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Distraction, distress and diversity: Exploring the impact of sensory processing differences on learning and school life for pupils with autism spectrum disorders

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ABSTRACT

Background: Many individuals with Autism Spectrum Disorders (ASD) experience sensory differences that impact daily functioning. This study aimed to capture parent and teacher perspectives on how sensory differences affect learning and life at school for pupils with ASD.

Method: Fifty-seven parents and seventy UK teachers completed a bespoke online questionnaire that focused on the type of sensory experiences encountered at school and how these experiences impacted learning and school life for autistic pupils.

Results: Despite considerable heterogeneity in the experiences perceived as enjoyable or distressing, parents and teachers reported that sensory experiences at school were frequently negative. Data indicate that it was largely negative sensory experiences that impacted learning, in turn causing distraction, anxiety and limited participation. Although five teachers highlighted positive sensory experiences, the examples offered focused on children's ability to engage in classroom activities, once their sensory needs had been met (*e.g.* using weighted blankets).

Factors including predictability of sensory input, school resources, and staff knowledge minimized sensory disruption.

Conclusions: According to teachers and parents, sensory experiences significantly impact learning and school life for autistic pupils and these findings can inform teacher training and intervention development.

1. Introduction

Within the UK, 27 % of pupils with a statement of Special Educational Needs or an Education Health and Care Plan (EHCP) have an Autism Spectrum Disorder (ASD; All Party Parliamentary Group on Autism, 2017). ASD is characterized by persistent difficulties with social communication and interaction, alongside restricted and repetitive patterns of behaviour and interests (American Psychiatric Association (2013)). Although the Autism Act (Her Majesty's Stationery Office (2009)) and the Children and Families Act (Her Majesty's Stationery Office, 2014) sought to improve educational outcomes for children with ASD, many continue to underachieve academically and experience high rates of exclusion (Brede, Remington, Kenny, Warren, & Pellicano, 2017; Keen, Webster, & Ridley, 2016). Moreover, 50 % of children with ASD report being unhappy at school and do not feel their needs are being met (All Party Parliamentary Group on Autism, 2017). While several of the problems reported by pupils relate to their social difficulties, many

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highlight that sensory processing differences are equally detrimental to their classroom experiences (All Party Parliamentary Group on Autism, 2017). Yet the impact of these differences within an educational context has been neglected. The current study addresses this gap by adopting a mixed-method approach to investigate the views of parents and teachers on sensory processing and the impact on learning and school life for pupils with ASD. The aim is not to study whether sensory issues exist for children with ASD as the literature is vast on this issue (Marco, Hinkley, Hill, & Nagarajan, 2011; Rogers & Ozonoff, 2005) but rather to focus on teacher and parent views on the impact of these differences within a school setting.

Sensory processing refers to the mechanism by which the central nervous system receives input from the senses and integrates this information to generate an appropriate behavioural response (Dunn, 1997). Based on the Dunn model of sensory processing whereby children can be distinguished on hyper- and hyposensitivity to sensory input and can be profiled as a 'sensory seeker' or a 'sensory avoider', the key measure of sensory processing is the Sensory Profile (Dunn, 1997, 1999). This questionnaire asks participants to rate how frequently they respond to a sensory event (Dunn, 1999). When asking caregivers and adults with ASD to complete this questionnaire, autistic individuals are consistently found to experience greater frequencies of sensory differences compared to typically developing individuals (Uljarević et al., 2017). Critically, autistic children differ on items reflecting both hypersensitivity and hyposensitivity to sensory inputs, suggesting that a single pattern of sensory processing is not characteristic of ASD; a conclusion that has now been confirmed (Kern et al., 2006; Rogers & Ozonoff, 2005). For individuals with patterns of hypersensitivity, the central nervous system, requires minimal sensory stimulation to produce a response, whereas for individuals with patterns of hyposensitivity, greater stimulation is needed for a comparable response to be generated (Dunn, 1997).

The Nordic Relational Model of Disability (Tøssebro, 2004) provides a useful framework for understanding how, and under what circumstances, sensory processing differences affect the day-to-day lives of individuals with ASD. Here, 'disability' is seen to occur when there is a mismatch between an individual's functional ability and their environment. For example, a blind individual, although impaired, only becomes disabled when the environment has not been adjusted to meet his/her needs. In the case of sensory processing differences, a child with hypersensitivity may be able to fully function at home but may experience 'disability' when placed in a busy classroom with significant sensory inputs such as bright lights and noisy children (Goodley & Runswick-Cole, 2012). Given that children typically spend the majority of the school day in the same classroom, a mismatch between the environment and an individuals' sensory needs could be especially adverse (Piller & Pfeiffer, 2016).

Supporting this position are the results of Ashburner, Ziviani, and Rodger (2008) who collated parent reports on the Short Sensory Profile (McIntosh, Miller, Shyu, & Dunn, 1999), from 51 parents of typically developing children and 28 parents of autistic children aged 6–10 years. Teachers completed the Conner's Teaching Rating Scale (Connors, 1997) and children completed the Kaufman Brief Intelligence Test (Kaufman & Kaufman, 1990). For typically developing children, IQ was found to be the only significant predictor of academic achievement. However, auditory filtering, under-responsiveness, and sensation seeking accounted for 47 % of the variance in academic achievement for pupils with ASD. This emphasizes that a mismatch between sensory needs and the classroom environment can significantly impact academic progression (Ashburner et al., 2008). However, this study provided little insights into *how* sensory differences affect academic achievement, and for this consideration a qualitative approach can be particularly insightful.

Howe and Stagg (2016) took such an approach and asked sixteen ASD pupils attending mainstream secondary school to complete the Adolescent and Adult Sensory Profile and an open-ended questionnaire. The questionnaire included four sections (auditory, touch, smell, and vision) and asked pupils if differences within each modality affected their learning, how it affected learning, feelings associated with these experiences, and positive outcomes related to sensory differences. Auditory differences were perceived to be the most disruptive to learning, followed by touch, smell, and vision. These sensory experiences affected learning by disrupting concentration and causing anxiety or physical discomfort (Howe & Stagg, 2016). Anxiety related to sensory differences has been reported more widely in the literature (Green, Ben-Sasson, Soto, & Carter, 2012; Neil, Olsson, & Pellicano, 2016). Indeed, recent models place hypersensitivities as central in developing and maintaining anxiety for autistic individuals (Boulter, Freeston, South, & Rodgers, 2014; South & Rodgers, 2017). One such model is the Intolerance of Uncertainty framework. This model proposes that an interplay been sensory sensitivities, rigidity of thought, difficulty with emotional processing, and social/environmental factors create the belief that "unexpected events are negative" and should be perceived as threatening, which then feeds into high levels of anxiety (Boulter et al., 2014; South & Rodgers, 2017). Supporting this are findings from Green et al. (2012) longitudinal study that assessed 149 autistic toddlers at two time points and found sensory over-responsivity significantly predicted an increase in anxiety. Given recent estimates suggest up to 40 % of the autistic population experience anxiety (van Steensel, Bögels, & Perrin, 2011), understanding the type of sensory experiences encountered at school and how this might relate to anxiety could be particularly important for improving school experiences for autistic pupils and informing future intervention work.

Thus, although the link between hypersensitivities and anxiety has been discussed and evidenced (Boulter et al., 2014; Howe & Stagg, 2016), it is possible that the role of hyposensitivity has been overlooked. Hyposensitivity however, has been associated with a range of psychological correlates that could be important for classroom behaviour and success, namely joint attention (Baranek et al., 2013), emotion dysregulation (Samson et al., 2014) and gross motor skills (Jasmin et al., 2009). It has been suggested that hyposensitivity is more difficult to self-report because individuals are often not aware if they have missed sensory input, for example the teacher calling their name (Smith & Sharp, 2013). Consequently, there is a need to adopt a multi-informant, multi approach to build a comprehensive understanding of sensory differences and their impact in school.

Taking a multi-perspective approach, Piller and Pfeiffer (2016) interviewed eight primary school teachers and five occupational therapists, who highlighted a range of stimuli and reactions that disrupted participation in the classroom for autistic pupils. Responses indicated sensory differences were often situated within a particular context rather than being a stable trait. For example, although several highly tactile tasks (*e.g.* painting) caused challenges for pupils with ASD, these same children would seek out touch from other pupils. Teachers explained that they would attempt to increase classroom participation by adopting routines and adapting

the classroom environment. This emphasizes how detrimental an incompatible environment can be, but also demonstrates the value of a multi-perspective approach (Piller & Pfeiffer, 2016). Nevertheless, the sample size was small (n = 8) and the nature of the school provision was unclear (*e.g.* mainstream, special educational provision). This is important because school design and sensory stimulation can vary (Hughes, 2014).

The current study built on previous literature by adopting a multi-method, multi-informant approach to understand the nature of sensory differences and their effect on learning and school life for autistic pupils. It is evident from the literature that sensory differences impact many individuals with ASD (Marco et al., 2011, Rogers & Ozonoff, 2005) and this study did not aim to replicate that evidence, but rather to explore how sensory issues impact in a more applied manner in the classroom. This was achieved by asking teachers from a range of school provisions to complete an online questionnaire containing both open and closed questions, thereby permitting quantitative and qualitative insights. This approach allowed for both the measurement of impact and also the opportunity to capture rich illustrations and gather new perspectives on sensory experiences that may not have been previously considered in existing frameworks. Parents also completed a similar questionnaire to add to the multi-informant perspective. The study first aimed to examine how parents and teachers identified sensory differences as affecting behaviour (Aim 1) before exploring the type of sensory experiences encountered at school (Aim 2) and their impact on learning (Aim 3).The study also aimed to investigate the factors that influence how sensory differences affect learning (Aim 4) and finally to assess current satisfaction with awareness of sensory differences at school (Aim 5). Given the heterogenous nature of sensory processing difference observed in ASD, we hypothesized that there would be considerable variation in the type of sensory experiences reported by parents and teachers- both in terms of severity, hyper/hypo responding, and the sensory domain (auditory, visual, tactile *etc*). Nevertheless, we expected that both parents and teachers would report significant impacts of sensory issues. Beyond this hypothesis, the project was exploratory in order to capture the insights of parents and teachers on sensory issues.

2. Method

2.1. Participants

Fifty-seven mothers completed the online parent questionnaire. Two caregivers reported that they had an additional child with an ASD diagnosis, leading to the experiences of fifty-nine children being represented. Demographic and school provision information is presented in Table 1.

Seventy teachers (62 female) completed the online questionnaire. On average, teachers had 14.5 years of teaching experience. All reported teaching pupils with ASD although this varied from working with three children up to several hundred children. All teachers had taught in the UK. Information on school provision is provided in Table 1.

The insights from parents and teachers in this study are provided by those who have experience with children who have a range of different reactions or sensitivities. Indeed, 98 % of parents stated that their child had sensory differences and seventy-three percent of teachers reported that at least half of the autistic children they had taught experienced sensory differences in the classroom.

Parents and teachers were recruited through SENCO networks, local links with schools, and advertisements on social media.

2.2. Materials

Two online questionnaires for i) parents and ii) teachers were designed. These questionnaires were developed based on two previous interview schedules, exploring sensory experiences in adolescents with ASD (Ashburner, Bennett, Rodger, and Ziviani, 2013) and parental understanding of sensory experiences (Dickie, Baranek, Schultz, Watson, & McComish, 2009). Two existing

Table 1
Parent and teacher demographic and school provision information.

Parent Demographic Information	
N Parent	57
Parent Mean Age	40.00
SD Parent Age	6.08
N Children	59
Child Mean Age	10.18
Child Age Range	4.5-17
Distribution of school provision (Parent)	
N Mainstream	42
N Special Education Provision	12
N Enhanced Provision	2
N Home School	3
Distribution of school provisions (Teacher)	
Mainstream	26
Special Education Provision	10
Mainstream with enhanced provision	4
Mainstream and Special Education Provision	27
Mainstream and mainstream with enhanced provision	3

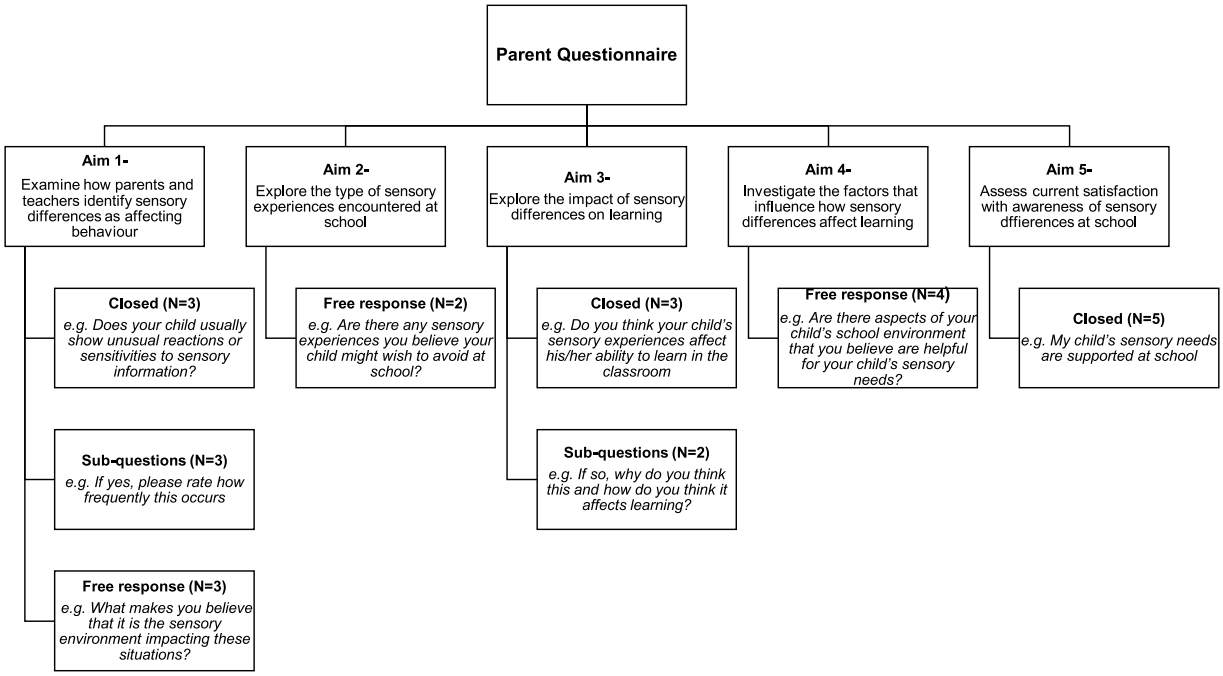

Fig. 1. Parent questionnaire structure (N = Number of questions).

surveys were also examined, one that asked teachers to consider how sensory differences affected classroom participation (Piller & Pfeiffer, 2016), and a second that asked adolescents with ASD how their sensory experiences impacted their learning (Howe & Stagg, 2016).

2.2.1. Parent questionnaire

The questionnaire began with a demographic section that probed age and type of school attended by their child. The main section included eleven closed questions that asked either for yes/no responses or Likert-Scale responses (Not at all, Rarely, Somewhat, Frequently or All of the time), five sub-questions and nine free response questions. Fig. 1 below shows the number of questions corresponding to each aim. See Supplementary Materials for full questionnaire.

2.2.2. Teacher questionnaire

The questionnaire began with a demographic section. The main body included fifteen closed questions that asked for yes/no responses or Likert-Scale responses, eighteen-sub questions and seven free-response questions. Fig. 2 shows the number of questions corresponding to each aim. See Supplementary Materials for full questionnaire.

2.2.3. Procedure

After obtaining ethical approval from the local ethics committee and ensuring that the research was GDPR complaint, the link for the online questionnaire, hosted *via* Bristol Online Survey (www.onlinesurvey.ac.uk), was distributed through SENCO networks in the UK and shared on social media. All data were anonymous, and participants were able to omit any questions they did not wish to answer.

2.3. Data analysis strategy

Qualitative data were analysed using data-driven thematic analysis. In line with Braun and Clarke (2006), and the process of data immersion, data were first read and re-read by the first author to ensure familiarly and closeness with the data. At this point, initial thoughts and ideas were also written down. The first author then took each question in turn and attached codes to the data. Codes represented features of the data that were considered pertinent to each of the study's aims. Although each question corresponded to a particular aim, often participants would include information that was also relevant for another of the study's aims. The next stage involved the first author grouping similar codes to identify themes within the data set. All three authors then examined these themes and ensured there was enough data to support its existence. Themes that were too heterogenous and did not have enough supporting data were subsequently removed. After re-reading the data and ensuring that the refined themes accurately reflected the full essence of parent and teacher responses, as a team we named each of the themes. Finally, the lead author chose examples from the data to illustrate each theme. 20 % of the data were double coded by two independent researchers with expertise in autism and an inter-rater agreement level of 96 % was obtained. Quantitative data (Likert scale and Yes/No responses) were analysed using descriptive

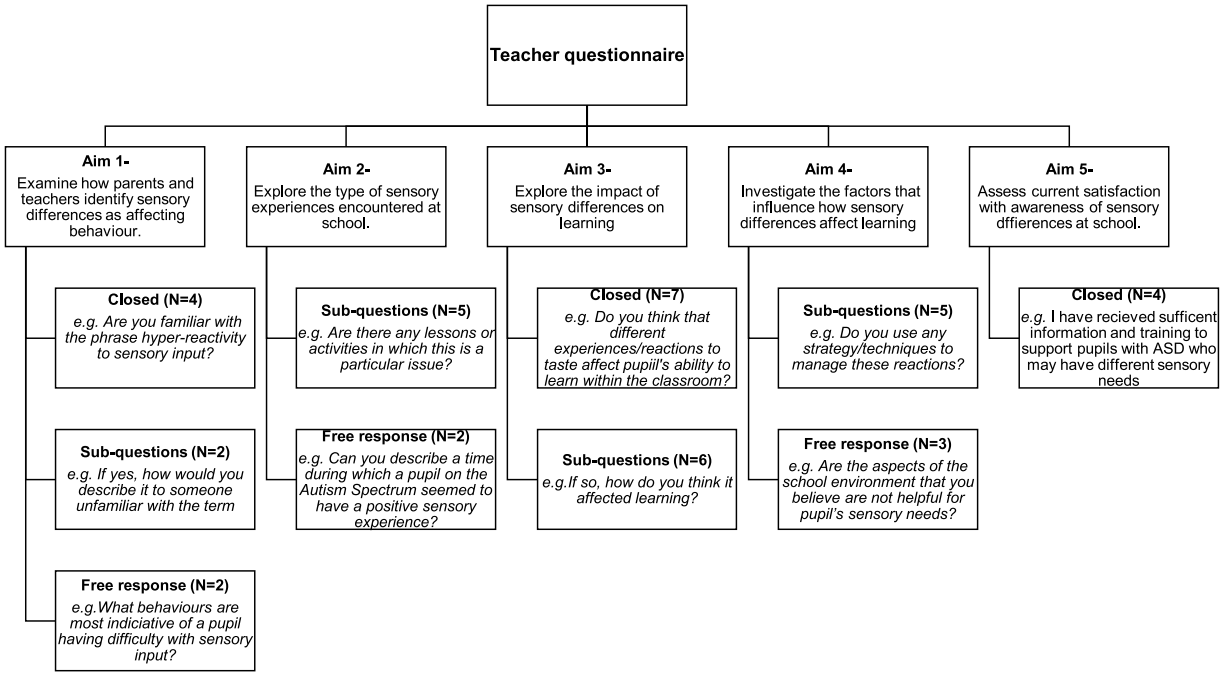

Fig. 2. Teacher questionnaire structure (N = Number of questions).

statistics and Fisher's exact test.

3. Results

Results for each of the five aims are outlined in turn with extracts from participants included and the school provision noted to compare experiences across school type. Table 2 below lists the themes identified during thematic analysis.

3.1. Aim 1- Identification of sensory differences

Parents and teachers explained three ways in which they identified sensory differences as affecting a child's behaviour. First, teachers (N = 12) and parents (N = 4) explained how changes in the environment were accompanied by changes in behaviour, for instance one teacher (mainstream and enhanced provision) reported "*I know that it is the humming noise of the projector that is causing distress to a child because the child will be calmer and will work better once it is turned off*". Understanding a child's idiosyncrasies also allowed parents (N = 3) and teachers (N = 8) to identify the sensory environment as the source of distress. For example, one teacher (enhanced provision) described a child who "*really did not like to touch anything that made him 'dirty'- didn't like to paint, touch play dough etc. This would make him flap, hit out and sometimes scratch or scream. He really did not like it and always reacted in the same sort of way*." Negative reactions also indicated that the child was experiencing sensory difficulties (Teachers N = 15, Parents N = 19) and included attempts to limit sensory input, with one parent (mainstream) explaining "*They try to protect themselves by covering their ears, closing their eyes, pulling their t-shirts over their noises to block out the smells*".

3.2. Aim 2- Sensory experiences encountered at school

The second aim was to explore the type of sensory experiences encountered and assess how frequently these experiences affected learning and school life. Table 3 shows that 49 % of parents and 36 % of teachers believed sensory differences affected life at school all of the time. Likewise, 47 % of parents and 30 % of teachers believed sensory differences affected learning all of the time. Importantly, no teacher believed that sensory differences had no impact and only one parent believed that sensory differences didn't impact learning. There was no significant difference in the distribution of responses between parents and teachers for impact on school life (Fisher Exact Test, two-sided), $p = 0.523$. Although there was a significant difference in the distribution of responses for the effect on learning (Fisher Exact Test, two sided), $p = 0.038$, adjusted (for multiple comparisons) pairwise comparisons were non-significant, $p > 0.05$. This demonstrates that both teacher and parents perceive sensory differences as having a profound impact on aspects of schooling for pupils with ASD.

To understand if differences within a particular sensory modality were driving this effect, the questionnaire asked teachers to report how frequently differences within each sensory modality affected learning. Table 3 shows that auditory differences are perceived to affect learning most frequently by teachers, with 78 % stating differences within this domain affected learning all the time

Table 2
Thematic analysis results.

Aim	Themes	Example Quote
1) Identification of sensory differences	Changes in the environment are accompanied by changes in behaviour	*You can't always tell but it is often changes in sensory stimulation that can cause a positive or negative effect. (*Teacher, Mainstream and Special Provision)
	Understanding a child's idiosyncrasies	*I know the children well enough to know what makes them react to certain sensory stimuli.* (Teacher, Special and Mainstream Provision)
	Negative reactions	*He shows clear signs of distress, hands over ears, crying, going to his dark den, getting his chew hammer out and asking for tight cuddles from his support worker. (Parent, Mainstream)*
2) Sensory experiences at school	Auditory- Loud, unpredictable.	*Both my boys are extremely sensitive to loud, unexpected noise. Fire alarms can be extremely distressing. They become very upset and can cry for long periods of time after the loud noise.* (Parent, Mainstream)
	Tactile- Diverse reactions	*We use a lot of different materials in the art room and sometimes students have either very positive or negative reactions to these.* (Teacher, Special)
	Visual- Florescent lights, displays	*Classrooms which had too much stimulation for asd pupils e.g. highly coloured displays, lots of things hanging down from the ceiling etc.* (Teacher, Mainstream)
	Taste- Distress at lunch time.	*Pupils getting stressed at lunchtimes because they don't like or are forced to try different foods.* (Teacher, Enhanced Provision)
	Olfactory- Incidental smells	*Smells may be much stronger for those on the spectrum, maybe even not detected by staff or other pupils. Pupils can become very distracted by smells that they perceive are very strong.* (Teacher, Mainstream and Special)
3) Impact on learning	Distraction	*Affects concentration on what teacher is saying (i.e. things like peers in room tapping a pen, sliding a ruler across desk, talking or whispering or messing around when he is trying to concentrate on what teacher saying.* (Parent, Mainstream)
	Distress	*Going into crisis for that child - flapping, run away, shouting, crying or just distressed.* (Teacher, Enhanced Provision)
	Anxiety	*She gets stressed, clammy, her heart races, she digs her nails into her hands and says she feels angry when the class is too loud and busy.* (Parent, Mainstream)
	Classroom participation	*Some children can't access classroom themselves because of the noises, spaces, heat and surfaces.* (Teacher, Mainstream and Special)
	Tool for learning	*I have a child who has ASD and was deaf- he was hyper stimulated by sensory touch etc and responded really well to have a tablet or diddle toy as calming tool.* (Teacher, Mainstream and Enhanced Provision)
4) Factors that influence how sensory differences affect learning.	Child Agency/Control	*For projects in which students work more at their own pace and are responsible for getting their own supplies I will give student a checklist so they can organize themselves and their materials. Sometimes I will offer students the choice to work at a quieter table in the room.* (Teacher, Special)
	Predictability	*When there is an activity which she is unfamiliar with, she tends to experience sensory overload. If she is fully prepared beforehand then she manages to cope quite well.* (Parent, Mainstream)
	Classroom design	*Often classroom environments are too visually busy which means many youngsters don't know what to attend to and are overwhelmed. This is particularly an issue in mainstream primary Foundation classrooms where everything is accessible/out all of the time. (Teacher, Mainstream and Special)*
	Occupational therapy tools	*Many of our children with ASD wear and have access as necessary to headphones or fiddle toys* (Teacher, Mainstream and Enhanced Provision)
	School resources	*We do not have multisensory rooms therefore any multisensory tasks we want to undertake we have to create our own experiences. Class sizes can also make this difficult.* (Teacher, Mainstream)
	Staff knowledge	*No 1 thing is understanding by all staff so they can prepare children, provide quiet time or activity as needed, explain to visitors etc. If staff don't 'get it' life is going to be very hard and children's mental health and academic achievements will suffer.* (Teacher, Mainstream)

or frequently, followed by tactile differences (49 %), visual (42 %) olfactory (30 %) and taste (7 %). Similarly, 70 % of parents reported auditory as being the most disruptive for learning, followed by tactile (16 %), visual (5 %), taste (5 %) and olfactory (4 %).

Parents and teachers reported a range of sensory experiences encountered by pupils at school, although these were often negative in nature. Within the auditory domain, loud unpredictable noises (Teachers N = 11) were the most common source of distress (e.g fire alarms, hand-dryers, noise from other pupils). However, lower-intensity sounds were also troublesome and included the sound of pencil on paper (Teacher, mainstream and enhanced provision) and the white-board pen (Teacher, mainstream and enhanced provision). Only two teachers reported enjoyable auditory experiences, and both related to music. For instance, one teacher (mainstream

Table 3
Impact of sensory processing as reported by parents and teachers (number of responses and percentages).

	Not at all and Rarely		Sometimes		Frequently		All the time		N Total
	N	%	N	%	N	%	N	%	
Impact of sensory processing									
Life at school – Teachers	0	1.4	15	21.7	28	40.6	25	36.2	69
Life at school – Parents	1	1.8	10	17.5	18	31.6	28	49.1	57
Learning at school – Teachers	1	1.4	19	27.5	28	40.6	21	30.4	69
Learning at school - Parents	3	5.3	16	28.1	11	19.3	27	47.4	57
Sensory modalities and impact									
Auditory	1	1.5	14	20.9	34	50.7	18	26.9	67
Visual	6	8.6	34	49.3	22	31.9	7	10.1	69
Taste	31	44.9	33	47.8	3	4.3	2	2.9	69
Tactile	7	10.5	27	40.3	23	34.3	10	14.9	67
Smell	19	28.4	28	41.8	18	26.9	2	3	67

and enhanced provision) explained, "*soothing music helps one of my little people concentrate. The other little people in my group can only tolerate it if played quietly.*

Tactile experiences evoked more diverse reactions, especially when they were social in nature. For example, one parent (mainstream) reported that their child would seek out "*physical touch such as hugs, kisses, repeatedly tapping someone, touching and squeezing their face. He likes to be really close to people*". Conversely, ten teachers and ten parents reported that children "*hated being touched by people*". Teachers reported that tactile differences were most prominent in situations such as assembly, group work, and transitioning through corridors.

Negative visual experiences related to *florescent lights*", "*strip lights*," and "*classroom with lots of displays*" (Teachers N = 17). Given the nature of these stimuli, unenjoyable visual experiences occurred throughout school. Few parents (N = 2) reported that their child would seek out visual input and teachers (N = 2) only noted positive visual experiences in relation to the use of visual timetables. However, it must be considered that this positive experience arose because of the increased structure afforded by visual timetables rather than the actual stimuli itself.

Taste differences were reported only to disrupt learning through affecting the child's nutrition or causing distress at lunchtime (Teachers N = 11), illustrated here by one teacher (special) "*Restricted diets = sub optimal nutrition = impact on energy levels for processing information*". For olfactory experiences, "*PE changing room*" and "*incidental smells such as perfume and cleaning products*" were reported as unenjoyable sensory experiences (Teachers N = 20, Parents N = 6). Seventeen parents also highlighted that their child would seek out vestibular or proprioceptive input, illustrated here by one parent (mainstream) suggesting "*She might seek vestibular input as this is calming for her. So spinning/swinging on chair"*

3.3. Aim 3 - How do sensory differences affect learning?

Parents and teachers reported several ways by which sensory differences could affect learning at school. Foremost, parents (N = 22) and teachers (N = 40) perceived sensory differences as causing distraction in the classroom. Visual sources of distraction included light fittings and classroom displays whereas tactile sources included other children and clothing, illustrated here by one teacher (mainstream) explaining "*because if a child is more focused on what they are wearing it distracts them from their work*". Teachers interpreted auditory distraction to be caused by an inability to *"tune out the noises they don't need affecting their ability to listen to instructions/input*".

Sensory differences also caused distress, which was expressed through emotional and physical reactions (Teachers N = 37). Teachers described how children reacted to sensory stimuli by "*lashing out*", displaying "*agitated behaviours*" or responding with "*meltdowns, tears, screaming, tantrum like behaviour*". Parents noted similar behaviours, with three also reporting incidents of self-harm, for example one-parent (special) stated in "*corridors, open halls where sounds can be echoed, my child will self-harm and try to cover his ears*".

Teachers (N = 15) and parents (N = 15) reported high levels of anxiety that was perceived to disrupt learning. One teacher (mainstream) explained, "*if something is making them anxious or uncomfortable or overstimulated it's going to be really hard to learn anything*" whereas another teacher stated "I *have seen heightened anxiety and increasingly more challenging behaviours in many pupils who have not had their sensory needs met*".

Classroom participation was also affected by sensory differences (Teachers N = 37, Parents N = 26). This included limited participation, leaving the classroom, or being unable to attend school all together, as illustrated by one parent (enhanced provision) writing "*he accessed no formal education for over 6 months. He now accessed full time education and is beginning to make progress.*

Finally, teachers (N = 5) reported how they could harness these sensory differences to improve regulation and learning in the classroom. For example, a teacher (mainstream) described one pupil "*was soothed by feeling a soft-blanket, when pupil was distressed the soft blanket would help calm him down.*

3.4. Aim 4 – Factors that influence how sensory differences affect learning

The fourth aim was to explore the factors that facilitated or inhibited a child's sensory differences from affecting their learning. Across modalities, increasing a child's agency was central in preventing distressing sensory experiences (Teachers N = 16). For example, teachers reported how they would manage visual sensitivities by allowing children to "*work individually on an IPad offering pupils control of how much visual stimuli they can manage*" (mainstream and special). Linked to the idea of agency was predictability, with teachers (N = 18) reporting how they would minimize the likelihood of unexpected events by establishing routines, as shown in the following quote from a teacher (mainstream and special) "*we structure the pupils day around the events, we pre-empt, and let the pupil know*".

Classroom designs were found to both facilitate and inhibit learning challenges. Teachers spoke of the "*deliberately stimulating*" nature of classrooms and how they would modify these spaces to meet the needs of their pupils. For instance, one teacher (enhanced provision) explained "*I have been able to introduce children into a year 6 classroom that is quiet, calm and still. The displays are neat, tidy and uniformed".* Accompanying these adaptions were modifications in school policy, for example providing early lunch passes and implementing different start and end times to the day.

Parents and teachers (N = 39) also reported that occupational therapy tools aided children in their learning. Most commonly reported were the use of ear defenders, weighted blankets, dividers, pop-up barriers, and individual workstations. Sensory diets and sensory breaks were also implemented, as were gradual programmes of de-sensitization. School resources also determined the extent to which sensory differences affected learning (Teachers N = 43, Parents N = 44). Overwhelmingly, parents and teacher reported that that "small class sizes", high staff to pupil ratio and 1:1 work enabled their child to fulfil their potential at school. This can be emphasized by a parent (special) who explained, "*he cannot manage being in a classroom more than 9. He cannot access many activities without 1:1 support".* Multisensory rooms, sensory integration rooms, and hydrotherapy were also beneficial. However, these resources were much more readily available in special educational provision than in mainstream schools. The lack of such resources in mainstream school often led to the idea that the mainstream setting was incompatible with children's needs (Parent special school N = 8, mainstream N = 3), as evidenced by the following extract: Parent (home-school) "*no local mainstream schools have class sizes small enough or the skillset to effectively manage his challenging behaviour, but a special school would not be appropriate to meet his academic needs*".

Finally, staff knowledge was seen as key in supporting the sensory needs of pupils (Parents N = 19, Teachers N = 27). This included knowledge on autism and sensory processing but also encompassed knowledge of each child's need. For example, one parent explained "*my child's school is a special school and they are fully aware of his and all the other kids in the class's sensory profiles. When they allocate groups this is primary concern".* This was not the case for many parents, with the thirty-three calling for more training and better communication between families and schools. Indeed, many parents highlighted that "*they know best*", illustrated by "*teachers need to listen and accept that parents know best in most areas, not ignore parents' requests*" (mainstream).

3.5. Aim 5 - Satisfaction with awareness and current understanding of sensory differences

The final aim was to assess teacher and parent satisfaction with current training and awareness of sensory issues in school (Aim 5). Table 4 shows that although 32 % of teachers strongly agreed that schools work closely with parents to support pupils with sensory differences, only 19 % of teachers strongly agreed that they had received sufficient training to support pupils.

Table 4
Satisfaction with awareness of sensory differences.

	Strongly Disagree		Disagree		Somewhat		Agree		Strongly Agree		N Total
	N	%	N	%	N	%	N	%	N	%	
Teachers											
I have received sufficient information and training to support pupils with ASD with different sensory needs.	3	4.3	7	10.1	21	30.4	25	36.2	13	18.8	69
School works closely with parents and pupils to support the sensory needs of the individual in class	2	2.9	7	10.1	7	10.1	31	44.9	22	31.9	69
Schools and teachers need more guidance to support ASD pupils who might have different sensory experiences.	0	0.0	3	4.3	13	18.8	31	44.9	22	31.9	69
I am not confident in my ability to teach pupils on the Autism Spectrum who have different sensory experiences	19	27.5	20	29.0	19	27.5	5	7.2	6	8.7	69
Parents											
School is aware that my child might experience and react to sensory information differently.	4	7.0	4	7.0	8	14.0	16	28.1	25	43.9	57
School works closely with parents and pupils to support sensory needs.	11	19.3	10	17.5	11	19.3	11	19.3	14	24.6	57
My child's sensory needs are supported in school	12	21.1	9	15.8	13	22.8	12	21.1	11	19.3	57
The school environment is compatible with my child sensory needs	14	24.6	17	29.8	12	21.1	10	17.5	4	7.0	57
Teachers have received sufficient training and guidance to support pupils on the Autism Spectrum who may have different experiences and reactions to sensory information	17	29.8	11	19.3	10	17.5	9	15.8	10	17.5	57

Conversely, while 44 % of parents strongly agreed that school was aware pupils with ASD might have sensory differences, 21 % strongly disagreed that their child's sensory needs were supported at school. These findings illustrate that although schools might be aware of sensory differences, greater training is needed to implement policies that can support sensory needs and enhance learning opportunities for pupils with ASD.

4. Discussion

This study adopted a multi-method approach to explore parent and teacher perspectives on the nature of sensory differences at school and their impact on learning for autistic pupils. Parents and teachers alike were able to provide rich insights into the type of sensory experiences encountered at school, highlight several pathways by which these could differences could affect learning, and identify factors that influence how sensory differences impact learning. Findings from this study emphasize that sensory differences can have a profound effect on aspects of schooling for autistic pupils and offer several suggestions for teacher training and intervention development.

We first aimed to explore how parents and teachers identified sensory differences as affecting behaviour. Key to this was understanding a child's idiosyncrasies and exposure to negative reactions. In line with the Nordic relational model, informants also explained how changes in the environment were often accompanied by changes in behaviour, for example "*He is fine any other time but when thunder and lightning are happening behaviour changes almost instantly*" (Teacher, special school). Whilst this reasoning is consistent with findings from Dickie et al. (2009), in which parents explained sensory reactions only occurred at certain times with certain things, it must be acknowledged that this type of attribution could lead to more subtle sensory experiences being missed. For instance, it might be easier to notice a child holding their hands over their ears in response to thunder than it is to notice a child reacting to smells from the canteen, yet both could be equally detrimental to the classroom experience. Acknowledging these constraints is important when considering findings from Aim 2, in which we asked about the type of sensory experiences at school and their impact on learning. Parents and teachers reported auditory differences as being the most disruptive for learning, citing loud noises (fire alarms, hand-dryers, noise from other pupils) as common sources of distress. Mirroring the views of autistic adolescents in Howe and Stagg (2016), tactile experiences were reported as being second in terms of impact, followed by visual, olfactory and taste. Although reactions to auditory and tactile stimuli might be more readily observed, and by proxy reported as most disruptive by informants, the consistency with autistic adolescents here suggests there are particular properties inherent to auditory and tactile stimuli that result in them having the greatest disruption on learning.

Insights from the current study suggest that it is the often uncontrollable and unpredictable nature of auditory and tactile stimuli that are driving this effect. Emphasizing this are findings from the tactile domain, whereby teachers reported "*unexpected touch*" and "*close proximity to other children*" in situations such as, "*assemblies*" "*group work*" and "*transitioning through corridors*" were highly distressing. This differs from the positive experiences reported by informants, for example "*physical touch such as hugs, kisses, repeatedly tapping someone, touching and squeezing their face. He really likes to be close to people*" (Parent, mainstream), whereby the pupil can exert control and agency over the interaction. Predictability and control could also explain why negative visual experience, including "*florescent lights*" and "*strip lights*", despite occurring throughout school, were ranked as third in terms of impact on learning. Indeed, compared to auditory and tactile stimuli, which often change rapidly, visual stimuli such as classroom displays tend to remain relatively constant throughout the school term. Supporting this are the findings from Robertson and Simmons (2015) focus group in which autistic adults reached a consensus that the ability to control a stimulus determined whether it was perceived as distressing or enjoyable. Importantly, when participants felt they had agency, many were able to interact with stimuli in positive ways, for example listening to loud music of their choice. Collectively, findings suggest that one strategy to increase the number of positive sensory experiences at school and reduce impact on learning would be to increase agency and control for pupils. Teachers in the current study offered several examples of how they were achieving this, for example "*Giving the students time to explore a room completely and look at things before they are expected to work*" (Teacher, mainstream) and "*Creating their own sensory experiences, such as mixing paint in the water trough*" (Teacher, mainstream) (Aim 4).

However, as noted by teachers, classrooms are "*deliberately stimulating places, they are loud, crowded and rarely completely calm*", and controlling every aspect of the environment would be impossible. Moreover, previous research suggests creating rigid and certain environments may not benefit mental health in the longer term (Boulter et al., 2014). This is a concern when considering findings from Aim 3 of this study, whereby parents and teachers reported high levels of anxiety that affected learning. For instance, one parent (mainstream) explained "*she either appears anxious or angry. How can you possibly learn with all that adrenaline rushing through you? It's like asking someone to do long division when they're free falling from a plane. Not going to happen".* The high levels of anxiety reported here are in accordance with recent estimates that suggest 40 % of the ASD population experience anxiety (van Steensel et al., 2011). Recent models propose that hypersensitivities play a central role in developing and maintaining anxiety for autistic individuals, for example the Intolerance of Uncertainty framework (Boulter et al., 2014). This model proposes that an interplay between sensory sensitives, rigidity of thought and difficulty with emotional processing, and social/environmental factors create the believe that "unexpected events are negative" and should be perceived as threatening, which then feeds into high levels of anxiety (Boulter et al., 2014). As discussed, much of the sensory stimuli noted as distressing in the current study was unexpected and unpredictable, supporting this relationship. Current findings thus suggest that one way to improve mental health and academic outcomes for autistic pupils would be through gradually increasing tolerance of uncertainty. The importance of intervention is highlighted by findings from Smith and Sharp (2013) in which participants explained that periods of high stress can lead to heightened sensitivities that in turn increase anxiety, and so forth. Participants noted a range of reactions that occurred in response to these situations, including anger, attacking the sensory input and escape. The current study contributes to the literature by demonstrating how similar responses can

manifest in a school environment and impact upon learning. Indeed, parents and teachers explained that sensory differences often led to distress which was expressed through "*lashing out*", "*flapping*" or the "*opposite-shutting down, into silence and stillness with head down and using their arms to shut out external stimulation*". This is also in line with Baker, Lane, Angley, and Young (2008) who found significant correlations between visual and tactile differences and disruptive behaviour. Parents and teachers also explained that sensory differences could affect learning by reducing participation; a theme akin to escape identified by Smith and Sharp (2013). In an applied classroom setting, this presented as limited engagement, leaving the classroom or being unable to attend school altogether. For instance, one parent (mainstream) explained "*He begs us to home school him. He misses a lot of lessons, often just getting the worksheet, then withdrawing from class to work elsewhere*". Sensory differences were also perceived to cause distraction in the classroom. Teachers interpreted auditory distraction to be caused by an inability to "*tune out the noises they don't need affecting their ability to listen to instructions/input*." This supports findings from Ashburner et al. (2008) study in which auditory filtering difficulties were found to contribute to variance in autistic pupils reading achievement. Likewise, participants in Howe and Stagg (2016) study reported auditory differences could result in a "reduction in concentration", which affected learning. Teachers also reported classroom displays and florescent lights as sources of distraction. The finding that the sensory environment can cause distraction and increase off-task behaviour is in line with previous research (e.g Fisher, Godwin, & Seltman, 2014). By manipulating the levels of visual stimulation in two mock classroom (decorated, sparse) it was shown that the decorated environment caused poorer learning outcomes and 10 % more off-task behaviour (Fisher et al., 2014). Taken together, findings suggest managing levels of auditory input in the classroom and minimizing visual clutter could improve academic progress for autistic pupils. Indeed, teachers in the current study identified classroom design as a key factor in creating positive sensory experiences. Teachers offered several examples of how they adapted their classrooms to meet the needs of their pupils, for example by ensuring that "*the displays are neat, tidy and uniformed*." Supporting this practice are findings from Barrett, Zhang, Moffat, and Kobbacy (2013) multi-site study in the UK that found seven design parameters, including light, temperature, complexity and colour accounted for 16 % of achievement variation over the course of an academic year. Importantly, the majority of these pupils were typically developing and can be expected, based on previous research, to have had minimal difficulties with sensory processing (Dunn, 1999). Yet even here, the sensory nature of the classroom was found to have an effect. This, therefore, emphasizes that managing sensory stimulation in the classroom may be beneficial for *all* pupils, not just those with a diagnosis of ASD. However, as noted by teachers and parents in the current study, some schools are much more readily equipped to implement such changes. School resources, which included number of staff and access to occupational therapy tools, were seen as central in determining whether positive or negative sensory experiences were had at school. This was also reflected in findings from Aim 5, whereby 44 % of parents agreed that school was aware pupils with ASD might have sensory differences, yet 21 % of parents did not feel as though their child's sensory needs were being supported. Linked to this was the idea that neither mainstream nor special school would be appropriate to meet the needs of autistic pupils. Echoing this view are insights from a recent paper that demonstrated although parents of children with ASD, Williams Syndrome and Down Syndrome all faced challenges in finding suitable educational provision or their child, autistic children seemed to be disproportionally disadvantaged (Van Herwegen, Ashworth, & Palikara, 2018). Similar concerns were raised in the All Party Parliamentary Report, leading to the Government proposing to develop an 'Autism and Education' strategy by the of 2020 (All Party Parliamentary Group on Autism, 2017). Findings from the current study very much emphasize the need to encompass sensory differences within this framework.

4.1. Limitations and future directions

Although the study demonstrated that parents and teachers are able to provide rich and informative insights regarding the impact of sensory differences in the classroom, the study did not include direct insights from pupils with ASD. This is a limitation because parents and teachers can only report on the behavioural outcomes of sensory differences and therefore may neglect the internalized effects of sensory experiences. Similarly, negative behavioural responses may be easier to identify than positive sensory experiences, which could explain why parents and teachers reported a limited number of enjoyable sensory experiences. Furthermore, the study relied on insights collated *via* questionnaires. Future work should therefore include autistic pupils and use varied methods (*e.g.* beyond questionnaires) to ensure their lived experiences are fully captured and allow for positive and negative sensory experiences to be reported in equal measure. It would be a useful next step to take a participatory perspective and feed these findings back to autistic individuals to ask whether they endorse the issues that have been raised by the parents and teachers in the current manuscript. The insights of autistic individuals on these issues can also help inform the direction of further research on these sensory issues.

The study also included an exploration of potential similarities / differences reported for pupils in mainstream *versus* specialised educational provision and there were some interesting insights based on schooling, both from parents and teachers. These differences warrant further investigation to ensure that all learning environments are suited to the needs of pupils with ASD. There is no doubt that both parents and teachers see sensory reactions and sensitivities as impacting upon learning for children with ASD and these multi-informant insights are particularly useful for gathering a wide variety of illustrations of how these differences might present in the child and impact their daily functioning.

4.2. Implications

The current study adopted a mixed-method, multi-informant approach with teachers and parents to understand how sensory differences affect learning and school life for autistic pupils. Parents and teachers reported that a significant proportion of children with ASD were affected by unusual sensory reactions of sensitivities and the study aimed to understand these impacts. The first aim was to examine how parents and teachers identified sensory differences as affecting children's behaviour. Key to this was

understanding that changes in the environment were often accompanied by changes in behaviour, knowing a child's idiosyncrasies and exposure to negative reactions.

The second aim was to understand the type of sensory experiences encountered at school and to assess how frequently these experiences affected learning and school life. Sensory differences, particularly within the auditory and tactile domain have a profound impact on learning. Responses from parents and teachers suggested that unpredictability and lack of control over stimuli caused specific challenges for pupils with ASD. Overall, sensory experiences, irrespective of school provision, were often negative although there was considerable heterogeneity in the experiences perceived as enjoyable or distressing.

Parents and teachers, across school provisions, explained that sensory differences affected learning through causing distraction, distress, anxiety and withdrawal from participation. The study considered the factors that influence how sensory differences affect learning, with parents and teachers reporting agency, predictability, classroom design, school resources and staff knowledge as key in minimizing the impact of sensory differences. Large class sizes and limited resources were challenges in mainstream schools, with several parents and teachers perceiving the mainstream environment as incompatible with pupil's sensory needs. Finally, teachers and parents believed more training was needed to support pupils with sensory differences in the classroom.

The insights provided by this multi-informant study can inform future research on sensory processing and aid the development of targeted interventions to enhance learning experiences and educational outcomes. The findings emphasize the need to incorporate sensory processing in the Autism and Education 2020 strategy to ensure that autistic pupils can obtain positive learning experiences at school.

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CRediT authorship contribution statement

Elizabeth K. Jones: Conceptualization, Methodology, Formal analysis, Investigation, Writing - original draft. **Mary Hanley:** Conceptualization, Methodology, Formal analysis, Writing - review & editing, Supervision. **Deborah M. Riby:** Conceptualization, Methodology, Formal analysis, Writing - review & editing, Supervision.

Declaration of Competing Interest

None.

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Appendix A. Supplementary data

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