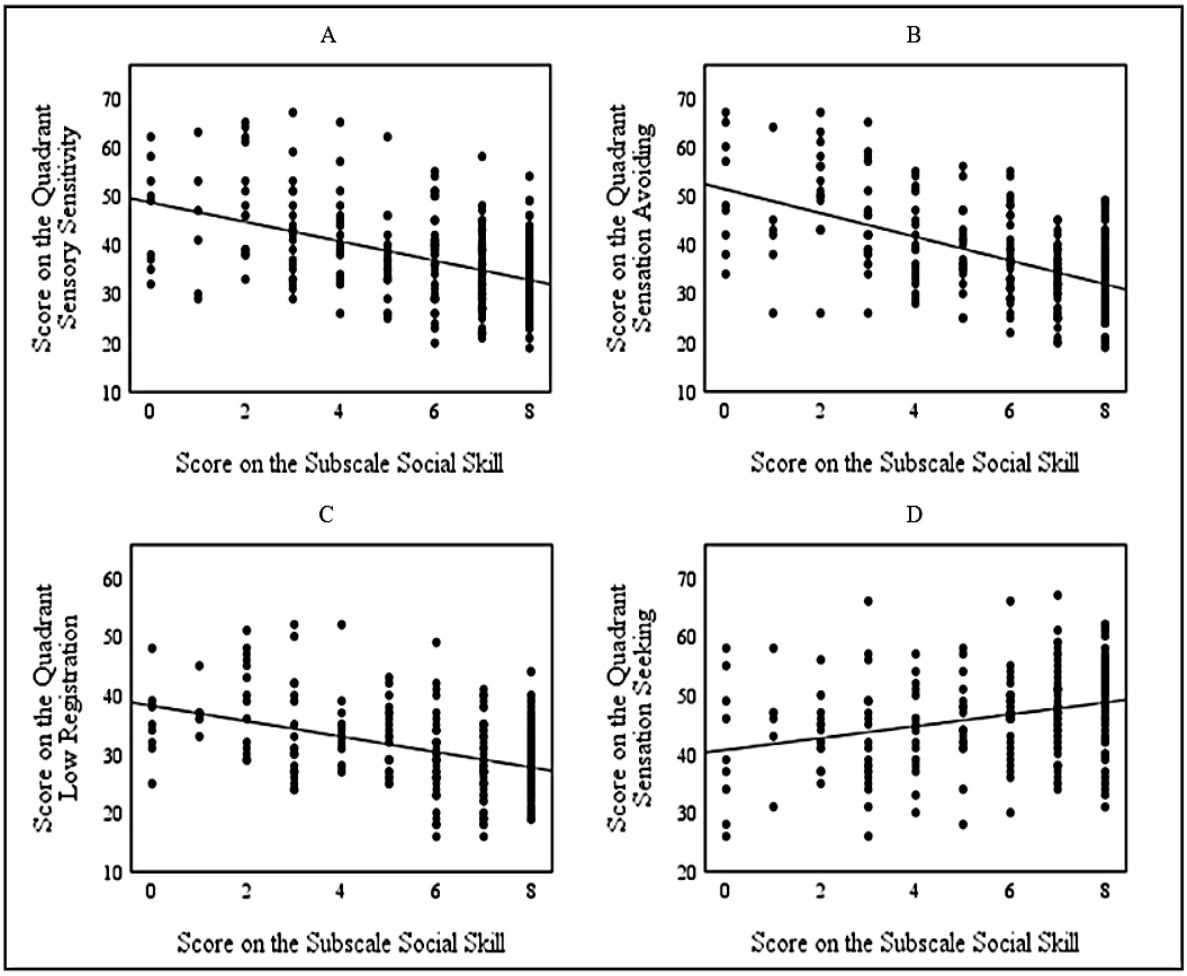

Figure 6. Scatter diagrams showing the relation between the AQf-NL subscale "Social Skill" and the Sensory Profile-NL quadrants A) "Sensory Sensitivity", B) "Sensation Avoiding", C) "Low Registration" and D) "Sensation Seeking".

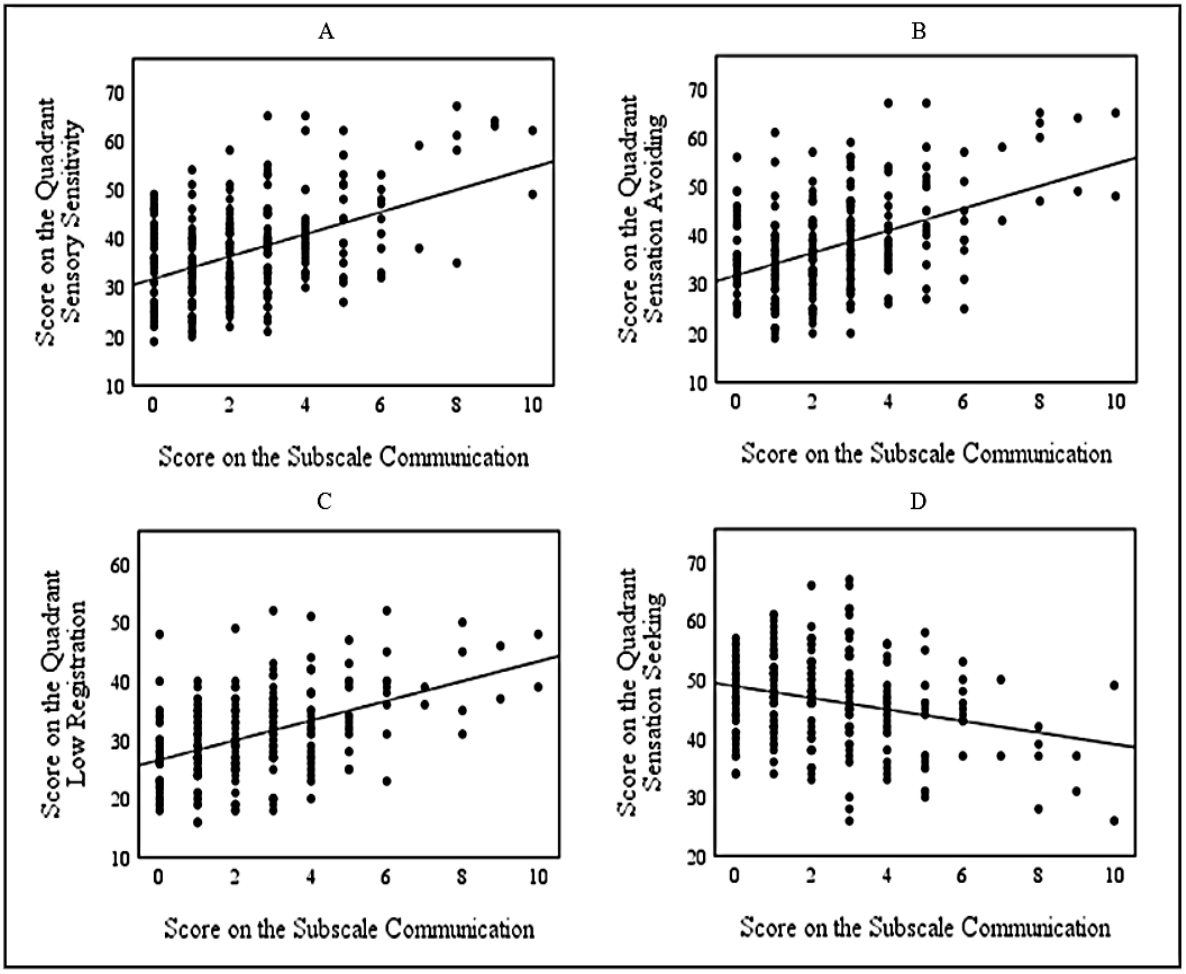

Figure 7. Scatter diagrams showing the relation between the AQ-NL subscale "Communication" and the Sensory Profile-NL quadrants A) "Sensory Sensitivity", B) "Sensation Avoiding", C) "Low Registration" and D) "Sensation Seeking".

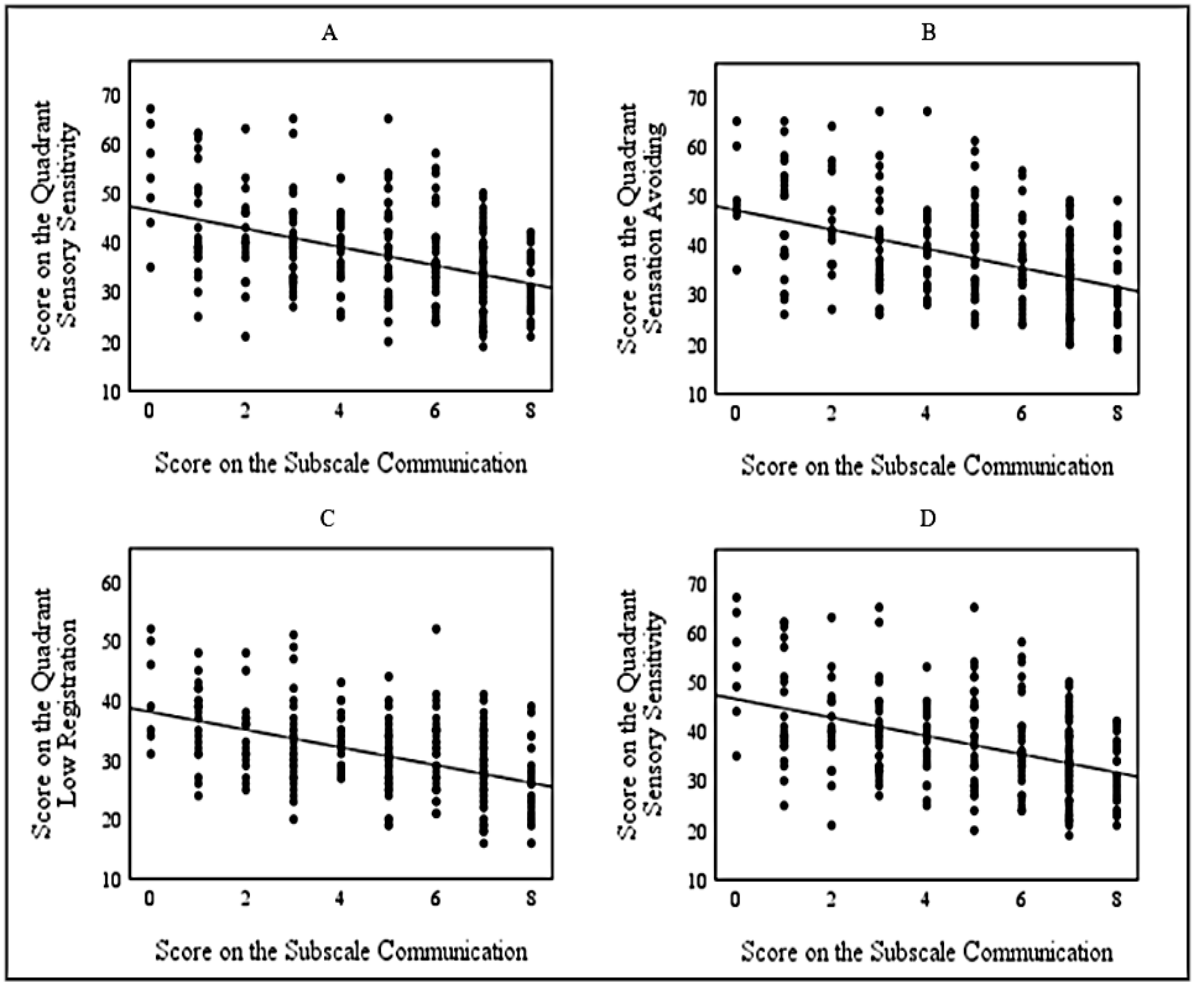

Figure 8. Scatter diagrams showing the relation between the AQf-NL subscale "Communication" and the Sensory Profile-NL quadrants A) "Sensory Sensitivity", B) "Sensation Avoiding", C) "Low Registration" and D) "Sensation Seeking".