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Quantitative sensory testing of temperature, pain, and touch in adults with Down syndrome

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ABSTRACT

The spinothalamic pathway mediates sensations of temperature, pain, and touch. These functions seem impaired in children with Down syndrome (DS), but have not been extensively examined in adults. The objective of the present study was to compare the spinothalamic-mediated sensory functions between adults with DS and adults from the general population and to examine in the DS group the relationship between the sensory functions and level of intellectual functioning. Quantitative sensory testing (QST) was performed in 188 adults with DS (mean age 37.5 years) and 142 age-matched control participants (median age 40.5 years). Temperature, pain, and touch were evaluated with tests for cold–warm discrimination, sharp–dull discrimination (pinprick), and tactile threshold, respectively. Level of intellectual functioning was estimated with the Social Functioning Scale for Intellectual Disability (intellectual disability level) and the Wechsler Preschool and Primary Scale of Intelligence – Revised (intelligence level). Overall, the difference in spinothalamic-mediated sensory functions between the DS and control groups was not statistically significant. However, DS participants with a lower intelligence level had a statistically significant lower performance on the sharp–dull discrimination test than DS participants with higher intelligence level (adjusted $p = .006$) and control participants (adjusted $p = .017$). It was concluded that intellectual functioning level is an important factor to take into account for the assessment of spinothalamic-mediated sensory functioning in adults with DS: a lower level could coincide with impaired sensory functioning, but could also hamper QST assessment.

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Individuals with Down syndrome (DS) have a higher prevalence of certain physical conditions that may cause pain, such as neck conditions and hip dislocation (Bull, 2011; Charleton, Dennis, & Marder, 2010; Smith, 2001). However, individuals with DS show a weak tendency to complain of pain (Smith, 2001) and seem slower in detecting pain (Aguilar Cordero, Mur Villar, & García García, 2015; Defrin, Pick, Peretz, & Carmeli, 2004; Hennequin, Morin, & Feine, 2000). Adequate pain management requires a better understanding of how individuals with DS experience pain. This could be supported by insight into the functioning of the somatosensory system, which transmits somatosensory information from peripheral receptors via the spinal cord and brain stem primarily to the thalamus and somatosensory cortex (Almeida, Roizenblatt, & Tufik, 2004; Kaas, Jain, & Qi, 2002). The somatosensory cortex plays a major role in the processing of pain (Kanda et al., 2000). Spinothalamic-mediated sensory functions are the abilities to detect sensations of pain, temperature (innocuous and noxious), and crude touch (Almeida et al., 2004; Fitzgerald, Gruener, & Mtui, 2007).

Techniques to map brain activity, such as electroencephalography (Chen & Fang, 2005; Cruccu et al., 2008) and functional magnetic resonance imaging (Gröschel et al., 2013), can be used to examine the functioning of the general somatosensory system. However, these methods could be stressful (Downie & Marshall, 2007) and are not always available in health care facilities for individuals with intellectual disabilities. Quantitative sensory testing (QST) facilitates assessment of nervous system functioning by using standardized tests for thresholds and stimulus-response functions (Arendt-Nielsen & Yarnitsky, 2009). The use of QST instruments to assess temperature discrimination, sharp–dull discrimination, and tactile threshold was found to be feasible in 85–88% of children with DS (Valkenburg, Van Dijk, & Tibboel, 2015).

Several studies have been conducted on spinothalamic-mediated sensory functions in individuals with DS. Compared to control participants, children and adults with DS had more difficulty in localizing cold stimuli and had a longer reaction time (RT) between the application of cold stimuli and the verbal indication of pain, suggesting a high cold-pain threshold (Hennequin et al., 2000). A higher cold-pain threshold was however not confirmed by quantitative sensory test results in children with DS (Valkenburg et al., 2015). When using RT-dependent measurements, the heat-pain threshold was comparable to control participants in adults with DS (Defrin et al., 2004) but was higher in children with DS (Valkenburg et al., 2015). In addition, the detection thresholds for cold and warmth were higher in children with DS than control participants, but this group difference disappeared when using an RT-free method (Valkenburg et al., 2015). Fewer children with DS than control participants were able to discriminate all stimuli between cold and warmth, to discriminate all stimuli between sharp and dull, and to detect the lowest possible tactile threshold of .026 g, with statistically significant group differences (Valkenburg et al., 2015).

The question arises whether spinothalamic-mediated sensory functions are also impaired in adults with DS. It is important to examine these functions over the entire life span of individuals with DS, because additional painful conditions emerge in adulthood, such as early onset of cervical arthritis (Ali, Al-Bustan, Al-Busairi, Al-Mulla, & Esbaita, 2006), and the functioning of the somatosensory system may decrease with aging (Shaffer & Harrison, 2007). Therefore, the next step is to examine the functions of the same somatosensory pathway (i.e., spinothalamic-mediated sensory functions of temperature, pain, and touch) in a large sample of adults with DS. Because individuals with Down syndrome form a heterogeneous group, with a mild to severe level of intellectual disability (Patterson, 2009) and an IQ ranging from 30 to 70 (Chapman & Hesketh, 2000), the level of intellectual functioning needs to be taken into account. The research questions of the present explorative study were: (1) are spinothalamic-mediated sensory functions (temperature discrimination, sharp–dull discrimination, and tactile threshold) in adults with DS different from general population control participants? and (2) are spinothalamic-mediated sensory functions in adults with DS related to level of intellectual functioning?

1. Materials and methods

1.1. Study design and ethical approval

A cross-sectional study was performed, including both between-group and within-group analyses, in 188 adults with DS and in 142 adults from the general population. Approval was obtained by the Medical Ethical Committee of VU University Medical Center in Amsterdam (NL33540.029.11).

1.2. Participants

1.2.1. Down syndrome group

Adults with DS were recruited from 15 care centers for individuals with intellectual disabilities (with permission from the Management Board) and through the Dutch Down Syndrome Foundation. Inclusion criteria were: 18 years of age or older, speaking and understanding Dutch, and the capability to verbally answer simple questions (e.g., "What is your name?"). Exclusion criteria were neurological disorders (e.g., cerebrovascular accidents or tumors), severe visual impairments or hearing loss, and the use of antipsychotics, anticonvulsants, or antidepressants. If there was doubt regarding participants' capacity to provide informed consent, consent was also required from parents or guardians. In case of any sign of resistance, assessments were curtailed. Participants were only included in the analyses if they had completed all three spinothalamic-mediated sensory tests, resulting in a decrease from 232 to 188 participants with DS. Reasons for failing to complete a spinothalamic-mediated sensory test are described in Table 1.