1. Introduction

Aron and Aron (1997) described Sensory Processing Sensitivity (SPS) as a genetically determined temperamental or personality trait which is present in some individuals and reflects an increased sensitivity of the central nervous system and a deeper cognitive processing of physical, social and emotional stimuli (Aron, Aron, & Jagiellowicz, 2012). The terms "hypersensitivity" or "highly sensitive", which are popular synonyms for the scientific concept of SPS, are increasingly used in psychological practice both with adults and with children. However, despite the rising popularity of the concept in general society and previous research on different genes, patterns of brain activation, behaviors, and physiological reactions associated with high SPS (see Aron, Aron, & Jagiellowicz, 2012 for an overview), there is still a lack of fundamental, empirical and independent scientific evidence for the temperamental concept of SPS. The present study has to be considered as exploratory since it is, to our knowledge, the first which examines SPS in children.

Aron and Aron (1997) suggested that the trait would be present in 15 to 20 percent of the population. Individuals with high SPS are believed to be easily overstimulated by external stimuli because they have a lower perceptual threshold and process stimuli cognitively deeper than most other people. In addition, they would respond more to cues in the environment by comparing them to previous experiences with similar cues. This may result in taking more time to observe and react slower whereby they seem less prone to act when confronted with a new situation and have more aversion towards risk-taking (Aron, Aron, & Jagiellowicz, 2012). Further, research in evolutionary biology provides evidence that the trait of SPS can be observed in over 100 nonhuman species in the form of sensitivity, responsiveness, plasticity and flexibility (Wolf, van Doorn, & Weissing, 2008).

Aron et al. (2012) state that both introversion (the inhibition of social behaviors) and neuroticism (the reporting of intense negative emotion) could theoretically, in some cases, be

aspects of a general sensitivity. Both Aron and Aron (1997) and Smolewska, McCabe and Woody (2006) undertook systematic statistical comparisons of the sensitivity measure and several measures of traditional personality traits of introversion and neuroticism to examine similarities and differences between SPS, introversion and neuroticism. Their findings indicated that SPS is a unique personality trait which deserves to be examined separately. This is an important finding, since the trait of sensitivity has often been confused with introversion and neuroticism in previous research on personality (see also Aron et al. 2012).

A low sensory threshold, an important characteristic of high SPS, is also present in different sensory processing patterns and disorders, such as "sensory sensitivity" and "sensory avoiding" (Dunn, 2001), "sensory defensiveness" (Ayres, 1963) and "Sensory Over-Responsivity" (SOR; Miller et al., 2007). It is important to note that, although SPS seems to be associated with these sensory processing patterns and disorders, it concerns a temperamental trait and should therefore not be confused with these disorders. However, the conceptual overlap between these various constructs shows the extensive interdisciplinary interest in characteristics of hypersensitivity and emphasizes the theoretical and practical importance of the concept.

The processing of sensory events, as a part of everyday life, is suggested to have a significant impact on human experience and behavior. In adults, high SPS is associated with high levels of stress, symptoms of ill-health, alexithymia, anxiety and depression (Benham, 2006; Liss, Mailloux, & Erchull, 2008; Liss, Timmel, Baxley, & Killingsworth, 2005), and in combination with a negative childhood environment, also with negative affectivity and shyness (Aron, Aron, & Davies, 2005). Sensory processing may interfere with the participation in daily activities, and social, cognitive, and sensorimotor development in children as well (Dunn, 2001). Despite the fact that no research seems to directly examine the association between high SPS and problems in the daily functioning of children, a number of studies examined the relationship with different sensory processing patterns and disorders. Although temperamental SPS and the different sensory processing patterns and disorders are not the same, they do have a low sensory threshold in common and can thus provide preliminary insight into the association

between high SPS and problems in daily functioning. Research showed that "Sensory sensitivity" is associated with sleeping and behavioral problems (Reynolds, Lane, & Thacker, 2012; Shochat, Tzischinsky, & Engel-Yeger, 2009), and ritualism and obsessive compulsive disorder (OCD) symptoms (Dar, Kahn, & Carmeli, 2012). "Sensory defensiveness" is related to eating, learning and other social, emotional and behavioral problems (Smith, Roux, Naidoo, & Venter, 2005; Stephens & Royeen, 1998). "Sensory Over-Responsivity" is related to internalizing and externalizing problems, impaired emotion regulation, and less adaptive social behavior, and seems to be more frequently present in children with clinically significant anxiety (Ben-Sasson, Carter, & Briggs-Gowan, 2009; Conelea, Carter, & Freeman, 2014). Further, research from Gourley, Wind, Henninger and Chinitz (2013) found that in a sample of children with a wide range of developmental and behavioral diagnoses the presence of sensory processing difficulties was related with more internalizing and externalizing behavioral problems. Furthermore, in children with an autism spectrum disorder (ASD), 'Sensory Sensitivity', 'Sensory Avoiding', 'Sensory Defensiveness' and 'Sensory Over-Responsivity', are related with more negative emotional reactions and more fear (Baranek, David, Poe, Stone, & Watson, 2006; Ben-Sasson, Hen, et al., 2009; Green, Ben-Sasson, Soto, & Carter, 2012; Green & Ben-Sasson, 2010; Kientz & Dunn, 1997; Pfeiffer, Kinnealey, Reed, & Herzberg, 2005). Overall, it can be concluded that different aspects of increased SPS seem to be mainly associated with internalizing problems. This emphasizes the need for a fundamental scientific framework for understanding the temperamental trait of SPS in children.

To measure individual differences in SPS in adults, Aron and Aron (1997) developed the self-report 27-item Highly Sensitive Person Scale (HSPS), containing items that measure sensitivity to a large variety of stimuli, the extent to which an individual quickly feels overwhelmed by intense sensory input, and artistic and emotional sensitivity. For research purposes, the items of the HSPS are rated on a 5- or 7-point Likert scale. However, there is also a yes/no response format available in the popular books and website of Elaine N. Aron. Despite the variety of types of sensitivity in the items, the HSPS was initially reported to have a one-

dimensional structure (Aron & Aron, 1997) and was shown to have adequate reliability, content-oriented validity, and validity regarding relationships with conceptually related constructs (American Educational Research Association, American Psychological Association, & National Council On Measurement In Education, 2014; Aron & Aron, 1997; Benham, 2006; Evans & Rothbart, 2008; Liss et al., 2008; Smolewska et al., 2006). To determine whether a person has high SPS or not on a group level, Aron and Aron use a relative cut-off score of the top 20 percent. This cut-off score is based on previous research which suggested that SPS in adults is best considered as a dichotomous category variable with a visible break point in the sample distribution around the 10 to 35 percent (for an overview of the studies on the sample distribution of SPS see Aron et al., 2012). The dimensionality of the HSPS in adults was examined by three independent studies. Liss et al. (2008) and Smolewska et al. (2006) revealed a post-hoc three-factor structure, with a strong intercorrelation between the factors suggesting a single higher order construct. Evans and Rothbart (2008) however, proposed a two-factor solution very similar to their model of adult temperament (Evans & Rothbart, 2007). More recently, Aron theoretically redefined the different facets of SPS using the acronym "DOES" (Aron et al., 2012; Aron, 2010, 2012). "Depth of Processing" includes features like empathy, conscientiousness, having intensive feelings for others, having living dreams and a rich imagination, and the presence of a general thoughtfulness or awareness of long term consequences (i.e. "pause-to-check approach"). "Overstimulation" refers to the presence of a more frequent and stronger autonomic arousal towards situations which are perceived as stressful. "Emotional Intensity" refers to the presence of both more intense negative and positive emotional responses. Finally, "Sensory Sensitivity" refers to the presence of a low pain threshold and a low tolerance of high levels of sensory input, and noticing subtle differences. It can be assumed that the presence of these four characteristics has a considerable influence on the daily functioning of children and is associated with different internalizing and externalizing behavioral problems. According to Aron and colleagues, these four factors would load together on the unidimensional construct of SPS. However, until now there has been a lack of empirical

evidence to support this theoretical four-factor model. Moreover, there is no explicit model available of which items from the HSPS load on the different theoretical factors, and some items seem to have a conceptual overlap which makes it impossible to compose an a priori factor model (see also table 1).

In analogy with the adult questionnaire, a 23-item parent-report questionnaire for children was developed and published in Aron's book "The Highly Sensitive Child (HSC)" (Aron, 2002). It is important to note that the items of the HSPS for children have a different content and number compared to the adult HSPS. Unlike its adult counterpart, the reliability, distribution, validity and dimensionality have not yet been investigated. Given the increasing use of the concept of "high sensitivity" in children, an instrument objectively measuring this trait is urgently needed.

The first goal of the present study was to explore the underlying factor structure of Aron's 23-item HSPS for children. Until now, research only focused on the factor structure of the HSPS for adults, resulting in a three- or two-factor model. However, based on the fundamental differences between the HSPS for children and the HSPS for adults, and the lack of an explicit model for the DOES-theory in SPS, there was no a priori factor model for the HSPS in children available that could be tested, except for the one-factor structure as proposed by Aron and Aron (1997).

The second goal was to investigate the association between high SPS and problems in daily functioning. First, differences in problems in daily functioning such as antisocial behavior, Medically Unexplained Physical Symptoms (MUPS) and, sleeping, eating and drinking problems between a group of children with high SPS and a group of children with average or low SPS were examined. Based on different studies including partial aspects of SPS such as "sensory sensitivity" (Dunn, 2001), we expected that children in the high SPS group would have more problems in their daily functioning, especially internalizing problems. Second, differences in the factors of the HSPS and the total 23-item HSPS, as used in clinical practice, were identified between children with few versus many problems in daily functioning. Again, children with especially more internalizing problems were expected to have higher SPS in

general and more specifically, were also expected to have higher scores on the characteristic of SPS that is associated with sensory (hyper)sensitivity.

2. Method

2.1 Procedure and participants

The present study was part of a broader online survey on temperament and behavioral functioning and was approved by the appropriate ethics committee in April 2013. Participation was voluntary and anonymous.

Caregivers of 235 children and adolescents (53.20% boys) between 3 and 16 years (*M*=8.27, SD=3.28) fully completed the 23-item HSPS along with questions about their children's problems in daily functioning. Initially, 258 respondents started to fill out the survey but 33 (14%) did not complete it. Based on the exploratory nature and the relatively large sample size of the present study, we decided to not impute the missing data.

The survey was distributed in Flanders, Belgium. Most questionnaires (*n*=223; 94.89%) were filled out by the biological mother of the child, 11 (4.68%) by the biological father and one (0.43%) by the grandmother. Most respondents (*n*=189; 80.43%) and also their partners (*n*=145; 61.70%) had a higher education.

To examine differences in problems in the daily functioning, two independent samples were selected from this original sample: a sample of children scoring high on SPS (i.e. high SPS group) and a control group scoring average or low on SPS. First, the 20% children (*N*=48) with the highest total scores on the HSPS (range 98-114) were selected for the high SPS group, as theoretically suggested by Aron and Aron (1997). Since problems in daily functioning could be associated with the presence of a clinical diagnosis instead of temperamental sensitivity, we excluded all children (*n*=7; 14.58%) with externalizing, internalizing, or developmental disorders. Based on parental report, clinical diagnoses were determined by a multidisciplinary

team or by accredited psychologists, speech therapists, child psychiatrists, pediatricians and pediatric neurologists. This resulted in a high SPS group of 41 children with 19 boys and 22 girls between 4 and 15 years (*M*=7.33, SD=2.43). The remaining 80% of children (*N*=187) with an average or low total score on the HSPS (range 39–97) comprised the control group. Again, all children with a clinical diagnosis (*n*=45; 24.06%) were excluded, resulting in a control group of 142 children with 69 boys and 73 girls between 3 and 16 years (*M*=7.95, SD=3.47). No significant gender ($\chi^2(1)=.065$, $p=.799$), respondent ($\chi^2(1)=.575$, $p=.750$) respondent education ($\chi^2(1)=1.886$, $p=.930$) and age ($U(183)=3{,}000$; $p=.765$) differences were found between the high SPS group and the control group. Since the scores on the variable age were not normally distributed ($D(183)=.160$, $p<.001$), a non-parametric Mann-Whitney U-test was used.

2.2 Measures

The parent-report 23-item Highly Sensitive Person Scale (HSPS; Aron, 2002). In the present study the 23-item parent-report HSPS, designed for measuring SPS in children and adolescents, was used. The questionnaire was published in a book about high sensitivity in children (Aron, 2002) and was based on the adult version of the HSPS (Aron & Aron, 1997). The Dutch translation of the questionnaire was published by Aron (2004) and Daele and T'Kindt (2011). In order to obtain sufficient variation in scores and according to previous research on the HSPS in adults, we decided to rate each item on a 5-point Likert scale (1="strongly disagree"; 5="strongly agree").

Measures of problems in daily functioning. Medically Unexplained Physical Symptoms (MUPS) were explored with the question: "Does your child often complain about headaches, stomach ache/abdominal pain or nausea without apparent medical reason?". Items that investigated sleeping problems were: "When going to bed, does your child often fall asleep within ten minutes?" and "Does your child have problems to fall back asleep when he/she

wakes up at night?". Further, questions regarding eating and drinking problems were: "Does your child sometimes refuse eating different kinds of food, e.g., certain tastes or textures, such as food with lumps?", "Does your child sometimes eat excessively or is it sometimes difficult to stop him/her from eating?", "Does your child sometimes drink excessively or is it sometimes difficult to stop him/her from drinking?" and "Does your child not drink at all during an entire day?". Furthermore, the presence of antisocial behavior was also explored: "Does your child often lie to others or deceive others?", "Does your child sometimes steal things?" and "Does your child often argue or fight with other children, or does he/she bully them?". Finally, the question "Did your child cry often when he/she was a baby?" was asked. In accordance with the HSPS, each item was rated from one to 5 (1="almost never true"; 5="almost always true").

2.3 Statistical analyses

First, Cronbach's alpha was computed as a measure of internal consistency and the distribution of the HSPS total scores was examined to validate if SPS in children can be considered as a dichotomous variable. Second, to extract the underlying factor structure of the HSPS in children, an Exploratory Factor Analysis (EFA) with oblimin oblique rotation was applied to 60 percent of the sample. To select the number of factors to retain, both the Scree Plot (Cattell, 1966), the Velicer (1976) minimum average partial (MAP) test and Horn's Parallel Analysis (Horn, 1965) were conducted. Third, a Confirmatory Factor Analysis (CFA) was conducted on the other 40 percent of the sample to evaluate and compare the fit of the exploratory factor solution with a one-factor solution. Fourth, the proportion of children in the high SPS and the control group with problems in daily functioning was compared using chi-square tests. Finally, we compared the HSPS total (23-items) and the HSPS factor scores, based on the results of the exploratory analysis, of children with no or little problems to children with some or many problems in both groups using independent sample *t*-tests. As a measure of practical significance, Cohens' *d* was reported (Cohen, 1988).

Within the group analyses, assumptions for parametric testing (additivity and linearity, normality, homogeneity of variance and independence, see also Field, 2013) were met. Further, since most of the items about problems in daily functioning lacked sufficient variation of scores or suggested a bimodal distribution, it was decided to dichotomize the items (0="no or little problems" and 1="some or many problems"). The item about stealing was removed from further analyses due to a floor effect of the scores.

Most analyses were executed in IBM SPSS Statistics for Windows, Version 20.0 (IBM Corp., 2013). Both the Velicer MAP test and Horn's Parallel Analysis were conducted in SPSS using a syntax from O'Connor (2000). The CFA was conducted in Amos 7.0 (Arbuckle, 2006) and to test for multivariate normality we used the program R (R Development Core Team, 2008).

3. Results

3.1 Internal consistency and distribution of the HSPS

The scores of the 23-item parent form of the HSPS had a Cronbach's alpha of .91 (N=235; 95% CI [.90,.93]) suggesting excellent internal consistency (DeVellis, 2012). The total scores of the HSPS did not deviate from the normal distribution ($D(235)$=.912, p=.376).

3.2 Exploratory factor analysis of the HSPS

The sample selected randomly for the EFA consisted of 140 cases and had an alpha coefficient of .91 (95% CI [.89,.93]) for the scores of the HSPS. Assumptions (non-multicollinearity, sampling adequacy and factorability) for EFA were met. The Kaiser-Meyer-Olkin measure of sampling adequacy evaluates tests of fit, and findings were very good at 0.874 (Hutcheson & Sofroniou, 1999). Bartlett's test of sphericity was significant ($\chi^2(253)$=1501,133, p<.001). Using the MVN package in R, the p-values for Mardia's multivariate skew and

Mardia's multivariate kurtosis were <.001 which indicated that the data are not multivariate normally distributed. Therefore, it was decided to use the "principal axis factors" method to extract the factors (Costello & Osborne, 2005). The EFA was followed by an oblique rotation (direct oblimin) to get a theoretically more accurate and reproducible solution (Costello & Osborne, 2005). The Scree Plot (Cattell, 1966) indicated that a two factor solution was optimal (eigenvalues: 8.06, 2.57, 1.38, 1.24, 1.13). Further, both the Velicer (1976) MAP test and Horn's Parallel Analysis (Horn, 1965) also suggested extraction of two factors. Based on this, a two factor solution was specified and accounted for 41,38% of the variance in the items (32.55% and 8.83%). Individual items were retained as indicators of a factor if their loading on that factor was larger than .364 (Stevens, 2002). When an item loaded higher than .364 on two factors, it was also eliminated from further analysis (Costello & Osborne, 2005). These criteria resulted in the elimination of four items: "My child notices the slightest unusual odor." (item 7), "My child notices subtleties." (item 20), "My child considers if it is safe before climbing high." (item 21), and "My child feels things deeply." (item 23). Table 1 shows the rotated factors and their respective items and provides mean inter-item correlations and alphas for each of the two factors. There was acceptable internal consistency for both factors (DeVellis, 2012). Since the scores of factor two were not normally distributed in this sample, Spearman's correlation coefficient was calculated (Hauke & Kossowski, 2011), showing a moderate intercorrelation (ρ=.48, p<.001) between factor one and two. Although the two factors accounted for nearly half of the variance in the items, Cronbach's alpha of the remaining 19 items was .89 (95% CI [.86,.91]), suggesting good internal consistency for the scores on the HSPS.

3.3 Confirmatory factor analysis of the HSPS

The sample selected randomly for the CFA consisted of the other 95 cases and had an alpha coefficient of .92 (95% CI [.89,.94]) for the scores of the HSPS. The fit of a one-factor model was evaluated and compared statistically to the fit of a two-factor model, based on the

foregoing EFA. The χ^2, root mean square error of approximation (RMSEA) and comparative fit index (CFI) are reported. An RMSEA of .08 or less is generally considered an acceptable fit, and fits of .90 or greater are considered acceptable for the CFI (Hu & Bentler, 1999). First, we examined the original one-factor model as suggested by Aron and Aron (1997). According to traditional cut-offs, the fit was not acceptable: $\chi^2(230)=589.216$ ($p<.001$), RMSEA=.129, CFI=.65. Next, a CFA was conducted to examine the two-factor solution: $\chi^2(151)=362.906$ ($p<.001$), RMSEA=.122, CFI=.73. Although the two-factor solution also fell short on the traditional fit indices, the χ^2 test comparing the difference between the one- and the two-factor model showed that the latter model fits the data better [χ^2 (79)=226.31 (p<.001)].

3.4 The association between SPS and problems in daily functioning

Differences in reported problems between high SPS and control children. Table 2 shows the percentages of children in the high SPS or control group with reported problems. Within the high SPS group there were proportionally more children with medically unexplained physical symptoms (MUPS) ($\chi^2(1)=15.833$, $p<.005$), problems to fall asleep ($\chi^2(1)=7.610$, $p<.008$) and fall back asleep ($\chi^2(1)=13.120$, $p<.005$), and eating problems ($\chi^2(1)=14.900$, $p<.005$). On a 5% significance level, there were proportionally less children in the high SPS group who were reported as sometimes or regularly lying and deceiving ($\chi^2(1)=5.312$, $p<.05$).

Differences in SPS between children scoring low vs. high on reported problems. Children with a high level of MUPS had significantly higher scores on the HSPS-total, HSPS-OS and HSPS-DP (($t(181)=5.392$, $p<.002$, $d=.8$), ($t(181)=5.010$, $p<.002$, $d=.7$), and ($t(181)=4.764$, $p<.002$, $d=.7$), respectively). Regarding sleeping problems, children with a high level of problems falling asleep had higher scores on the HSPS-total ($t(181)=3.712$, $p<.002$, $d=.6$) and HSPS-OS ($t(181)=4.214$, $p<.002$, $d=.6$), and on a 5% significance level also on the

HSPS-DP (t(181)=2.508, p<.05, d=.4). Children with a high level of problems falling back asleep also had higher scores on the HSPS-total, HSPS-OS and HSPS-DP ((t(181)=6.467, p<.002, d=1.0), (t(181)=7.433, p<.002, d=1.10), and (t(181)=3.647, p<.002, d=.5), respectively). Further, children with a high level of eating problems had higher scores on the HSPS-total and HSPS-OS ((t(181)=4.606, p<.002, d=.7), and (t(181)=6.001, p<.002, d=.9), respectively). On a 5% significance level, children who drink excessively during the day had higher scores on the HSPS-total (t(181)=2.052, p<.05, d=.3) and HSPS-OS (t(181)=2.099, p<.05, d=.3). Children who do not drink enough had higher scores on the HSPS-total (t(181)=3.905, p<.003, d=.6) and HSPS-OS (t(181)=3.922, p<.002, d=.6) and on a 5% significance level also on the HSPS-DP (t(181)=2.871, p<.05, d=.4). Furthermore, on a 5% significance level, children with a high level of lying and deceiving had lower scores on the HSPS-total, and HSPS-DP ((t(181)=2.643, p<.05, d=.4) and (t(181)=2.897, p<.05, d=.4), respectively). Children with a high level of arguing, fighting and bullying had lower scores on the HSPS-total (t(181)=2.953, p<.05 d=.44), HSPS-OS (t(181)=2.219, p<.05, d=.3) and HSPS-DP (t(181)=2.963, p<.05, d=.4). Children who often cried when they were a baby had higher scores on the HSPS-OS (t(181)=3.055, p<.05, d=.5). See Table 3 for details.

4. Discussion

4.1 The 23-item parent-report HSPS for children

The first goal of the present study was to explore the underlying factor structure of Aron's 23-item parent-report HSPS (Aron, 2002).

Analysis of internal consistency suggested that the scores of the parent form of the HSPS are a reliable measure of SPS in children.

Previous studies of the latent structure of SPS in adults have suggested that the variable is best considered as dichotomous with a break point around 10 to 35 percent (Aron et al., 2005, 2012;

Aron & Aron, 1997). Hence, to decide which children could be considered as having 'high SPS' in the present study, the recommendation of Aron and colleagues to consider the top 20% of the population as 'highly sensitive' was followed. However, similar to the findings from another independent study on SPS in adults (Benham, 2006), the results of the present study demonstrated that SPS in children is best considered as a continuous variable without a clear cut-off. Further research in both adults and children is needed to determine whether the trait of SPS is best considered as normally distributed or as a dichotomous (binominal) trait.

In contrast to Aron and Aron's (1997) conclusion that the HSPS measures a unidimensional construct, the present results supported a two-factor structure. Although the two-factor solution was retrieved in a very robust way in the exploratory analysis, it did not have a good traditional fit in the confirmatory analysis. However, confirmatory analysis showed that the two-factor solution fits the data better than the one-factor solution. Possible explanations for the bad fit of the models could be the fact that the data are not multivariate normally distributed and/or the rather small sample size (only 40% of the total sample was analyzed). Hence, further research on the fit of the underlying factor structure of the HSPS in children is recommended.

In the present study, the two factors could be theoretically interpreted according to the recent DOES-conceptualization of SPS (Aron et al., 2012; Aron, 2010, 2012). The first factor, labelled "Overreaction to Stimuli" (OS), included 10 items and seemed to be related with the following characteristics of SPS: "Overstimulation", "Emotional Intensity" and "Sensory Sensitivity". The second factor included 9 items and was mostly related to the characteristic "Depth of Processing" (DP). As expected, there was no clear conceptual overlap with previously found factor structures in research with adults (Evans & Rothbart, 2008; Liss et al., 2008; Smolewska et al., 2006). Next to the fact that the items differ in number and content between the adult and child version of the HSPS and the use of parent-report in children versus self-report in adults, a possible explanation could be that SPS in childhood is expressed in a different way than in adulthood. It is possible that SPS in adulthood is influenced by different factors such as

education, the social environment, life stressors, and other various aspects in an individual's life (cf. differences between temperament and personality, see e.g., Evans & Rothbart, 2007; Rothbart, Ahadi, Hershey, & Fisher, 2001).

The moderate positive intercorrelation among the factors is consistent with a general, higher-order construct of SPS that was also found in previous research with adults (Liss et al., 2008; Smolewska et al., 2006).

4.2 The association between SPS and problems in daily functioning

A second goal of this study was to examine the relationship between SPS and problems that may arise in the daily functioning of children. Children with high SPS showed more MUPS (i.e. headaches or stomach ache without an apparent medical reason) and more sleeping and eating problems compared to children with average or low SPS. In accordance, children with more MUPS, sleeping, eating and drinking problems showed high SPS in general and, more specifically, high OS. Crying excessively as a baby was only related with high OS. Hence, this factor seems to be related with more problems in the daily functioning compared to the second factor DP. We can assume that a high OS, which includes also (hyper)sensitivity for sensory stimuli (a characteristic which is associated with different sensory processing disorders), has a negative influence on the life of some children in making their daily functioning more difficult, even as a baby. However, children with more MUPS and sleeping problems showed also high DP, which is consistent with the idea that DP refers to a general thoughtfulness or a sense of long-term consequences (Aron et al., 2012; Aron, 2010, 2012), possibly implying that these children are more prone to worry and ruminate about the present and the future, which may lead to internalizing problems. In general, the present results are complementary to previous studies addressing the association between problems in daily functioning and high SPS in adults (Benham, 2006) or other aspects of hypersensitivity in children (e.g., Reynolds et al., 2012), supporting the idea that high SPS in children may interfere with the participation in daily

activities.

Further, in the present study, children with high SPS showed less antisocial behavior. Children who were reported to lie, deceive, argue, fight or bully regularly, showed low SPS and low DP and OS. However, these results were only significant on a 5% level and must therefore be interpreted with caution. Overall, it can be concluded that SPS seems to be associated with more internalizing problems.

Finally, despite the intercorrelation of the two subscales and a high internal consistency for the overall scale, the present results suggests that the subscales of the HSPS are valuable to consider separately both on the level of interpretation and especially because of their different associations with problems in daily functioning. However, since the two subscales only account for half of the variation in total scores, it remains valuable to also include the total score in future studies using the 23-item HSPS in children.

4.3 Limitations

There are some limitations in the present study. First, since the scope of the present article was to investigate the questionnaire as it is currently used in clinical practice and on the internet, we decided not to undertake an official translation process. However, undertaking an official translation process may be useful in future studies. Second, given the cross-sectional, correlational nature of the present study, a causal relationship between measures of SPS and problems in the daily functioning of children cannot be inferred. Environmental factors such as parental warmth and exposure to stressful life events, and child factors such as high neuroticism, may, at least partly, account for the observed correlations (Aron et al., 2005). Further longitudinal research is needed to address the possible mediating or moderating factors in the relationship between SPS and inter- and externalizing problems in children.

4.4 Future research directions and implications

The present study can be seen as an exploratory study since it is the first which examines the HSPS in children. Our main goal is to encourage further research in temperamental sensitivity and we hope this can be a first step towards further investigation of SPS in children. Hence, there are several aspects that are in need of further study. First, to further explore the psychometric properties of the scale, an investigation of the discriminant and convergent validity against other measures of temperament, sensitivity and behavior would be valuable. Second, to corroborate the present findings on the association between SPS and problems in daily functioning, additional studies could implement other measures of hypersensitivity and temperament [e.g., the Sensory Profile; (Dunn, 1994), the SensOR; (Schoen, Miller, & Green, 2008) and the Child Behavior Questionnaire (CBQ; Rothbart, Ahadi, Hershey, & Fisher, 2001)], standardized measures of problems in daily functioning [e.g. the Child Behavior Checklist (CBCL; Achenbach & Rescorla, 2001)], and experimental measures on the behavioral, perceptual or neurophysiological level that are associated with high SPS. Further, a very recent 12-item child self-report version of the HSP scale (Pluess & Boniwell, 2015; Pluess et al., in preparation) could be converged with the parent-report version in future research. Finally, further research on the HSPS in children could also apply some more sophisticated statistical methods such as tests of measurement invariance.

Although further research is needed, the present results encourage addressing the temperamental trait of SPS in children in both psychological research and practice. Recently, Pluess & Boniwell (2015) provided evidence that high SPS could predict a better treatment response, probably based on a deeper processing of the content of the intervention than individuals scoring low on SPS. Therefore, during the diagnostic process in psychological practice, it can be recommended to conduct a personality analysis which also contains a measure of SPS such as the HSP scale. By considering both subscales Overreaction to Stimuli

and Depth of Processing of information, a broader perspective on the daily functioning of the child or adolescent could be obtained.

5. Conclusions

In sum, the current exploratory study provided the first evidence for a two-factor structure of the 23-item parent-report HSPS for children, together with the absence of a clear cut point. High SPS was associated with more internalizing and probably also less externalizing problems. The first factor OS was associated with excessive crying as a baby, more MUPS, more sleeping, eating, and drinking problems while the second factor DP was associated with more MUPS and more sleeping problems. Hence, OS seems to be associated with more problems in the daily functioning compared to DP. The HSPS may therefore provide valuable information in the assessment of children and adolescents with problems in daily functioning.

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Table 1

Exploratory factor analysis with oblimin direct rotation (pattern matrix)

Items	Factors	
	1 (OS)	2 (DP)
	n=10	*n*=9
19. My child is bothered by noisy places.[d]	.82	
11. My child doesn't do well with big changes. [b c]	.79	
3. My child doesn't usually enjoy big surprises. [b c]	.74	
1. My child startles easily. [b d]	.67	
22. My child performs best when strangers aren't present. [b]	.65	
2. My child complains about scratchy clothing, seams in socks, or labels against his/her skin.[d]	.60	
12. My child wants to change clothes if wet or sandy.[d]	.50	
16. My child prefers quiet play. [b d]	.44	
10. My child is hard to get to sleep after an exciting day. [b d]	.43	
18. My child is very sensitive to pain.[d]	.42	
9. My child seems very intuitive. [a]		.75
17. My child asks deep, thought-provoking questions. [a]		.74
5. My child seems to read my mind. [a]		.69
8. My child has a clever sense of humor. [a]		.68
6. My child uses big words for his/her age. [a]		.62
15. My child notices the distress of others. [a c]		.60
13. My child asks a lot of questions. [a]		.52
4. My child learns better from a gentle correction than strong punishment. [a c]		.41
14. My child is a perfectionist. [a]		.38
Cronbach's alpha	.86	.85
Cronbach's alpha 95% CI	[.82,.89]	[.81,.89]
Mean inter-item correlation	.38	.39

Note. N=140; (OS) Overreaction to Stimuli; (DP) Depth of Processing;
[a] Depth of Processing; [b] Overstimulation; [c] Emotional Intensity; [d] Sensory Sensitivity, according to the DOES-model.

Table 2

Proportion of the high SPS and control group with reported problems

	% High SPS (*n*=41)	% Control (*n*=142)	$\chi^2(1)$
MUPS	82.93	47.89	15.833**
Problems falling asleep	56.10	32.39	7.610**
Problems falling back asleep	80.49	48.59	13.120**
Eating problems	68.29	34.51	14.900**
Excessive eating	56.10	58.45	.072
Excessive drinking	53.66	44.37	1.104
Not drinking enough	63.41	54.23	1.092
Lies or deceives	31.71	52.11	5.312*
Argues, fights or bullies	19.51	33.10	2.794
Excessive crying	48.78	42.25	.551

Note. MUPS=Medically Unexplained Physical Symptoms.
**Significant after Bonferroni-Holm correction; *$p<.05$.

Table 3

Descriptives of HSPS factor and total scores for children scoring low versus high on the reported problems.

	HSPS-OS (*n*=10) M(SD)				HSPS-DP (*n*=9) M(SD)				HSPS-total (*n*=23) M(SD)			
	Low	High	t(181)	*d*	Low	High	t(181)	*d*	Low	High	t(181)	*d*
MUPS	32.20(6.84)	37.53(8.01)	5.010**	.7+	32.89(6.10)	37.14(5.37)	4.764**	.7+	79.81(13.54)	90.99(14.22)	5.392**	.8++
	n=81	*n*=102			*n*=81	*n*=102			*n*=81	*n*=102		
Problems falling asleep	33.32(7.80)	38.22(7.29)	4.214**	.6+	34.39(6.02)	36.68(5.90)	2.508*	.4	82.96(14.81)	91.14(13.87)	3.712**	.6+
	n=114	*n*=69			*n*=114	*n*=69			*n*=114	*n*=69		
Problems falling back	30.86(7.13)	38.59(6.87)	7.433**	1.1++	33.48(6.66)	36.67(5.15)	3.647**	.5+	78.79(15.02)	91.80(12.20)	6.467**	1.0++
asleep	*n*=81	*n*=102			*n*=81	*n*=102			*n*=81	*n*=102		
Eating problems	32.42(7.44)	38.96(7.06)	6.001**	.9++	34.58(5.90)	36.19(6.19)	1.794	.3	81.92(14.30)	91.71(14.04)	4.606**	.7+
	n=106	*n*=77			*n*=106	*n*=77			*n*=106	*n*=77		
Excessive eating	35.53(8.03)	34.91(7.93)	.525	.1	35.73(6.77)	34.92(5.51)	.894	.1	87.23(15.67)	85.18(14.44)	.917	.1
	n=77	*n*=106			*n*=77	*n*=106			*n*=77	*n*=106		
Excessive drinking	34.03(8.60)	36.48(6.97)	2.099*	.3	34.72(6.66)	35.87(5.26)	1.278	.2	83.95(16.31)	88.46(12.92)	2.052*	.3
	n=98	*n*=85			*n*=98	*n*=85			*n*=98	*n*=85		
Not drinking enough	32.65(8.25)	37.13(7.16)	3.922**	.6+	33.83(6.61)	36.37(5.37)	2.871*	.4	81.33(15.85)	89.71(13.18)	3.905**	.6+
	n=80	*n*=103			*n*=80	*n*=103			*n*=80	*n*=103		
Lies or deceives	36.21(7.97)	34.02(7.82)	1.869	.3	36.47(6.08)	33.92(5.79)	2.897*	.4	88.78(15.18)	83.02(14.19)	2.643*	.4
	n=96	*n*=87			*n*=96	*n*=87			*n*=96	*n*=87		
Argues, fights or bullies	36.02(8.02)	33.20(7.50)	2.219*	.3	36.11(5.74)	33.27(6.39)	2.963*	.4	88.14(15.07)	81.16(13.62)	2.953*	.4
	n=128	*n*=55			*n*=128	*n*=55			*n*=128	*n*=55		
Excessive crying	33.62(7.64)	37.16(7.96)	3.055*	.5+	35.23(6.11)	35.29(6.04)	-.060	.0	84.18(14.98)	88.44(14.68)	1.922	.3
	n=103	*n*=80			*n*=103	*n*=80			*n*=103	*n*=80		

Note. OS=Overreaction to Stimuli; DP=Depth of Processing; MUPS=Medically Unexplained Physical Symptoms

** Significant after Bonferroni-Holm correction; *p<.05.

++ Cohen's' d=.8 (large); + Cohen's d=.5 (medium)