Feature Article

Sensory processing and stereotypical and repetitive behaviour in children with autism and intellectual disability

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**Background:** Sensory processing disorders have been linked to stereotypical behaviours in children with intellectual disability (ID) and autism spectrum disorders (ASD) and to anxiety in children with ASD. In earlier phases of this study with the same participants, we found that those with both ASD and ID were more motivated than those with ID alone to engage in stereotypical behaviour to alleviate anxiety. In this phase, we confirmed that children with both ASD and ID and those with ID alone process sensation differently than typically developing children. We asked: Do the sensory processing difficulties of children with ASD and ID differ significantly from those of children with ID alone in a way that would help explain the increased anxiety of the former group?

**Method:** Parents of children with ASD and ID (n = 29; mean age 9.7 years) and with ID alone (n = 23; mean age 9.5 years) completed a Sensory Profile (SP) to provide information about their children’s sensory processing abilities. SP quadrant scores for each group were compared with each other and with the published norms of typically developing children.

**Results:** Children with ASD and ID and with ID alone processed sensory information differently than typically developing children ($P = 0.0001$; $d > 2.00$). Children with both ASD and ID were significantly more sensitive ($P = 0.007$; $d = 0.70$) and avoidant ($P < 0.05$; $d = 0.47$) than the children with ID alone.

**Conclusion:** We conclude that increased sensitivity and the tendency to avoid sensation may help explain anxiety in children with autism.

**KEY WORDS** autism, avoidance, intellectual disability, sensation, sensitivity.

**Introduction and background**

Since autism was first described, individuals with autism have been reported to process sensation differently from others. Occupational therapists frequently assess and provide intervention to address sensory processing abnormalities when they are thought to interfere with participation and performance in daily life. More than 20 years ago, researchers and therapists posited links between stereotypical and repetitive behaviours and difficulties in processing sensation (Wieseler, Hanson, Chamberlain & Thompson, 1985). However, recent studies have provided evidence that these behaviours are multifunctional and are sometimes also motivated by a desire to reduce anxiety (Ben-Sasson \textit{et al.}, 2007), to gain attention or a desired object or to escape (McGill, Bradshaw & Hughes, 2007). This work is part of a larger study designed to improve our knowledge on stereotypical and repetitive behaviours.

Although stereotypical and repetitive behaviours are included in the diagnostic criteria for autism, they also occur in the repertoire of behaviours for children with other developmental disorders (Berkson, 2002). Management of stereotypical and repetitive behaviours is important as these behaviours are described in the literature as not being compatible with learning new skills, hindering the ability to interact with human and non-human environments and affecting the ability to learn and to communicate. Stereotyped behaviours can contribute to stigmatising and isolating individuals, often into segregated communities (Cunningham & Schreibman, 2007). Teachers, therapists and classroom assistants of the participants in this study were concerned that the children’s
stereotypical and repetitive behaviours were interfering with their participation and performance in activities that they needed to do and sometimes in activities that the children wanted to do. The behaviours included flapping their arms and rocking instead of completing academic tasks and similar behaviours interfering with completion of functional activities related to self-care and domestic tasks, community involvement and play and social interaction with other children and adults that are typical of a school day.

Stereotypical and repetitive behaviours are rigid and invariant (Turner, 1999) and in this study, they included simple body movements such as rocking and flapping arms, finger posturing and more complex rhythmical repetitive patterns of movement. Turner classified these motor behaviours as ‘lower-level behaviours’ which were distinct from ‘higher-level repetitive behaviours’ such as circumscribed interests, resistance to change and rigid routines and rituals. Repetitive and stereotypical behaviours reduce interaction, participation and new learning (Lancioni, Singh, O’Reilly & Sigafos, 2009). They can also restrict the environments where children are welcome (Cunningham & Schreibman, 2007). Enabling participation in occupations and purposeful activity is the focus of occupational therapy intervention, and more knowledge is required to reduce or replace behaviours that affect participation and performance.

Researchers and theorists continue to be interested in the relationship between stereotypical behaviours and sensation and they commonly posit links with both decreased registration of sensation and sensory defensiveness (Liss, Saulnier, Fein & Kinsbourne, 2006; Rogers & Ozonoff, 2005). The logic for the link with decreased registration is that when neurological thresholds are high, the child actively seeks sensory input and may engage in stereotypical and repetitive behaviour in an attempt to generate sensation and thus self-regulate (Miller, Anzalone, Lane, Cermak & Osten, 2007). The link with sensory defensiveness or sensitivity is that sensory input influences arousal level and action. When arousal level is optimal, the child is calm and alert, and function is maximised. However, when a child is very sensitive to sensation that others would not mind, over-arousal is likely and this oversensitivity can result in increased stress and anxiety (Blairs & Slater, 2007). Engagement in stereotypical behaviour may then be a means of self-calming and reducing anxiety (Bauer, Quas & Boyce, 2002). Anxiety is a commonly reported, but not well-understood, problem in individuals with autism (Breton, Tonge & Einfeld, 2006).

**Sensory processing**

Dunn’s (1999, 2006) sensory processing model provides an overall framework to understand behaviours that stem from abnormal sensory processing. Dunn proposed that individuals respond to sensation based on sensory thresholds (high or low) and that they respond passively or actively (i.e. in accord with expectations of the threshold, or in a way to counteract the threshold and ‘normalise’ the system). Thus, she proposed that behaviours associated with sensory processing could be described using a four-quadrant model with ‘threshold’ on one axis and ‘behavioural response’ on the other. She labelled the quadrants: ‘Seeking,’ ‘Registration,’ ‘Sensitivity’ and ‘Avoidance’ (Dunn, 1999). Low registration represents high neurological thresholds with passive behavioural responses, whereas seeking represents high thresholds with active responses. Sensitivity represents low thresholds with a passive behavioural response, and avoidance also represents low thresholds but with an active response. Of importance is that all quadrants are independent of each other, with each one having its own continuum. All individuals have some aspects of each quadrant in their individual sensory processing patterns; therefore, a particular child’s sensory processing strengths and difficulties are better understood by considering the combination of all quadrants (Dunn, 2006).

**Assessing the motivation for stereotypical behaviours**

Although professionals clearly understand the need to ascertain why a child engages in a particular stereotyped behaviour, the methods employed for determining those motivators are not clear. In an earlier phase of this study (Joosten & Bundy, 2008), we identified the Motivation Assessment Scale (MAS; Durand & Crimmins, 1988) as one of the indirect assessment tools most frequently used in functional analysis of behaviour in individuals with intellectual disabilities and other developmental disorders. The MAS is a 16-item questionnaire with items grouped to reflect four sources of motivation to: (i) gain attention, either positive or negative; (ii) gain access to tangible objects or as a response to removal of tangible reinforcers; (iii) escape from or avoid people or activities; and (iv) experience sensory feedback or stimulation.

In our investigation of the construct validity of the MAS (Joosten & Bundy, 2008), we found evidence that the sensory items formed a different construct than the remaining motivators. We proposed that whereas most items reflected extrinsic motivators (i.e. they resulted in children obtaining a reward or a response from a source other than the child), the sensory items reflected an intrinsic motivation (i.e. the process of engaging in them ‘made the child feel good’).

Based on our review of the literature, we further proposed that alleviating anxiety, like experiencing enhanced sensation, was an important intrinsic motivator for a child’s stereotypical behaviour. Thus, we revised the MAS by adding four items designed to reflect reduction in anxiety. These questions were based...
on the symptoms of anxiety commonly reported in individuals with autism: resistance to change; being easily upset; tantrums, fearfulness and tenseness; agitation and irritability (Loveland & Tunali-Kotoski, 2005). The newly created items correlated significantly \((r = 0.75; P < 0.0005)\) with the Anxious Behaviour Rating Scale (ABRS), a subset of the Developmental Behaviour Checklist (DBC; Einfeld & Tonge, 2002; Joosten, Bundy & Einfeld, 2009). The ABRS has been used widely in research on psychiatric disorders in children with autism, in epidemiological studies, in behaviour phenotype studies and in investigations of psychopathology in children with intellectual disability (ID) (Brereton et al., 2006; Einfeld & Tonge, 2002).

We called our revised scale the MAS:R. The sensory and anxiety items form one 8-item construct of intrinsic motivators and the items escape, attention and gaining a tangible object form a second 12-item construct of extrinsic motivators (Joosten et al., 2009). We found that the children with autism were more likely \((P < 0.001)\) to receive high scores on the anxiety items on the MAS:R. More detailed information about these results is available (Joosten et al.). We interpreted these findings as indicating that children diagnosed with both autism spectrum disorders (ASD) and ID are more motivated than children with ID alone to engage in stereotypical behaviour to alleviate anxiety. The results provided support for the notion that although abnormal sensory processing in children with autism may result in seeking sensory input, sensory input from the environment might also generate considerable anxiety, particularly if it is unpredictable (Liss et al., 2006; Pfeiffer, Kinnealey, Reed & Herzberg, 2005).

In the current phase of this study, we sought to understand more about the way children with intellectual disability, with and without autism, processed sensation to better understand the intrinsic motivations to engage in stereotyped behaviours. Specifically, the authors hypothesised that (i) children with intellectual disability (with and without autism) have sensory processing patterns that are different from those of children with typical development; and (ii) children with autism and intellectual disability have sensory processing patterns that are qualitatively different from those of children with intellectual disability alone, and poor sensory processing might contribute to the anxiety of children with autism. If the groups did differ, as hypothesised, we believed that those differences might help us in understanding the differences in motivations for stereotypical and repetitive behaviours that we had found earlier (Joosten & Bundy, 2008; Joosten et al., 2009).

## Methods

### Participants

All 265 children enrolled in the Ballarat Specialist School in Australia were eligible to receive occupational therapy services if referred by their teachers, other professionals or parents. Participants were 74 children whose referral to occupational therapy specifically identified concerns that low-level stereotypical and repetitive behaviours (Turner, 1999) were interfering with their participation in school activities. Parents of 74 children were invited by letter to participate by completing a Sensory Profile (SP; Dunn, 1999) on their children; 52 returned a fully completed protocol sheet to the school. The 52 participants were divided into two groups: Group 1 comprised 23 children diagnosed with ID and Group 2 comprised 29 children diagnosed with both ID and ASD. The ages of both groups ranged from 5 to 18 years (mean age = 9.7 years for ID; 9.5 years for ASD). A dual diagnosis of ASD and ID had been established by an Autism Assessment and Diagnostic Team using the criteria for autistic disorder from the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV; 1994).

Enrolment at the school required evidence of ID, determined by scores more than two standard deviations (SDs) below the mean on at least one psychometric test administered by a psychologist (e.g. The Wechsler Intelligence Scale for Children (WISC-III; Wechsler 1991) or the Vineland Adaptive Scale (VABS; Sparrow, Balla & Cicchetti, 1984)). The VABS was used in this study as not all participants were able to obtain a score on the WISC-III. The VABS provides a norm-referenced description of functional outcomes in the form of domain (communication, daily living skills, socialisation and motor skills) and an Adaptive Behaviour Composite score based on a mean of 100 (SD = 15).

The two groups were very similar in terms of IQ (VABS score) and gender, but differed significantly on the level of anxiety as measured by the ABRS (Einfeld & Tonge, 2002; \(t = 7.11; P < 0.001\)). Table 1 presents specific information about the gender, diagnosis, VABS and ABRS scores of the participants. All children live at home with parents or caregivers.

These same children had also participated in earlier phases of this study using the MAS (Joosten & Bundy, 2008; Joosten et al., 2009). The results of those studies identified that children with the dual diagnoses were significantly more anxious than children with ID alone \((t = 7.11; P < 0.001)\). Mean values and ranges of the ABRS scores for the two groups are shown in Table 1. Children with ASD and ID were also more motivated than children with ID alone to engage in repetitive stereotyped behaviours to decrease anxiety than to gain enhanced sensation. This is evident in the differences in the average measure scores of the two groups on three of the four anxiety items from the revised MAS:R (Joosten et al.). MAS:R anxiety item scores are compared by group in Table 2.

### Instrument

The SP (Dunn, 1999) was used in this study with scoring and interpretation based on the Sensory Profile Supplement (SPS; Dunn, 2006); the SPS enables quadrant scores
to be calculated from the SP data. The SP is a questionnaire in which caregivers report on the frequency of their child’s engagement in 125 behaviours. It is the assessment tool most commonly used by occupational therapists working with children with sensory processing disorders for the purpose of intervention planning (Long, de Jonge, Ziviani & Jones, 2009). Dunn’s original factor analysis yielded nine factors that characterised children by their responsiveness to sensory input. Dunn (1999) established SP norms using a sample of 1037 North American children (91.4% White) without disabilities. Standard errors of measurement for each possible section and factor raw score total are reported. These can be used to construct confidence intervals to examine whether change is greater than can be attributed to measurement error. In developing the SP, Dunn (1999) calculated mean values of the raw scores for the normative samples’ Section and Factor scores, and used them to compare children with and without disabilities. The mean scores are available in the SP manual (Dunn). In the original sample, the mean and SDs of the Section and Factor scores of 32 children with autism were also calculated. These scores were meaningfully different on nearly 90% of the items compared with the scores of children without disabilities, and the items that were different were across all factors of the SP (Dunn).

The same data used in the development of the SP were used to develop the SPS, where Dunn (2006) reported mean raw scores for the quadrants for the normative sample. In the original SP, the cut scores (i.e. the selected points on the scale used to determine whether the person’s score fits a particular category) only proceeded in the direction of ‘Much More Than Others’. In the development of the SPS, Dunn added cut scores below the mean to reflect the entire range of behaviours. The expanded cut scores are reported in SD-based labels from ‘Much More Than Others’ (2 or more SDs below the mean) to ‘Much Less Than Others’ (2 or more SDs above the mean). Responses to the SP and questions are recorded on a five-point scale from Always (1 point) to Never (5 points). This means that frequent behaviours attract lower scores and the items are written so that frequent behaviour is undesirable. All items need to be completed for accurate interpretation (Dunn). The SP data are used to complete the scoring for the SPS quadrant scores.

The SPS (Dunn, 2006) quadrant scores were developed by using statistical analyses to determine the items that best reflected each quadrant. Only 90 of the original 125 items are included in the quadrant scores: Registration (15 items), Seeking (26 items), Sensitivity (20 items) and Avoiding (29 items). Dunn recommended that quadrant scores be examined first and that it is acceptable to limit the scope of interpretation to the quadrant scores. Section scores could provide further information, if required, about (i) processing of individual sensations (e.g. auditory), (ii) modulation and management of simultaneous sensory inputs or (iii) emotional responses to sensation.

Internal reliability of the SP using Cronbach’s α ranged from 0.47 to 0.91 (Dunn, 1999). Dunn addressed content validity during the development of the SP through a literature review, expert review and category analysis by 155 experienced occupational therapists.

**Procedure**

Research protocols were approved by the Human Research Ethics Committee (HREC) of the University of Sydney and the HREC of the Victorian Department of Education and Training. Parents who agreed to participate completed the SP at home according to the standard instructions in the manual.

**Data analysis**

Statistical analyses were completed using Excel (2007) to investigate differences between the diagnostic groups

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**TABLE 1: Descriptive data for participants**

<table>
<thead>
<tr>
<th>Gender</th>
<th>Diagnosis</th>
<th>Number</th>
<th>VABS composite</th>
<th>ABRS scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>ASD + ID</td>
<td>24</td>
<td>Range 28–70</td>
<td>Mean 45.2</td>
</tr>
<tr>
<td>Female</td>
<td>ASD + ID</td>
<td>5</td>
<td>Range 20–63</td>
<td>Mean 43.0</td>
</tr>
<tr>
<td>Male</td>
<td>ID</td>
<td>15</td>
<td>Range 27–57</td>
<td>Mean 43.1</td>
</tr>
<tr>
<td>Female</td>
<td>ID</td>
<td>8</td>
<td>Range 29–67</td>
<td>Mean 50.6</td>
</tr>
</tbody>
</table>

*Denotes statistically significant difference between groups (t = 7.11; P < 0.001).
†High scores indicate more anxiety.

ASD, autism spectrum disorders; ID, intellectual disability; ABRS, Anxious Behaviour Rating Scale (from Joosten et al., 2009); VABS, Vineland Adaptive Scale.

**TABLE 2: Average scores† on anxiety items of Motivation Assessment Scale (revised) by group**

<table>
<thead>
<tr>
<th>Anxiety item</th>
<th>ASD + ID</th>
<th>ID</th>
<th>t</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.34</td>
<td>0.18</td>
<td>1.15</td>
<td>0.25</td>
</tr>
<tr>
<td>2</td>
<td>0.68</td>
<td>0.17</td>
<td>3.51</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>3</td>
<td>0.35</td>
<td>0.03</td>
<td>2.27</td>
<td>0.02</td>
</tr>
<tr>
<td>4</td>
<td>0.71</td>
<td>0.14</td>
<td>3.98</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

†Expressed in measure scores derived from Rasch analysis.

ASD, autism spectrum disorders; ID, intellectual disability.

Source: From Joosten et al., 2009.
based on the SPS quadrant scores. The mean raw scores for the quadrants for the normative sample calculated by Dunn (2006) were used for comparison with typically developing children in this study. Items contribute to one quadrant score only; therefore, each response was only used in one between-group analysis. These tests were planned before the data were collected; they were not based on any information on the resulting sample mean values and each analysis was conducted on a different data set. Thus, Bonferroni correction was not applied (Berk & Carey, 2004).

Mean values of the quadrant scores from the two independent groups were compared with those of the normative sample using two-sample t-tests (one-tailed) assuming unequal variances. One-tailed t-tests assuming unequal variances were also calculated to investigate whether the mean scores of the children with the comorbid diagnoses were significantly lower than the mean scores of the children with intellectual disability alone. An a-level of 0.05 was set for statistical significance. The effect size between the two groups was calculated using a d-index. If \( d = 0 \) – 0.19, the effect is negligible; if 0.20 – 0.49, the effect is small; if 0.50 – 0.79, the effect is moderate; 0.80 – 0.99 reflects a large effect and \( \geq 1.00 \) reflects a very large effect: the larger the effect size, the greater the power to detect differences between groups (Tomita, 2006).

**Results**

All mean quadrant scores for the children with ASD and ID and for the children with ID alone were significantly lower than those of the typically developing children (\( P < 0.0001; \ d \geq 2.00 \)). Thus, the first hypothesis was supported and the effect size was found to be very large.

The mean scores for the children with ASD and ID were significantly lower than the mean scores of the children with ID alone for Quadrant 3 (Sensitivity: \( P = 0.007; d = 0.70 \)) and Quadrant 4 (Avoidance: \( P < 0.05; d = 0.47 \)). Thus, the second hypothesis that the children with ID and ASD have qualitative differences in sensory processing, which might help us understand their increased anxiety, was also supported by the statistically significant differences. The effect size was moderate for the sensitivity quadrant, but small for the avoidance quadrant. Mean values, SDs, t-values and d-indices for the children with ASD and ID and for those with ID alone are reported in Table 3.

**Discussion**

In the context of the larger study, all the children in this sample were selected because they engaged in low-level stereotypical behaviours (e.g. arm flapping, finger posturing and rocking; Turner, 1999). In this phase, we found evidence of abnormal sensory processing in the children, which reflects both increased and decreased sensory thresholds. These findings suggest that low-level stereotyped behaviours can be used to meet one or more needs related to abnormal sensory processing. Extreme scores for children with ASD and ID and for children with ID alone in all quadrants indicated that all sensory processing patterns are very different for children with ID, when compared with those of typically developing children. That the scores in all quadrants can potentially be different in the children with ID indicates that the differences can be the result of both increased and decreased thresholds. This may help explain why, with different samples of children, some researchers have concluded that children with autism are more likely to have over responsive patterns (Rogers & Ozonoff, 2005) and others have concluded that they are more likely to be under responsive (Dunn, 2006).

The most compelling findings in this study were those distinguishing between the groups of children with ID. The children with ASD and ID, who were found to use stereotypical behaviours to alleviate anxiety in earlier phases of the study (Joosten et al., 2009), were significantly more sensitive to sensation and more extreme in their avoidance responses than the children with ID alone. These findings provide empirical support for the

**TABLE 3: Sensory Profile Quadrant t-test**

<table>
<thead>
<tr>
<th>Quadrant</th>
<th>ASD + ID, mean raw score</th>
<th>ASD, SD</th>
<th>ID, mean raw score</th>
<th>ID, SD</th>
<th>t</th>
<th>d.f.</th>
<th>( P (T&lt;=t) ) one-tailed</th>
<th>d-index</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Registration</td>
<td>50.1</td>
<td>11.3</td>
<td>53.7</td>
<td>11.3</td>
<td>−1.140</td>
<td>47</td>
<td>0.130</td>
<td>0.32</td>
</tr>
<tr>
<td>2. Seeking</td>
<td>86.5</td>
<td>16.6</td>
<td>91.6</td>
<td>13</td>
<td>−1.243</td>
<td>50</td>
<td>0.150</td>
<td>0.34</td>
</tr>
<tr>
<td>3. Sensitivity</td>
<td>68.5</td>
<td>10.9</td>
<td>76.1</td>
<td>10.7</td>
<td>−2.511</td>
<td>48</td>
<td>0.007*</td>
<td>0.70</td>
</tr>
<tr>
<td>4. Avoiding</td>
<td>99.8</td>
<td>12.2</td>
<td>106</td>
<td>14.4</td>
<td>−1.683</td>
<td>43</td>
<td>0.049*</td>
<td>0.47</td>
</tr>
</tbody>
</table>

*Significant difference (0.05).

Mean raw scores indicate that higher scores are closer to typical performance.

ASD, autism/intellectual disability; ID, intellectual disability; SD, standard deviation; d.f., degrees of freedom.
widely held belief that sensory sensitivities may contribute to anxiety and the behavioural disorganisation commonly seen in children with ASD (Kimball, 1999).

The d-values associated with differences in the Sensitivity quadrant between the two groups of children with ID indicate quite clear and meaningful differences, whereas the d-values associated with avoidance show a somewhat less robust difference. Nonetheless, according to Dunn, hypersensitivity and avoidance are flip sides of a low-threshold coin. That is, behaviours reflecting hypersensitivity are a passive response to low-sensory thresholds whereas avoidance behaviours represent an active response to the same low thresholds. Thus, as a group, children with comorbid ASD and ID have significantly lower thresholds to sensation than children with ID alone. When these findings are considered together with those of the earlier phase in which we found that the stereotyped, repetitive behaviours of children with autism are commonly motivated by anxiety (Joosten et al., 2009), they suggest that low thresholds to sensation may contribute to increased anxiety, which many children attempt to alleviate by engaging in low-level stereotyped, repetitive behaviours.

However, it is important to note that sensory processing difficulties are unlikely to be the only source of anxiety in individuals with ASD. Cognitive limitations (e.g., difficulty generating new solutions to problems, or to cope when overwhelmed by demands) and communication and social interaction deficits are also likely to result in anxiety (Loveland & Tunali-Kotoski, 2005) and possibly in stereotyped behaviours. The intricate connections among these various behavioural manifestations of ASD will require ongoing research.

Limitations

An important limitation of this study was the relatively small sample sizes (29 children with comorbid diagnoses and 23 children with ID alone), which was largely determined by the number of participants available from this clinical setting. This sample may not fully represent the population of children with these diagnoses. Replicating the study with a larger population is necessary.

Implications for further study

Importantly, not all children with ID engage in stereotypical behaviour. Further investigation of the extent to which children with ID who do not engage in stereotypical, repetitive behaviour have sensory processing difficulties is required. Further, not all children with sensory processing disorders have an ID or do they all engage in stereotypical and repetitive behaviours. Further study to investigate if and how the presence of ID increases the likelihood that a child with sensory processing difficulties will engage in stereotypical and repetitive behaviour is also required.

Conclusions

This study provides evidence that children with comorbid diagnoses and children with ID alone who engage in stereotypical and repetitive behaviour both experience sensory processing difficulties compared with typically developing children. A particularly important contribution of this study is the identification of behaviours that reflect low-sensory thresholds (increased sensitivity and avoidance), which may contribute to our understanding of the increased anxiety experienced by children with autism and ID, and an improved understanding of the stereotypical and repetitive behaviours in which children with autism and children with ID commonly engage. Understanding the source of the anxiety enables interventions to prevent or minimise the emergence of stereotypical and repetitive behaviours and other secondary problems that result from the child’s avoidance of situations likely to cause distress.

References


