Research article

Title: What is the current practice of therapists in the measurement of somatosensation in children with cerebral palsy and other neurological disorders?

Short running title: Measurement of somatosensation in paediatrics

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Abstract

Introduction: Somatosensation is the ability to detect and recognise body sensations such as touch, vibration, pressure, pain, temperature and proprioception. Cerebral palsy is a neurological disorder that is often accompanied by impairments in somatosensation. Current somatosensory assessments have limited psychometrics established for use with these children. The aim of this study was to identify therapists' current practice and perspectives related to the assessment of somatosensation in children with neurological disorders.

Method: A cross-sectional questionnaire was used to identify the somatosensory assessments currently used in clinical practice, time allocated to assessment, and therapists' satisfaction and confidence using the available assessments of somatosensation. The questionnaire was adapted from a previously utilised questionnaire that identified therapists' use of somatosensory assessments with adults post stroke.

Results: A total of 135 therapists responded to the questionnaire. Seventy-nine (92%) occupational therapists and 44 (89.7%) physiotherapists indicated that they currently assessed or treated children with somatosensory deficits. Sixty-four (82.1%) occupational therapists and 38 (86.3%) physiotherapists regarded assessment of somatosensation in children with neurological disorders as important to very important. However, only 7 (8.8%) occupational therapists and 7 (15.9%) physiotherapists reported confidence in their ability to do so. The methods with which therapists detect and measure somatosensory impairment in children with neurological disorders are variable, with non-standardised and/or informal assessments most frequently used.

Conclusion: Despite there being recommendations of best practice for the assessment of specific domains of somatosensation in children with cerebral palsy, current practice does not yet mirror these recommendations. Additionally, therapists' have low satisfaction and confidence with what they are currently using, highlighting the need for a comprehensive and standardised assessment of somatosensation for use in children with neurological disorders.

Introduction

Sensation is the conscious or subconscious awareness of information from the external environment (Tortora & Grabowski, 2000). Without the function of sensation, it is challenging for humans to make sense of their surroundings (Parham & Mailloux, 2010). Somatosensation is the ability to interpret body sensations and incorporates the detection, discrimination and recognition of body senses such as touch, vibration, pressure, pain, temperature, proprioception and more complex integrations of somatosensory inputs such as haptic object recognition (Carey, 2012). Somatosensation can help to enable exploration of the environment, has the potential to enhance performance and participation in functional tasks, and contributes to our learning and interaction as social beings (Auld, Boyd, Moseley, & Johnston, 2011; Bentzel, 2008; Parham & Mailloux, 2010).

Cerebral palsy (CP) is a common neurological disorder of childhood (Koman, Smith, & Shilt, 2004), with an increasing body of evidence to support the presence of somatosensory deficits in the upper limb (Auld, Boyd, Moseley, Ware, & Johnston, 2012b; Cooper, Majnemer, Rosenblatt, & Birnbaum, 1995; Van Heest, House, & Putnam, 1993). A recent study reported that in a sample of 52 children with hemiplegic CP, 77% had tactile deficits and 40% were found to have both tactile registration and perception deficits of the hand

(Auld, Boyd, Moseley, & Johnston., 2012a). In other studies involving children with CP, somatosensory deficits have been reported for 46% to 97% of these children (Yekutiel, Jariwala & Stretch, 1994; Van Heest et al., 1993).

Impairment in tactile sensation and proprioception have the potential to reduce fine motor control and manipulative ability and can make it difficult to identify the physical properties of objects as well as judge the amount of force required to complete a task (Bentzel, 2008; Cascio, 2011; Bumin & Kavak, 2010; Simões-Franklin, Whitaker, & Newell, 2011; Parham & Mailloux, 2001). The effect of these impairments on participation in everyday activities can be extensive (Parham & Mailloux, 2001) and a child's overall development and learning experiences can be compromised as a result of being unable to interpret tactile sensation in an accurate and proficient way (Arnould, Penta, & Thonnard, 2007; Cascio, 2011; Parham & Mailloux, 2001). Despite this, very little is known about how therapists assess these impairments in children with neurological disorders.

Of the clinical measures available, most only have established psychometric properties for use with adults post stroke or peripheral nerve injury (Connell & Tyson, 2011; Krumlinde-Sundholm & Eliasson, 2002). Over recent years, the clinimetric properties of some of these assessments have been explored for use in children with CP (Auld, Russo, Moseley, & Johnston, 2014). In the impaired hand of 16 children with CP, Auld and colleagues (2012a) compared the reliability of the following assessments using the intra-class correlation coefficient (ICC) and agreement scores compared using the percentage of exact agreement (%EA). The Semmes-Weinstein Monofilaments (SWMs), a measure of tactile registration, demonstrated excellent test-retest reliability (ICC = 0.96) and acceptable test retest agreement (%EA ± 1 = 75). Static and moving two point discrimination are measures of spatial perception, with the static component having demonstrated excellent test retest reliability (ICC = 0.96) and acceptable test retest agreement (%EA = 80), with moving two point discrimination resulting in less agreement (%EA = 53). The AsTex is a measure of texture discrimination which demonstrated fair test retest reliability (ICC = 0.42 - 0.48) (Auld et al., 2012a). These measures focus on touch registration and discrimination. Despite some of these assessments demonstrating adequate reliability, a comprehensive, high quality assessment needs to have all its measurement properties evaluated, including the reliability, validity and responsiveness for its intended population (Mokkink et al., 2010).

Auld and colleagues (2011) concluded there was no one tool that can sufficiently address all areas of somatosensation, with recommendations directed towards combining the use of subtests from existing assessments. The SWMs (Weinstein, 1993), Disk-Criminator (MacKinnon & Dellon, 1985) as well as Single Point Localisation (SLP) and Double Simultaneous which are both subsets of the Neurological, Sensory, Motor, Developmental Assessment (NSMDA) (Burns, 1992), are recommended to provide a comprehensive evaluation of tactile function (Auld et al., 2011). Additionally, a comprehensive assessment of somatosensation should evaluate multiple domains of somatosensation such as touch, proprioception and haptic object recognition (Carey, 1995; Connell & Tyson, 2011; Cooper et al., 1993). Given this knowledge, the aim of the current research was to identify therapists' current practice, and their perspectives, related to the assessment of somatosensation for children with neurological disorders, and to compare current measures used with evidence based practice recommendations.

Methods

Participants

Occupational therapists and physiotherapists working with children with neurological disorders and somatosensory deficits were identified and invited to participate in the study. Therapists were required to have one year or more of clinical experience in the field of paediatrics and currently be working in Australia.

Instrument

A cross sectional questionnaire was developed for this study based on previous research by Pumpa, Cahill and Carey (2015) who developed a questionnaire to identify somatosensory assessments used by therapists for adults post stroke. The adapted questionnaire used in the current study included 34 questions and obtained information about therapists' current practice and perspectives on somatosensory assessment for their current paediatric neurological caseload. Paper and online versions of the questionnaire were disseminated. Questions sought information on demographics, somatosensory assessments currently used in clinical practice, time allocated to somatosensory assessment, and therapists' satisfaction and confidence using currently available somatosensory assessments. The questionnaire was piloted with five practicing occupational therapists prior to distribution. Minor changes were made to the questionnaire based on their recommendations. Dichotomised (e.g. yes/no,

male/female), five point likert-type scales (i.e. strongly disagree to strongly agree) and frequency ratings (always to never) were included in the questionnaire. Some question items allowed for multiple response options i.e. What sensory assessments do you normally use? Please tick all that apply.

Procedure

Participants were recruited in three separate streams. Steam one involved attending a one-day somatosensory workshop intended for paediatric occupational therapists and physiotherapists at Princess Margaret Hospital for Children in Perth, Western Australia in November 2013. A brief outline of the study was presented, with hard copies of the participant information sheets, informed consent forms and questionnaires provided to all 33 eligible attendees of the workshop. Completed questionnaires were collected at the end of the workshop.

Stream two involved contacting the head therapists of occupational therapy and physiotherapy departments in 52 hospitals within Australia that were identified as having a paediatric department. In addition to this, ten organisations and services were also identified as having therapists that met the inclusion criteria. Hospitals (both public and private) and organisations in metropolitan, regional and rural areas of Australia were included.

Between March and June 2014, the head therapists of occupational therapy and physiotherapy departments or relevant therapists working in paediatric departments were contacted via phone and provided with a verbal outline of the study. If therapists expressed interest and deemed the study relevant to their department, additional information and the link to the online questionnaire was provided via email. A total of 179 emails were sent to paediatric occupational therapists and physiotherapists around Australia, most of whom circulated the questionnaire within their departments and to other relevant therapists.

Stream three involved a brief outline of the study presented to attendees at the monthly Developmental Occupational Therapy (DOT; WA) Inc. meeting. DOT WA Inc. is affiliated with the Western Australia Occupational Therapy Association and facilitates the Paediatric Interest Group. Convenience sampling was utilised and participant information sheets and the link to the online questionnaire were circulated via email to their member base of approximately 300 paediatric occupational therapists within Western Australia.

Data analysis

The online responses of the questionnaire were extracted from Qualtrics (Qualtrics, 2013). Both online and hard copy responses were manually entered into IBM SPSS Version 20 software (SPSS Statistics, 2010) for cleaning, coding and analysis. Frequencies were calculated for ordinal and nominal data. Responses that appeared in questionnaire sections titled 'other' and qualitative responses were reviewed by the research team using content analysis for common themes and relevant information included in the results.

Ethical considerations

Participants that completed the hard copy of the questionnaire gave informed written consent to participate. Consent to participate in the online study was assumed by completion and submission of the online questionnaire. Ethical approval was obtained from The Human Ethics Research Committee at Curtin University (approval number OTSW-12-2013).

Results

A total of 135 questionnaires were completed and returned. Stream one yielded 26 responses out of a possible 33 therapists who attended the workshop, while an additional 109 responses were obtained from stream two and three combined.

Table 1 illustrates the demographic characteristics of the participants. Eighty-nine (63.7%) of the questionnaires were completed by occupational therapists and 49 (36.3%) completed by physiotherapists. The majority of the sample was female (97.8%). Most of the respondents were from Western Australia (n = 69, 51.5%), and New South Wales (n = 37, 27.4%). Participants from the two aforementioned states made up 78.5% of the sample. Most therapists worked in the metropolitan areas of Australia (n = 96, 72.2%), followed by regional (n = 28, 21.2), then rural (n = 6, 4.5%), and most worked in the private sector (n = 103, 76.3%). Therapists worked an average of 32 (sd 9.5) hours per week.

Somatosensory assessment

Most occupational therapists (n = 79, 91.8%) and physiotherapists (n = 44, 89.7%) reported that they currently assess for somatosensory loss in children with neurological disorders. Of these, a smaller proportion of occupational therapists (n = 25, 31.6%) and physiotherapists (n = 29, 65.9%) reported that they "routinely" assessed somatosensation. CP

was the most common neurological disorder reported by therapists (n = 86, 69.9%), followed by acquired brain injury (n = 45, 36.6%).

Therapists typically saw between one and two children a week with somatosensory impairments, and tended to assess for somatosensory capacity on admission (n = 75, 62.5%) or when it was clinically indicated (n = 34, 28%). The majority of therapists allocate five (n = 39, 32.0%) or ten (n = 44, 36.1%) minutes to somatosensory assessment, with a proportion of therapists indicating no time at all allocated to somatosensory assessment (n = 20, 16.4%). Sixty-four therapists (61.0%) indicated they felt their allocated time for somatosensory assessment was sufficient. The most common reasons for conducting a somatosensory assessment were to: assist with treatment planning (n = 113, 93.4%), diagnosis (n = 67, 55.4%), for educating the child, family and other staff members (n = 64, 52.9%) and to review progress (n = 56, 46.3%). A smaller proportion of therapists conducted somatosensory assessment in the discharge planning phase (n = 19, 15.7%). Although both occupational therapists (n = 63, 88.7%) and physiotherapists (n = 32, 74.4%) conducted somatosensory assessments on the upper limb, physiotherapists most commonly assessed the lower limbs (n = 40, 93%).

Main types of somatosensory assessments used in clinical practice

Participants were asked to nominate the non-standardised, informal and published assessments they used to asses somatosensation. As shown in Figure 1, respondents more frequently used non-standardised and/or informal assessments than published assessments. The most commonly used non-standardised assessment was light touch (n = 82, 66.7%), followed by proprioception (limb matching) (n = 73, 59.3%). The other methods of informal assessment used by therapists included observation through play (n = 110, 89.4%), observation through daily activities (n = 95, 77.2%) and observation in other tests (n = 93, 75.6%). The use of three or four methods of informal assessment was common (n = 90, 73.1%) across both disciplines. The SWMs (Weinstein, 1993), or Weinstein Enhanced Sensory Test (WEST) hand monofilaments (Weinstein, 1993), were the most commonly used published assessment by therapists (n = 16, 13.8%) to measure tactile registration. In addition to the somatosensory assessments listed on the questionnaire, physiotherapists indicated the use of the NSMDA (Burns, 1992) (n = 6, 14.6%) and American Spinal Injury Assessment (ASIA) (Maynard et al., 1997) (n = 5, 12.2%). A large proportion of occupational therapists

(n = 53, 70.1%) and physiotherapists (n = 28, 68.2%) reported not using any published assessments.

Perceptions of current somatosensory assessments

The majority of occupational therapists (n = 64, 82.1%) and physiotherapists (n = 38, 86.3%) considered assessing somatosensation in children with neurological disorders to be 'important' to 'very important'. Despite acknowledging the importance of somatosensation assessment, many occupational therapists (n = 39, 52.0%) and physiotherapists (n = 16, 32.3%) indicated they were 'not confident at all' to 'somewhat confident' in their ability to detect somatosensory loss. Only a small proportion of occupational therapists (n = 7, 8.8%) and physiotherapists (n = 7, 15.9%) reported confidence in their ability to measure degree of somatosensory loss for this population. Overall, more than half of the occupational therapists (n = 51, 66.2%) and physiotherapists (n = 23, 58.1%) reported they were 'somewhat' to 'not at all' satisfied with the somatosensory assessments they currently use in clinical practice. Across both disciplines, 64.2% (n = 79) believe there is a need to change the current method of assessing somatosensation in children with neurological disorders.

Discussion

This study identified therapists' current practice and perspectives related to the assessment of somatosensation in children with neurological disorders within Australia. Occupational therapists and physiotherapists acknowledged the importance of assessing somatosensation for these children. This acknowledgement is vital as research indicates that a large proportion of children with CP experience impairments in somatosensation (Auld et al, 2012b; Cooper et al., 1995; Van Heest et al., 1993), with the most commonly reported areas affected being tactile object recognition, two-point discrimination and limb position sense (Auld et al., 2012a; Auld et al., 2012b; Curry & Exner, 1988; McLean, Taylor, Blair, Valentine, Carey, & Elliott, 2017).

The findings of this current study are consistent with the findings from Pumpa and colleagues (2015) who found more than 70% of therapists were not using standardised assessments with stroke survivors. They are also consistent with the recent findings of Auld and Johnston (2016), who examined the use of assessments for the somatosensory domain of tactile registration among paediatric therapists. They reported that paediatric occupational

therapists and physiotherapists might not be conducting tactile assessment methods according to evidence-based recommendations (Auld and Johnston, 2016).

Measures of tactile registration, i.e. the SWMs or WEST hand monofilaments, were the most frequently reported published assessments used by therapists in the current study. Auld and colleagues (2012b) explored the properties of the SWMs as an assessment of tactile registration in children with CP. They reported excellent test-retest reliability and clinical utility, and acceptable test-retest agreement in children with unilateral CP aged 8 to 18 (Auld et al., 2012b). However, the monofilaments alone only measure one aspect of tactile function (tactile registration), thereby providing limited information to inform treatment planning or predict rehabilitation outcomes if not used in conjunction with other tactile perception assessments (Auld et al., 2012b) or other measures of somatosensory function, such as proprioception and haptic objects recognition (Carey, 2015; McLean et al., 2017).

Light touch and proprioception were the non-standardised assessments most commonly used by therapists in the current study. This is consistent with findings of non-standardised somatosensory assessment used for adults post stroke (Pumpa et al., 2015; Doyle, Bennett, & Gustafsson, 2013; Winward, Halligan, & Wade, 1999). The use of these subjective assessments however can result in a decrease in measurement accuracy as well as increase the risk examiner of bias relative to quantitative and standardised measures (Bentzel, 2008; Carey, Matyas & Oke, 2002). Additionally, the use of informal assessment such as observation through play, daily activities and/or through observation of performance during other assessment tools was frequently reported in this current study. Although clinical observation is important, using that alone can make it difficult to monitor the childs' progress and change over time in response to intervention.

Therapists in the current study also reported they lacked confidence in their ability to detect and measure the degree of somatosensory loss in their usual caseload. Low levels of confidence are reflected despite the largest proportion of therapists having 10 or more years of experience in paediatrics. In contrast, 72.7% of therapists working with adults post stroke reported they were moderately to very confident in their ability to detect sensory loss using the available somatosensory assessments (Pumpa et al., 2015). The difference in confidence levels among therapists could be reflective of a possible increase in awareness of the presence of somatosensory impairment in adults post stroke, in line with increased evidence base and

the introduction of clinical guidelines, which are yet to be established for a paediatric population. Despite this, therapists across both the adult and paediatric populations indicated an overall lack of satisfaction with the available somatosensory assessments for use with their respective clinical populations.

Additionally, therapists in the current study reported satisfaction with the time they allocated for use of somatosensory assessments, despite the majority (68.1%) completing the assessment within 5 or 10 minutes. This warrants further investigation into the use of comprehensive somatosensory assessments for use with children with neurological disorders. Measures of registration such as the SWMs may only take 5 to 10 minutes for administration and interpretation, however more comprehensive and functional measures that generate more meaningful data may take a lot longer.

As with all survey methodologies, this study has its limitations. The number of occupational therapists and physiotherapists working in paediatrics in Australia is unknown and therefore the number of eligible therapists that could have participated in this study cannot be determined. Therefore, the calculation of return rates or comparison between responder and non-responders could not be determined. In addition to this, the majority of respondents were female and therefore results may not be representative of the male therapist population.

Despite known limitations, this study had a large response sample of 135 therapists representing all Australian states, apart from the Northern Territory. This included metropolitan, regional, rural and remote areas, and therapists working in private and public sectors. Variance existed in the years of clinical experience and degrees obtained among therapists. As a result of the diversity across both disciplines, the information obtained from this study is useful to help understand clinical practice and therapists' perceptions of somatosensory assessment for paediatric populations.

The overall aim of this study was to identify current practice and therapists' perspectives related to somatosensory assessment in children with neurological disorders. The results indicate therapists more often use non-standardised and/or informal assessments than assessments with standardised published administration manuals or instructions. To our knowledge, there is currently no standardised somatosensory tool for use with children with

neurological disorders that incorporates touch, limb position sense and haptic object recognition, which are the domains recommended for the assessment to be a comprehensive measure of somatosensation (Taylor et al., 2016).

Interventions designed to promote neuroplastic changes in somatosensation is a growing field of research (Aisen et al., 2011; Anderson, Spencer-Smith, & Wood, 2011; Carey, Macdonell, Matyas, 2011). The concept of neural plasticity has guided somatosensory intervention for adults post stroke, with specific interventions demonstrating the ability to increase cortical activation of the brain as measured by functional MRI (Carey, Abbott, Lamp, Puce, Seitz, Donnan, 2016). Likewise, children with CP have the potential to respond in a similar way (Wittenberg, 2009). There is emerging evidence to support the efficacy of somatosensory discrimination interventions to improve body position sense for children with spastic hemiplegic CP aged six to fifteen years (McLean et al., 2017). Preliminary findings indicate improvements in goal performance, proprioception, and bimanual hand use (McLean et al., 2017). A quality comprehensive assessment of somatosensation is crucial to the ongoing development of somatosensory discrimination interventions. Such an assessment could be used to determine an individual's baseline function and monitor changes over time in response to somatosensory discrimination intervention.

Future research should be directed towards the development of a comprehensive and quantitative tool to measure somatosensation in children; with consideration made for the various types, severity and associated impairments children with neurological disorders experience. Additionally, effort should be made to translate the evidence we do know about somatosensory impairment and assessment for these children into clinical practice. In 2011 Auld and colleagues made recommendations as to the most appropriate combination of measures to assess tactile registration and tactile perception in children with CP. The outcomes of this clinimetric review recommended the use of five tactile assessments; the SWMs (Weinstein, 1993), the Disk-Criminator (MacKinnon & Dellon, 1985), Single Point Localisation (SLP) and Double Simultaneous, which are both subsets of the NSMDA (Burns, 1992), and stereognosis following the Klingels method (Klingels, De Cook, Molenaers, Desloovere, Huenaerts & Jaspers, 2010). While the SWM was the most commonly used published assessment in this current study, the NSMDA was under-utilised with only six physiotherapists indicating use of this assessment. This suggests this research has not yet been fully translated into clinical practice. The translation of knowledge from research into

clinical practice is vital and occupational therapists and physiotherapists have a responsibility to seek and integrate this new knowledge to ensure the best possible care is provided (Metzler & Metz, 2010).

Active collaboration between therapists as end users, and researchers is needed to ensure the transfer of new knowledge (Metzler & Metz, 2010). This collaboration can occur through researchers identifying knowledge users (i.e. therapists) and offering educational outreach through interactive groups or in house clinical research symposiums (Barwick, & Heiden, 2016). Departmental managers can assist in this process by ensuring clinical performance feedback for evidence-based practices, and continuing quality improvement activities within departments (Barwick, & Heiden, 2016).

The results of this current study, along with that recently completed by Auld & Johnston (2016), have established a baseline of what therapists working with children with neurological disorders currently know and are using clinically for the assessment of somatosensation. One of the long-term goals for somatosensory measurement and treatment should be the development of an assessment approach that can inclusively measure all domains of somatosensation and which takes into consideration the facilitators and barriers identified to aid successful clinical implementation (Auld & Johnson, 2016). This study highlights that effort needs to be directed towards effectively disseminating what we currently know and what is readily available for therapists to utilise in the meantime to ensure the assessment of somatosensation is not being overlooked for this population.

Conclusion

There is an emerging awareness of the important role that somatosensation plays in the functional outcomes of children with neurological disorders (Auld et al., 2011; McLean et al., 2017). Deficits in somatosensation are known to exacerbate motor impairments, potentially impacting on a child's occupational performance and participation in the home, school and wider community (Boyd et al., 2010). Valid and reliable assessment tools are limited for children with neurological disorders and this study has highlighted that although therapists understand the importance of somatosensation they are not confident with current somatosensory measures.

Gathering knowledge of current practice related to the assessment of somatosensation in children with neurological disorders will help guide clinical knowledge towards best practice. This study has highlighted the need for more standardised, reliable, and valid methods of assessing somatosensation in children with CP and other neurological disorders. It also highlights the need to systematically translate evidence-based research on measurement of somatosensation in children with CP into clinical practice.

Key Points for Occupational Therapy

- Therapists are utilising non-standardised and/or informal assessments of somatosensation for children with neurological disorders.
- Future research should be directed towards the development of a comprehensive somatosensory assessment for this population.
- Recommendations of best practice for the assessment of specific domains of somatosensation in children with CP exist, however current practice does not yet mirror these recommendations.
- Current and future research needs to be more effectively disseminated to encourage evidence based practice.

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TABLE 1: *Demographic information of participants (n = 135)*

Characteristic	Variable	
	N	%
Gender		
Female	132	97.8
Male	3	2.2
Discipline		
Occupational Therapy	86	63.7
Physiotherapy	49	36.3
Highest degree level		
Bachelor degree	94	69.6
Entry level masters	9	6.7
Postgraduate diploma/certificate	18	13.3
Post graduate masters	12	8.9
Honours	2	1.5
Years of clinical experience working in paediatrics		
1-2	19	14.1
3-5	41	30.4
6-10	30	22.2
>10	45	33.3
Population area of practice		
Metropolitan	96	72.2
Regional	28	21.2
Rural	6	4.5
Remote	2	1.5
Sector of work		
Private	103	76.3
Public	29	21.5
Both	3	2.2
Setting		
Acute care hospital	25	18.5
Rehabilitation ward within acute hospital	6	4.4
Outpatient (hospital-based)	14	10.4
Rehabilitation in the home	2	1.5
Community health centre	36	26.7
Community rehabilitation	8	5.9

centre		
Private practice	12	8.9
Non-government organisation	14	10.4
Government organisation	2	1.5
Community not specified	11	8.1
Other	5	3.7

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