Sensory Perception in Autism Spectrum Conditions: a brief research update

Anecdotal reports suggest that sensory processing issues are a key feature of Autism Spectrum Conditions (ASC). This article will describe some of the key methods for researching sensory processing issues in ASC and findings in this area.

Many people on the autism spectrum report having difficulties or differences in sensory perception. For example, in Temple Grandin’s famous book “Thinking In Pictures” she describes her sensory experiences the following: “From as far back as I can remember, I always hated to be hugged. I wanted to experience the good feeling of being hugged, but it was just too overwhelming. It was like a great, all-engulfing wave of stimulation, and I reacted like a wild animal”(1). Temple Grandin also highlights the high variability seen in sensory perception across ASC: “Over the years I have observed that sensory sensitivities in autism are highly variable. One child will love to play with running water, and another autistic child will run away and scream when a toilet flushes”. Anecdotal reports provide valuable information and help us to understand how people with ASC perceive the world differently, however they are not quantitative and can not reveal underlying mechanisms of sensory processing differences. One important question is at what level are people with ASC experiencing sensory differences? Is it at a low-level, e.g. are individuals with ASC better able to detect small differences in vision, hearing, smell or taste? Or at a high-level of perception, e.g. individuals with ASC might interpret sensory stimuli differently, such as a light touch on the shoulder (i.e. their sensory receptors perceive touch in the same way, but their brain interprets it as more intense).

Several research methods have been used to quantify and describe sensory processing difficulties in ASC and attempt to answer some of these important questions. These methods include sensory questionnaires, observations, experimental studies and neuroimaging studies for example.

**Sensory Questionnaires**

Sensory questionnaires can be used to quantitatively measure sensory issues in ASC and to see how many people on the autism spectrum report having difficulties. The Sensory Profile for example is a questionnaire, which assesses sensory processing using questions such as “I stay away from noisy settings” or “I dislike having my back rubbed”(2). Research using this methods...
questionnaire has found differences in sensory processing in over 90% of children and adults with ASC and cross-culturally (3-7). Leekam et al. (2007) (8) used the Diagnostic Interview for Social and Communication Disorders (DISCO) and found sensory symptoms in 94% of the children with autism compared to 5% in typical developing children. Another tool, the Sensory Sensitivity Questionnaire (SSQ) (9), also shows more sensory sensitivities in individuals with ASC than individuals without ASC. So far questionnaires robustly confirm anecdotal reports on sensory differences in children and adults with ASC.

**Observations**

Observations can also be used to investigate sensory issues in ASC (10, 11). Observations can take place in various settings, e.g. laboratory or clinical (12, 13). Early case study observations by Kanner (1943) for example mention sensory issues; “he does not want me to touch him or put my arm around him” (14). In a later case study which observed a little boy from birth to two years of age a paediatric neurologist noted: “he showed hypersensitivity to approach, loud noise, and tactile contact, and autonomic overarousal”.

**Experimental Studies**

A full description of the many experimental studies examining sensory differences in ASC is beyond the scope of this article. However simplified speaking studies focusing on higher-levels of perception (such as face processing) have reported diminished performance in ASC (15, 16), while studies focusing on low-level perception across different modalities (such as pitch processing) mostly suggest enhanced processing in ASC (17-19). The complexity and type of stimuli used influence perceptual differences in individuals with ASC and without. For example, Bertone et al. (2005) found that individuals with ASC are more accurate at detecting the orientation of simple visual stimuli but less accurate at identifying complex visual stimuli (20). For a comprehensive review on vision in ASC see Simons et al. (2009).

Studies exploring low-level hearing perception have shown enhanced pitch processing in ASC (21-24). Bonnel et al. (2003) for example show superior pitch sensitivity for individuals with ASC using psychoacoustic tasks (judge the pitch of pure tones in a "same-different" discrimination task). The pitch discrimination task used tones with various frequencies (e.g. 500, 750, 1000, and 1500 Hz). Participants were presented with two tones and participants...
with ASC were better in judging if a second tone was different compared to the first tone (22). However looking at more complex auditory processing such as speech, individuals with ASC show difficulties (25, 26).

Results of studies into tactile perception have also been mixed. Some studies have shown hypersensitivity in ASC (18, 27, 28), for example adults with ASC showed lower tactile perceptual threshold than adults without ASC (being more sensitive) (18). In addition, adults with ASC rated suprathreshold tactile stimulation (touch by a piece of foam) as significantly more tickly and intense than did adult without ASC. Other studies however have shown no differences in tactile perception between individuals with and without ASC; for example on a tactile discrimination task using four different types of sandpaper, O’Riordan and Passetti (2006) find no differences in children with autism compared to controls (29).

The chemical senses smell and taste have been investigated less than other senses showing mostly impaired or intact processing in ASC depending on measure used (30-32). When adults with and without ASC are presented with sticks containing a smell and participants have to indicate if they can smell something or not, individuals with ASC perform as good as participants without ASC (31). As for taste, adolescent with ASC were less accurate in identifying sour and bitter tastes but showed similar identification for sweet and salty tastes (32). Future studies looking at atypical eating in children with ASC should explore the affect of smell, taste and texture of food (33).

**Neuroimaging**

Sensory perception can also be measured at a neural level using neuroimaging techniques such as positron emission tomography (PET), functional magnetic resonance imaging (fMRI), electroencephalography (EEG) or magnetencephalography (MEG) (34). So far studies show differences in brain volume and functional connectivity in ASC, e.g. early brain overgrowth, differences in structures such as the amygdala, hippocampus, cerebellum, fusiform gyrus and the thalamus (35-39). Few studies in ASC however linked underlying neural differences to sensory issues in ASC. Visual, tactile and hearing studies suggest atypical neural sensory processing in ASC (40, 41). Additionally multisensory information, e.g. integrating sound and touch, seem to be processed differently in ASC (42). For a more comprehensive review please see Marco et al.’s summary on neurophysiologic findings (41).
Beside experimental work, theories exist such as Mottron’s et al. (2006) ‘enhanced sensory functioning’ model. This theory states better low-level sensory perception in ASC and suggests enhanced activation of primary areas in ASC, such as visio-perceptual areas, along difficulties in areas responsible for more complex tasks (e.g. frontal areas) (20, 43-48). Other brain theories such as the ‘intense world hypothesis’ put forward by Makram & Makram (49) suggests that there are hyperplastic neural microcircuits in the brain of individuals with ASC, which cause excessive neural processing in leading to hyper-perception and attention.

**Applications of Sensory Research**

Research so far acknowledges sensory perception differences in ASC. One important application of this is the proposed changes to autism diagnostic criteria in the new DSM-V. Sensory differences will be included in DSM-V, as described by “hyper-or hypo-reactivity to sensory input or unusual interest in sensory aspects of environment”.

In addition, sensory issues have a great impact on daily live, which led the Royal College of Art and the Helen Hamlyn Center for Design’s to develop design guidelines for housing for adults with autism (50). Sensory perception issues in ASC were critical to develop the “triggers” section for example, including guidelines to designing environments with comfortable lightening, acoustics, and colours and materials. A specific design guide example would be to use ‘muted, matt and harmonious colour schemes in communal areas and consult residents on their colour preference for private space’ (page 25) (50).

In conclusion, individuals on the autism spectrum consistently report differences in sensory perception. However, findings from research into sensory processing differences vary depending on sense tested and the type of method used. It is necessary to come to a consensus in the terminology used to describe sensory processing differences and to develop standardised tools for diagnosing sensory processing problems. This is particularly important for the new DSM-V. In addition, research is needed to examine at what level of sensory perception differences in ASC emerge. Further, future research is needed to examine sensory perception in all senses separately and also investigate the multimodal nature of sensory issues (51). Studies should try to include children and adults and males and females with ASC to explore the implications age and gender might have on the aetiology of sensory processing.
Including different age groups and following children from a young age is necessary to explore the complex interplay between the development of sensory issues and other autism related behaviours (51).

References


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