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Discriminant Validity of the **Sensory Profile** in Australian Children with Autism Spectrum Disorder

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Discriminant Validity of the *Sensory Profile* in Australian Children with Autism Spectrum Disorder

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ABSTRACT. *Objective*. The discriminant validity of the *Sensory Profile* was evaluated by comparing the sensory processing scores of Australian

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children, 5 to 8 years of age, diagnosed with autism spectrum disorder (ASD) to a control group of children with typical development matched for age and gender. *Method*. Twenty-six parents of children with ASD and 26 parents of typically developing children without ASD completed the *Sensory Profile*. *Sensory Profile* category, factor, and quadrant scores were compared using multivariate analysis to investigate if there were differences between the two groups. *Results*. The results indicated that the children with ASD had significantly lower sensory processing scores on all fourteen categories, eight out of nine factors, and all four quadrants of the *Sensory Profile*. *Conclusion*. The results also provide evidence of discriminant validity of *Sensory Profile* scores between children with ASD and children with typical development. In addition, the study findings indicate that the *Sensory Profile* can be used with confidence in cross-cultural contexts, such as Australia.

KEYWORDS. Autism spectrum disorder, *Sensory Profile*, sensory processing, validity, occupational therapy

Sensory and perceptual problems are common in children diagnosed with autism spectrum disorder (ASD) and it is estimated that between 30% and 100% of children with ASD display some form of sensory-perceptual abnormality (Baranek, 2002; Dawson & Watling, 2000; Watling, Deitz, & White, 2001). Sensory processing problems include tactile defensiveness, auditory hypersensitivity, olfactory hypersensitivity, and sensory overload. Hyporeactivity, hyperreactivity, inappropriate responses to multiple sensory stimuli, and faulty sensory input modulation have also been documented (Dunn, 1997a; Baranek, 2002). According to Kern et al. (2006a), "A better understanding of sensory processing in autism, including threshold differences, will improve on our understanding of what persons with autism experience everyday and how their sensory experience may shape their behavior and their response to their world" (p. 2).

Occupational therapists and other health care professionals often evaluate sensory processing in their assessment of young children with ASD since impairments in sensory processing can have a negative impact on occupational performance, learning ability, and achievement of developmental milestones (Bundy, Shia, Qi, & Miller, 2007; Dunn, 1997b; Parham & Mailloux, 2005; Williamson & Anzalone, 1997). Methods of assessment used by occupational therapists include unstructured clinical observations, informational forms, behavioral questionnaires, symptom checklists, and informal parental interviews (Watling, Deitz, Kanny, & McLaughlin, 1999;

Reed, 2001; Richardson, 2005). "These approaches lack standardization and the normative data necessary for establishing consistent interpretation of sensory processing abilities" (Watling et al., 2001, p. 417). It is important, therefore, that therapists use measures that are reliable and valid (Baranek, 2002; Law, Baum, & Dunn, 2005; Kielhofner, 2006; McDowell, 2006; Rodger & Ziviani, 2006).

The *Sensory Profile,* developed by Dunn (1999), is a judgement-based questionnaire that measures a child's sensory processing abilities and provides an overview of their impact on daily functioning. The questionnaire is designed for completion by caregivers (usually parents) of children 5 to 10 years of age, but can be adapted for use with 3- and 4-year-olds. The questionnaire consists of 125 items divided into three main sections: Sensory Processing, Modulation, and Behavioral and Emotional Responses. Each section is made up of a number of sensory processing categories.

The Sensory Processing section is made up of six item categories that reflect particular types of sensory processing as part of daily life (e.g., auditory processing or touch processing). The Modulation section contains five item categories that reflect various combinations of input for use in daily life (e.g., modulation related to body position and movement or modulation of sensory input affecting emotional responses). The behavioral and emotional responses section contains three item categories that reflect emotional and behavioral responses that might indicate a child's sensory processing abilities (e.g., emotional/social responses). In total, there are 14 sensory processing category scores that are calculated.

On the basis of Dunn's model of sensory processing, children can also be classified as fitting into one of the four general sensory processing "quadrants": sensation seeking, sensation avoiding, sensory sensitivity, and low registration (Dunn, 1997a, 2001). *Sensation seeking* refers to a pattern of sensory processing that is characterized by high sensory thresholds and an active self-regulation strategy/active responding. *Sensation avoiding* refers to a pattern of sensory processing that is indicative of low sensory thresholds and an active self-regulation strategy/active responding. *Sensory sensitivity* is associated with a pattern of sensory processing characterized by low sensory thresholds and a passive self-regulation strategy/passive responding. *Low registration* refers to a pattern of sensory processing that is characterized by high sensory thresholds and a passive self-regulation/passive responding.

Nine factors based on principal-components factor analysis results of the 125 *Sensory Profile* items have also been identified: sensory seeking, emotionally reactive, low endurance/tone, oral sensory sensitivity,

inattention/distractibility, poor registration, sensory sensitivity, sedentary, and fine motor/perceptual (Dunn & Brown, 1997). The factors characterize children by their responsiveness to sensory input across sensory systems. The information gained from the *Sensory Profile* category scores, quadrant scores, and factor scores provide indicators where sensory processing intervention might be required.

A caregiver completes the *Sensory Profile* by indicating for each item the frequency that the behavior is observed using a five-point Likert rating scale. Choices are never (five points); seldom (four points); occasionally (three points); frequently (two points); and always (one point). A low frequency rating is undesirable, consequently lower scores indicate great symptoms. The *Sensory Profile* includes low and high threshold items. High threshold items measure an individual's lack for response or need for more intense stimuli. Low threshold items measure a person's awareness, irritation, or annoyance with sensory stimuli. Raw scores are totalled and plotted in the classification column (e.g., typical performance, probable difference, definite difference) of the factor grid and category summary score forms. On the basis of the category scores, four quadrant scores are then derived. The quadrant with the lowest score is considered to characterize a child's sensory processing. The *Sensory Profile* takes about 30 min to complete and 20 min to score manually. A computer-based scoring program is also available.

Studies by Kientz and Dunn (1997), Ermer and Dunn (1998), Watling et al. (2001), Kern et al. (2006b), Rogers, Hepburn, and Wehner (2003), and Tomchek and Dunn (2007) provide evidence of sensory processing differences between children with and without ASD. Using a pilot version of the *Sensory Profile*, Kientz and Dunn (1997) reported that a group of 3- to 13-year-old children with ASD ($n = 32$) performed differently from 3- to 10-year-old children with typical development ($n = 64$) on 84 of the 99 items (85%) on the pilot version. Ermer and Dunn (1998) identified 46 items and 4 factors (sensory seeking, oral-motor, inattention/distractibility, and fine motor/perceptual) that discriminated among children with ASD ($n = 38$), children with attention deficit hyperactivity disorder ($n = 61$), and children with typical development ($n = 1{,}075$).

Watling et al. (2001) compared *Sensory Profile* factor scores of 40 children 3 to 6 years of age with ASD and 40 children without ASD in the same age range. Children with ASD were significantly different from children without ASD on 8 out of 10 factors (sensory seeking, emotionally reactive, low endurance/tone, oral sensitivity, inattention/distractibility, poor registration and fine motor/perceptual). Kern et al. (2006b) reported that

sensory quadrant scores of 103 persons with ASD, 3–43 years of age, were significantly different compared with the scores of a control group of 103 persons matched for age and gender.

In a recent American study, Tomchek and Dunn (2007) investigated the differences in sensory processing among a group of 281 age-matched children between ages 3 and 6 years with ASD and those who are typically developing using the *Short Sensory Profile* (McIntosh, Miller, & Shyu, 1999). Tomchek and Dunn found that 95% of the sample of children with ASD demonstrated some degree of sensory processing dysfunction on the *Short Sensory Profile* total score, with the greatest differences reported on the Underresponsive/Seeks Sensation, Auditory Filtering, and Tactile Sensitivity sections. The ASD group also performed significantly differently ($p < .001$) on 92% of the items, total score, and all sections of the *Short Sensory Profile*. In another study using the *Short Sensory Profile* that involved children with ASD, Rogers et al. (2003) found that this paediatric group had significantly more sensory symptoms overall, particularly in the areas of taste/smell sensitivity, tactile sensitivity, and auditory sensitivity. Researchers also have reported that the *Sensory Profile* discriminates sensory processing abilities of children with Fragile X Syndrome, attention deficit hyperactivity disorder, and Asperger's Syndrome (Dunn & Bennett, 2002; Dunn, Myles, & Orr, 2002; Dunn, Saiter, & Rinner, 2002; Myles et al., 2004; Rogers et al., 2003).

The ability of an instrument to differentiate two groups of participants with a known difference is referred to as discriminant validity (Nunnally & Bernstein, 1994). Validation of an instrument, such as the *Sensory Profile*, is an ongoing process that involves establishing a cumulative body of validity evidence (American Educational Research Association et al., 1999; Downing 2003). Replications of validation studies in other contexts (e.g., cross-cultural) or with different clinical populations add to the body of evidence about the validity of an instrument (Anastasi & Urbina, 1997; Goodwin, 2002, 2003). Discriminant validity of the *Sensory Profile* quadrant scores has only been examined in one American study completed by Kern et al. (2006b) involving children with ASD. Discriminant validity also has not been examined in children from countries other than the United States. Knowledge of scores reported by caregivers from other countries is necessary to demonstrate whether the constructs evaluated by the *Sensory Profile* are generalizable to other cultures. The purpose of this study was to examine the discriminant validity of the sensory processing category, factor, and quadrant scores in Australian children ages 5 to 8 years with and without ASD. Continual appraisal of the validity of the *Sensory Profile* will assist occupational therapists in selection of high quality instruments

to identify children with sensory processing problems (Fairbank, 2005; Vacca, 2005).

METHODS

Participants

Twenty-six mothers of children 5 to 8 years of age diagnosed with ASD were recruited from specialist schools, early intervention programs, and paediatric therapy clinics in the Melbourne metropolitan area. Twenty-six mothers of children between the ages of 5 and 8 years without developmental delays were recruited from area state public schools located in Melbourne, Victoria, Australia for this study. Each child with ASD was matched to a child without ASD on the variables of age and gender. The children with ASD had a mean age of 72.1 months (SD = 9.1) and included 21 boys and 5 girls. The children without ASD had a mean age of 75.1 months (SD = 9.4) and included 18 boys and 6 girls. The difference in gender reflects the higher prevalence (3–4:1) of ASD in boys than girls (Reed, 2001). The two groups did not differ significantly on age ($t(50) = 1.08$, $p > .05$) or gender ($\chi^2(1, N = 52) = .60$, $p > .05$).

Inclusion criteria for the children with ASD were parental consent to participate in the study, the child being the correct age, and the child having a formal diagnosis of ASD made by a qualified professional (such as a psychologist or physician). Inclusion criteria for the typically developing children included parental consent to participate in the study, the child being the correct age, the child having no major formally diagnosed intellectual or physical impairments, and the child having no siblings diagnosed with ASD.

Approvals from the Royal Children's Hospital Research Ethics Committee, Parkville, Victoria, Australia and the Department of Education and Training, Melbourne, Victoria, Australia were obtained. All parents provided informed consent prior to data collection.

Measures and Procedure

A *demographic questionnaire* was used to gather relevant background data about the participants (such as age, gender, and any known diagnoses of child and which parent or caregiver completed the *Sensory Profile*). For each child, the *Sensory Profile* was completed by his/her mother.

Data Analysis

Each item on the *Sensory Profile* is worded so that the optimal rating is that the behavior was never observed. Points are assigned to the rating of the frequency that each behaviour was observed as follows: always = 1 point; frequently = 2 points; occasionally = 3 points; seldom = 4 points; never = 5 points. Lower numbers, therefore, are indicative of sensory processing difficulties. Standard scoring procedures for calculating category, quadrant, and factor scores for the *Sensory Profile* were used.

Statistical package for the Social Sciences, Version 14.0 (SPSS) software was used for data entry, storage, and analysis. The data did not violate assumptions of normality (univariate and multivariate) and linearity, therefore, parametric statistics were used. Separate multivariate analyses of variance (MANOVA) were conducted to identify differences in category, factor, and quadrant scores between children with and without ASD. The number of analyses increased the likelihood of making a Type I error. As such, the probability level was set at $p < .017$ using Bonferroni's adjustment (whereby the desired alpha level is divided by the number of comparisons) (Godfrey, 1985).

RESULTS

Category Scores

Means, standard deviations, effect sizes, and power are shown in Table 1. A significant multivariate effect was found for the two groups, F (14, 37) = 17.18, $p < .001$, (partial $\eta^2 = 0.87$, power = 1.0). MANOVA results revealed that children with ASD scored significantly lower than the control group on all 14 sensory processing categories with small to medium effect sizes (0.16–0.52) and high power (0.84–1.00).

Factor Scores

Means, standard deviations, effect sizes, and power are shown in Table 2. A significant multivariate effect was found for the two groups, F (9, 42) = 7.63, $p < .001$, (partial $\eta^2 = 0.62$, power = 1.0). MANOVA results revealed that the ASD group scored significantly lower than the control group on 8 of the 9 factors with small to medium effect sizes (0.14–0.40) and high power (0.78–1.0). The only nonsignificant group difference was on the sensory sensitivity factor (although there was a nonsignificant trend in the expected direction, $p = .06$).

TABLE 1. Sensory Profile Category Scores: Means, Standard Deviations, Effect Sizes and Power for Children with and without ASD

Sensory Profile Category and Sections				
Sensory Processing Section (categories 1–6)	Children with ASD n = 26) M (SD)	Children without ASD (n =26) M (SD)	Effect size (partial $\eta 2$)	Power
1. Auditory processing	24.97 (6.33)	32.57 (4.78)	0.31	1.00
2. Visual processing	33.55 (6.14)	38.74 (5.55)	0.17	0.87
3. Vestibular processing	44.62 (5.90)	49.57 (5.78)	0.16	0.84
4. Touch processing	64.10 (12.46)	78.04 (9.35)	0.28	0.99
5. Multisensory processing	22.93 (5.09)	30.39 (4.14)	0.39	1.00
6. Oral sensory processing	37.79 (9.68)	52.39 (7.35)	0.42	1.00
Modulation Section (categories 7–11)				
7. Sensory processing related to endurance/tone	37.03 (7.97)	42.96 (3.78)	0.18	0.90
8. Modulation related to body position and movement	38.69 (6.26)	43.91 (4.27)	0.19	0.92
9. Modulation to movement affecting activity level	21.41 (3.81)	25.57 (3.78)	0.24	0.97
10. Modulation of sensory input affecting emotional responses	11.34 (3.41)	17.35 (2.48)	0.50	1.00
11. Modulation of visual input affecting emotional responses and activity level	13.07 (2.66)	16.83 (2.87)	0.32	1.00
Behavioral and emotional Section (categories 12–14)				
12. Emotional/social responses	56.48 (12.01)	69.52 (9.44)	0.27	0.99
13. Behavioural outcomes of sensory processing	17.03 (4.56)	24.65 (4.79)	0.41	1.00
14. Items indicating thresholds for responses	10.24 (1.87)	13.61 (1.31)	0.52	1.00

All group differences significant at $p < .017$.

TABLE 2. Sensory Profile Factor Scores: Means, Standard Deviations, Effect Sizes and Power for Children with and without ASD

Sensory Profile Factor	Children with ASD (n = 26) M (SD)	Children without ASD (n = 26) M (SD)	Effect size (partial η 2)	Power
Sensory seeking	55.66 (10.80)	65.83 (11.44)	0.18	0.90
Emotionally reactive	48.31 (11.99)	64.39 (9.95)	0.35	1.00
Low endurance/tone	37.03 (7.97)	42.96 (3.78)	0.18	0.90
Oral sensory sensitivity	27.69 (9.01)	39.04 (6.38)	0.34	1.00
Inattention/distractibility	21.41 (5.57)	28.96 (4.48)	0.36	1.00
Poor registration	29.34 (5.58)	37.00 (3.29)	0.40	1.00
Sensory sensitivity	16.62 (3.42)	18.26 (2.58)	0.07	0.47
Sedentary	12.45 (4.08)	15.26 (2.90)	0.14	0.78
Fine motor/perceptual	7.83 (3.39)	12.17 (2.93)	0.32	1.00

All group differences significant at p < .017 with the exception of 'sensory sensitivity'.

Quadrant Scores

Means, standard deviations, effect sizes, and power are shown in Table 3. A significant multivariate effect was found for the two comparison groups, $F\ (4, 47) = 7.20$, $p < .001$, (partial $\eta^2 = 0.38$, power $= 0.99$). MANOVA results revealed that the group of children diagnosed with ASD scored significantly lower than the control group on all four sensory processing quadrants with medium effect sizes (0.25–0.35) and high power (0.98–1.00).

TABLE 3. Sensory Profile Quadrant Scores: Means, Standard Deviations, Effect Sizes and Power for Children with and without ASD

Sensory Profile Quadrant	Children with ASD (n = 26) M (SD)	Children without ASD (n = 26) M (SD)	Effect size (partial η 2)	Power
Sensation seeking	99.24 (18.98)	122.04 (11.54)	0.34	1.00
Low registration	57.66 (10.78)	68.26 (4.97)	0.28	1.00
Sensation svoiding	88.24 (16.11)	106.57 (16.01)	0.25	0.98
Sensory sensitivity	68.69 (13.54)	87.74 (12.41)	0.35	1.00

All group differences significant at $p < .017$.

DISCUSSION

The results indicate that scores on the *Sensory Profile* were significantly lower for Australian children with ASD compared with children without ASD for: (a) all fourteen category scores; (b) eight of the nine factor scores; and (c) all four quadrant scores. The only nonsignificant group difference was on the sensory sensitivity factor. This adds to the body of evidence supporting the discriminant validity of the *Sensory Profile*. The results indicate that the category, factor, and quadrant scores can be used with confidence in cross-cultural contexts (such as Australia) and that the quadrant scores can discriminate between two groups of children with known differences.

The study results are consistent with previous findings (Kientz & Dunn, 1997; Ermer & Dunn, 1998; Watling et al., 2001; Rogers et al., 2003; Tomchek & Dunn, 2007). In particular, the results are consistent with Kern et al. (2006b) who reported that all four quadrant scores were significantly different between individuals with and without ASD. The mean age (19.9 years; SD = 10.6) and range (3 to 43 years) of subjects in the study by Kern et al. was considerably higher than in our study. Kern and colleagues found that the quadrant scores of older persons with autism were closer to the scores of people in the control group than were the scores of younger persons with autism (Kern et al., 2006b).

A limitation of the study by Kern et al. (2006b) is that the *Sensory Profile* is designed for use with children ages 3 to 10 years of age. It would have been more appropriate to utilize the *Adolescent/Adult Sensory Profile* with adult participants (Brown, Tolefson, Dunn, Cromwell, Filion, 2001; Brown & Dunn, 2002).

Collectively, the research on sensory processing of children with ASD provides insights into relationships between behavioral responses and neurological thresholds as proposed in Dunn's model of sensory processing (Dunn, 1997a). Some researchers have suggested that there is a link between sensory processing difficulties experienced by children with ASD and the problems they experience managing daily life routines and environments (Cook & Dunn, 1998; Dunn, 2001). Kern et al. (2006a) reported that sensory processing differences may play a role in certain ASD-associated behaviors, such as self-injury, rigidity in daily routines, limited range of food preferences, sensitivity to different textures of clothing, or stereotypic behaviour. Baranek et al. (1997) found that children with ASD with higher levels of tactile defensiveness were also more apt to exhibit rigid, inflexible behaviors and repetitive verbalizations. In this study, the children with ASD had lower average responsiveness quadrant scores in relation to

poor registration, sensation seeking, sensitivity to stimuli, and sensation avoidance than their typically developing peers.

There are several limitations inherent in this study. Only younger school-age children from one geographical region were included in the sample. Having a wider age range from more than one location would have made the sample more representative of the Australian population. The sample size was small. However, given that participation in the study was voluntary, the number of participants recruited was unpredictable. Finally, only one diagnostic group was included. Having another clinical comparison group (such as children with attention deficit disorder) in addition to the control group with typical development would have provided more insight into sensory processing characteristics unique to children with ASD.

Recommendations for the future research include completing similar studies with other paediatric diagnostic groups (e.g., child and adolescent mental health, paediatric neurology, paediatric genetic disorders) and in other settings (community health care centers, special schools, rural regions). For example, comparing three groups of children presenting with a learning disability, motor coordination disorder (e.g., developmental coordination disorder), a genetic disorder (e.g., William's Syndrome or Down Syndrome), or an acquired neurological disorder (e.g., acquired brain injury) would provide additional information. Finally, evaluation of intra-rater and inter-rater reliability of the *Sensory Profile* is recommended, since reliability is not reported in the manual. Inter-rater reliability could be determined by having the mothers and fathers of a group of children both complete the *Sensory Profile* and then compare their item ratings for consistency. Intra-rater reliability could be evaluated by having the mothers of a group of children complete the *Sensory Profile* on one occasion and then have them complete the *Sensory Profile* on the same child a second time two weeks after their first completion.

CONCLUSIONS

The discriminant validity of the *Sensory Profile* in a cross-cultural context was investigated by comparing the responses of a group of Australian parents of 26 children with ASD and 26 children with typical development (ages 5 to 8 years) matched for age and gender. Children with ASD had significantly lower sensory processing scores compared to a control group of children without developmental delays on all 14 category scores, 8 out of 9 factor scores, and all 4 quadrant scores. The results support the

discriminant validity evidence and that the *Sensory Profile* can be used with confidence in cross-cultural settings such as Australia.

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