ORIGINAL ARTICLE

Impact of Tactile Dysfunction on Upper-Limb Motor Performance in Children With Unilateral Cerebral Palsy

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ABSTRACT. Auld ML, Boyd RN, Moseley GL, Ware RS, Johnston LM. Impact of tactile dysfunction on upper-limb motor performance in children with unilateral cerebral palsy. Arch Phys Med Rehabil 2012;93:696-702.

Objective: To determine the relationship between tactile function and upper-limb function in children with unilateral cerebral palsy (CP).

Design: Cross-sectional study.

Setting: Assessments were performed in community or hospital venues or in participants' homes.

Participants: Recruitment information was sent to 253 possible participants with unilateral CP (aged 8–18y), and N=52 participated (median age [interquartile range], 12y [9–14y]; Gross Motor Functional Classification System level I=34; II=18; Manual Abilities Classification Scale level I=36; II=16).

Interventions: Not applicable.

Main Outcome Measures: Tactile assessment included 1 test of registration, 5 tests for spatial perception, and 1 test for texture perception. Upper-limb motor function was assessed using 2 unimanual tests, the Melbourne Unilateral Upper Limb Assessment (MUUL) and Jebsen-Taylor Test of Hand Function (JTTHF), and 1 bimanual test, the Assisting Hand Assessment (AHA).

Results: Tactile registration and all tests of spatial perception were moderately related to the MUUL, JTTHF, and AHA ($P<.001$). Texture perception was not related to upper-limb motor function. Regression analysis showed that single point localization, a unilateral tactile spatial perception test, contributed most strongly to unimanual capacity (29% explained variance in MUUL and 26% explained variance in JTTHF), whereas double simultaneous, a bilateral tactile spatial perception test, contributed most strongly to bimanual performance (33% for the AHA).

Conclusions: Spatial tactile deficits account for approximately 30% of the variance in upper-limb motor function in children with unilateral CP. This emphasizes the need for routine tactile assessment and targeted treatment of tactile spatial deficits in this population.

Key Words: Arm; Cerebral palsy; Hemiplegia; Perception; Rehabilitation; Sensation; Touch.

INTERVENTIONS FOR children with unilateral cerebral palsy (CP) have traditionally focused on training upper-limb performance and reducing motor impairments associated with muscle spasticity, weakness, and contracture. However, recent studies have begun to examine impairments in tactile registration and perception[1-3] and their potential impact on unimanual capacity[4,5] and bimanual performance.[1,6] In recent years, specific tactile deficits, such as spatial tactile discrimination, texture perception, and object recognition, have been identified in children with dystonia[7] and diplegia.[8,9] Although information is increasing, systematic analysis of how tactile and motor deficits interact in children with unilateral CP is lacking.

In children with unilateral CP, tactile impairment disrupts unimanual function including grasp, anticipatory control, and grip-lift tasks with the involved hand.[4,5,10] Where tactile deficits are present in the impaired hand, sensory information from previous performance of a grip-lift task with the less impaired hand can be used to facilitate anticipatory scaling of the same object in the impaired hand.[4] This indicates that initially impaired anticipatory control is not due to disturbed motor output, but rather to sensory disturbances in the impaired hand that lead to a poor representation of the object's physical properties.[4,5] Grasp dysfunction in the impaired hand is, therefore, proposed to result from an inability to appropriately integrate tactile input with subsequent motor output of the same hand.[11,12] However, this proposal is based on a limited repertoire of tactile assessments—Semmes-Weinstein monofilaments[a] (SWM),[13] two-point discrimination (2PD),[14] and Manual Form Perception[15]—and, as such, the mechanisms that link tactile registration and perception to unimanual capacity and bimanual performance are not fully explained. That is, performance in different tactile domains may impact upper-limb motor function to different degrees.

List of Abbreviations

AHA	Assisting Hand Assessment
CP	cerebral palsy
ICC	intraclass correlation coefficient
JTTHF	Jebsen-Taylor Test of Hand Function
MACS	Manual Abilities Classification Scale
MUUL	Melbourne Unilateral Upper Limb Assessment
SWM	Semmes-Weinstein monofilaments
2PD	two-point discrimination

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A study of 25 children with unilateral CP reported no relationship between tactile function and bimanual performance despite finding relationships between bimanual performance and unimanual capacity (as assessed by the Pick-up test, an assessment of dexterity), and between unimanual capacity and tactile function as measured by the SWM, 2PD, Manual Form Perception, and stereognosis tests.[1] Krumlinde-Sundholm and Eliasson argued that impaired tactile input may have been augmented by vision, and/or children effectively compensated by increased reliance on the less impaired hand.[1] Another study of 80 children with unilateral CP reported that unimanual capacity and haptic recognition of objects (stereognosis) were the strongest predictors of bimanual performance.[6] As stereognosis has a primary tactile component, this supports the potential link between tactile and motor function. However, as the particular stereognosis protocol allowed movement of the impaired hand to facilitate recognition of objects, it is difficult to isolate the relative contribution of tactile function from simultaneous proprioceptive, motor, and/or musculoskeletal contributions.[6] This factor has been raised by previous author groups who attribute the relationship to the strong motor component of the haptic test.[16] To ensure that results on tactile ability tests are not impacted by a concomitant motor impairment, tests that allow the participant to move his/her hand to receive the stimulus need to be differentiated from tests that do not.

More specific assessment of tactile function is needed to establish the potential impact on upper-limb motor function.[3] In particular, where previous studies have focused on assessment of tactile registration (eg, SWM) and haptic tests of stereognosis, tests of tactile spatial resolution might be required to find the relationship between manual ability and tactile function.[16] A recent systematic review recommended that tactile assessment evaluate 2 phases of tactile function: registration, the initial awareness of tactile stimuli; and perception, the interpretation of spatial, temporal, and textural aspects of tactile stimuli.[3] During tactile assessment, it is important to examine tactile registration first because it involves basic detection, as a precursor to perception, which is the interpretation and understanding of the where, when, and what qualities of the stimulus. Assessment of each of these qualities, therefore, informs the extent of the tactile deficit and the specific area of deficit. For example, tactile registration can be examined by the SWM, a test that only requires the child to report whether or not they felt a stimulus. Tactile perception demands a further level of processing, as in single point localization or double simultaneous,[17] which requires the child to identify not just the presence of stimuli, but also their spatial location. Tactile registration, detecting the stimulus, is therefore the more simple precursor to being able to identify the spatial (location), temporal (timing), and textural properties of the stimulus.

This comprehensive tactile assessment should be paired with an equally comprehensive motor test battery. A recent systematic review of upper-limb activity measures for children with unilateral CP recommends the Melbourne Unilateral Upper Limb Assessment (MUUL)[b] for unimanual capacity and the Assisting Hand Assessment (AHA)[c] for bimanual performance.[18] Specifically, the MUUL is a test of unimanual capacity of the impaired upper limb. It consists of 16 items assessing reach, grasp, release, and manipulation, examining the range, accuracy, fluency, and dexterity of motor performance.[19] The AHA is an assessment of bimanual performance that examines the use of the impaired hand as an assisting hand. It consists of 22 items that test a child's bimanual performance in everyday tasks.[20] Tests such as the Jebsen-Taylor Test of Hand Function (JTTHF) may also measure speed and dexterity, although psychometric properties for this test are unknown in children with unilateral CP.

Based on these tactile and motor frameworks, the primary aim of this study was to comprehensively examine the relationship between upper-limb tactile and motor function in children with unilateral CP. We hypothesized there would be significant relationships between tactile registration and perception and both unimanual capacity and bimanual performance in children with unilateral CP.

METHODS

Study Design

We conducted a cross-sectional study on children with unilateral CP aged between 8 and 17 years in Queensland, Australia, from July 2009 to September 2010. Ethical approval was received from The University of Queensland, the Cerebral Palsy League, and the Royal Children's Hospital, Brisbane, Australia.

Participants

Children were eligible to be enrolled if they had a confirmed diagnosis of unilateral CP. Exclusion criteria were an inability to understand and/or follow test instructions due to intellectual or behavioral difficulties, receipt of upper-limb botulinum toxin type A injections fewer than 3 months prior to recruitment, previous upper-limb orthopedic surgery, or uncorrected visual impairment. Recruitment information was provided to families of all 253 known children with unilateral CP in Queensland, Australia. Children were identified via databases held by the 2 main services for children with unilateral CP in Queensland: the Cerebral Palsy League and the Royal Children's Hospital Department of Paediatric Rehabilitation. All children had their motor ability classified according to the Manual Abilities Classification Scale (MACS).[21]

Assessment Procedure

Tactile function. Tactile and motor performance of each child was assessed by the same experienced physiotherapist (M.A.) at the child's home, a Cerebral Palsy League venue, or the Royal Children's Hospital, Brisbane. First, cognitive ability (Kaufman Brief Intelligence Test[22,d]) was established. Assessment of tactile registration and perception was then performed. Available clinimetric properties for the chosen tactile assessments have been described in a previous systematic review.[3]

Tactile registration. Tactile registration was measured using the full 20-item SWM kit[13] on the distal pad of the thumb, index, 4th, and 5th digits (dermatomes of C6, C7, and C8). The monofilament was applied to the skin surface of the 4 fingers 3 times in a pseudorandom order, with 1 response out of 3 taken as an affirmative response, as indicated by the original test methodology.[13] The score was the lowest monofilament (value) at which the child was able to correctly identify at least 1 touch (out of a possible 3) on all 4 fingers and 1 sham trial in a test set.

Spatial tactile perception: Single point localization.[23] The largest Semmes-Weinstein monofilament was used to touch 3 dermatomes (C6, C7, C8) on 4 fingers in a pseudorandom order. The child was told that the touch may be on the front, back, or side of one of their fingers and that they were to accurately identify both the finger and the position that was touched. The score was the number correct out of 12.

Spatial tactile perception: Two-point discrimination. Two-point discrimination was assessed using the Disk-Criminator.[14,e] Stimuli were delivered to the palmar side of the distal phalanx of the index finger. Moving 2PD and then static 2PD were tested, with pressure applied to the point of skin blanching. The score was the smallest separation (in mm) between the 2 points that could be perceived on at least 7 of 10 trials.

Spatial tactile perception: Double simultaneous.[23] Tactile stimuli were provided by identical bristles similar to the design of the monofilaments that exerted a supra-threshold force. The thumb, index, 4th, and 5th digits were each touched individually and simultaneously with every other finger on the opposite hand in a pseudorandom order (a total of 24 trials). The child reported which fingers were touched either verbally or by touching or moving the relevant fingers. The score was the number of correct responses out of a possible maximum of 24.

Motor-enhanced tactile perception: Stereognosis. Nine common objects were placed to the side of the child within the child's view.[6] These objects were 3 unrelated objects (peg, key, spoon) and six objects that come in associative pairs (a 10-cent coin and a button of similar size, a pen and a pencil, a paperclip and a safety pin). The examiner (M.A.) had an identical set of objects that she placed in the child's testing hand one at a time in a random order. The child was encouraged to manipulate the object and/or was assisted to touch the object and to either name or point to the object that was identical to the one placed in his/her hand. The score was the number of correct responses out of a possible maximum of 9.

Texture tactile perception. Texture perception was tested using a Perspex board (AsTex)[f] that displays tactile gratings of reducing tactile discrimination index.[24] Starting at the rough end of the board, movement of the child's index finger, then thumb, then 5th finger was guided by the examiner along the board at a constant speed in a standardized manner. Children were instructed to stop immediately when the board felt smooth (gratings became too close together to determine their separation). Each point was recorded, with the final outcome the average of 3 trials for each digit. The averaged scores were converted to the tactile discrimination index for each finger using the chart available with the test kit.

Upper-Limb Function

Unimanual capacity was assessed using the MUUL,[19] and unimanual speed and dexterity was assessed using the JTTHF.[25] The MUUL was found to be the best measure of unimanual capacity in children with unilateral CP in a systematic review,[18] showing excellent reliability in this population (intraclass correlation coefficient [ICC]=.93).[26] The JTTHF was used to assess unimanual dexterity in 6 timed subtests and has high interrater (ICC=.99) and intrarater (ICC=.99) reliability in adults but has not been tested in children.[25] The test was performed using the modified protocol reported by Charles et al.[27] Specifically, this involved the omission of the writing task and a maximum time limit of 2 minutes for any 1 test item to limit frustration on difficult tasks.[27] Bimanual performance was assessed using the AHA.[28]

Statistical Analysis

The median and interquartile ranges for each test were calculated. Associations between performance on tactile tests and motor and classification tests were investigated using linear regression after confirming the assumptions underlying the regression model were satisfied. Independent variables considered were performance on tactile registration (SWM) and tactile perception (single point localization, static and moving 2PD, double simultaneous, stereognosis, and AsTex) tests, and dependent variables were performance on motor tests (MUUL, JTTHF, AHA). Potential collinearity between all tactile tests and motor tests was examined. Tactile function was included in the model as the single explanatory variable, and the standardized beta coefficient was computed. The beta coefficients are a measure of effect size. They are standardized to have a mean of 0 and SD of 1, and they represent the expected change in the motor performance, per SD increase in tactile performance. They identify the aspects of tactile function that have the greatest effect on motor performance when the variables are measured on different scales. Subsequently, the relative contributions of individual tactile deficits to both unimanual capacity and bimanual performance were established using multiple linear regression. Initially, the tactile variable most significantly associated with the motor outcome was included in the model. Variables were successively added to the model and retained if they added significant information at the $P<.05$ level as assessed by the likelihood ratio test.

RESULTS

Participants

Of the 253 potential participants identified from client databases, 59 provided informed parental consent to participate and 52 met the criteria (median age, 12y; range, 8–17y; 29 [56%] boys; 23 left unilateral CP; Gross Motor Functional Classification System level I=34; level II=18; MACS level[21] I=36; II=16). Seven children were excluded due to cognitive deficits and difficulty understanding the task. No children had received botulinum toxin type A within 12 months of participating. Summary statistics for each test are reported in table 1. The results of each test could not be adequately approximated with normative distribution, so data were described using the summary statistics of median and interquartile ranges. Although each participant was included on specific criteria, 1 participant appeared to have demonstrated registration performance >2 SD below the median result. To confirm that this participant was not skewing the results, analyses were carried out with the participant both included and excluded. As there was no significant difference between the 2 analyses (ie, all analyses still yielded a statistically significant relationship between tactile registration and upper-limb motor function at $P<.01$) and it was considered that the participant responded reliably, these data were maintained in the sample.

Relationships Between Tactile and Motor Scores

For the entire group (N=52), registration and all aspects of spatial perception of the impaired hand were moderately-strongly related to performance on the MUUL, JTTHF, and AHA (all $P<.005$) (fig 1). There was no statistically significant relationship between upper-limb motor function and texture perception as assessed by the AsTex (table 2). Stereognosis (β=.59), followed by single point localization (β=.55), showed the strongest relationships with unimanual capacity on the MUUL. Single point localization also showed the strongest relationship with unimanual speed and dexterity on the JTTHF (β=.53). Stereognosis (β=.60) and double simultaneous (β=.59) showed the strongest relationships with bimanual performance on the AHA.

In a multivariate regression analysis, stereognosis accounted for 34% of the variation in unimanual capacity (MUUL; $P<.001$) and 34% of the variation in bimanual performance (AHA; $P<.001$). However, as the haptic stereognosis protocol allowed movement of the hand for object recognition, it was removed from the model in order to elucidate the relative contribution of motor-free tactile performance. In this analysis, single point localization was the strongest contributor to unimanual capacity: it accounted for 29% of the variation in MUUL scores ($P<.001$) and 26% of the

Table 1: Tactile and Motor Assessments in Children With Unilateral CP (Median and IQR)

Assessments	Test Range: Lowest to Highest Score (Minimum Unit)	Median (IQR) of the Total Sample (N=52)	
		Impaired	Unimpaired
Classification			
Age (y)	8–17 (1)	12 (9–14)	NA
MACS level	I–V	1 (1–2)	NA
Kaufman Brief Intelligence Test	Standard IQ composite mean±SD, 100±15	91 (76.5–105)	NA
Tactile function			
Registration			
SWM	1–20 (1) monofilament	4 (2–6)	3 (2–5)
Spatial perception			
Single point localization	1–12 (1) correct	11(6–12)	12 (11–12)
Static 2PD	15–2 (1) mm	3 (3–7)	2 (2–3)
Moving 2PD	15–2 (1) mm	3 (2–6)	2 (2–2)
Double simultaneous	1–24 (1) correct	17 (12–22)	NA
Stereognosis	1–9 (1) correct	7 (4–9)	9 (8–9)
Textural perception			
AsTex index	2.5 (0.03) (mm)	0.60 (0.4–0.83)	0.44 (0.24–0.69)
AsTex thumb	2.5 (0.03) (mm)	0.64 (0.37–0.90)	0.44 (0.27–0.67)
AsTex 5th digit	2.5 (0.03) (mm)	0.60 (0.39–0.77)	0.44 (0.27–0.67)
Upper-limb function			
Unimanual function			
MUUL	100%	88.5 (72.9–97.5)	NA
JTTHF	1–120 (1) s	110.5 (63–321)	37 (31–45)
Bimanual function			
AHA	0–100 (1) logits	65.5 (58–72.5)	NA

Abbreviations: IQ, intelligence quotient; IQR, interquartile range; NA, not applicable.

variation in JTTHF scores ($P<.001$) (table 3). The addition of other tactile variables did not strengthen the relationship between tactile function and unimanual capacity. Only double simultaneous contributed significantly to the regression model for bimanual performance on the AHA: it accounted for 34% of the variation ($P<.001$).

There were no significant relationships between age, sex, side of lesion, and upper-limb motor outcomes (all $P>.40$).

DISCUSSION

Overall, the results of this study support findings from previous studies indicating that tactile function is compromised in CP.[1,8,9] In addition, the results support the hypothesis that there is a relationship between some domains of tactile function and both unimanual capacity and bimanual performance in children with unilateral CP. Tactile registration and spatial tactile perception were found to be related to all aspects of upper-limb motor function; however, there was no relationship with textural perception.

Tactile registration was moderately related to both unimanual capacity and bimanual performance. This confirms that children with impaired basic sensation are likely to have greater unimanual and bimanual motor difficulties. Previous studies investigating the relationship between tactile function and unimanual capacity have found either no relationship or only a weak relationship between tactile registration using SWM and various unimanual assessments.[1,12,16] Arnould et al suggest that the relationship between tactile registration and unimanual capacity is likely to be weaker than the relationship between tests of tactile spatial resolution and unimanual capacity, because tests of spatial resolution more closely examine tactile processing at the cortical level, which is often impaired in CP.[16] It is important to note, however, that different motor assessments were used in these studies, some requiring fine force control, and thus the lack of relationship between tactile registration and upper-limb function may be related to the chosen motor assessment, rather than to the assessment of tactile registration (SWM). The current results indicate that children with tactile registration deficits will likely demonstrate impairments in their upper-limb motor performance. This is important for 2 reasons: it implies that tactile registration assessment should be undertaken in all children with unilateral CP and that the outcome of this assessment will have implications for upper-limb function.

Our results indicated moderate to strong relationships between all aspects of spatial tactile perception and both unimanual capacity and bimanual performance. This means if a child has difficulty identifying the location or spatial characteristics of a tactile stimulus, this difficulty will be related to his/her deficits in upper-limb motor function. This is consistent with the many spatial aspects to planning, executing, and processing feedback for movement and concurs with the views of Arnould et al[16] on the role of testing tactile spatial resolution.

Stereognosis showed significant relationships on univariate and multivariate analyses with both unimanual and bimanual motor function. This concurs with previous results from children with unilateral CP.[6] These results not only support the presence of a relationship between tactile function and unimanual capacity but also indicate that fine force control and proprioceptive feedback, as required for stereognosis, may be crucial for manual performance.

In contrast, texture perception (as measured by the AsTex) was not directly related to motor outcomes, which indicates that, although texture perception is important for object identification, force control, and speed, it may be of secondary importance to the spatial aspects of tactile perception required to perform the motor tasks in this study. Other sensory systems, especially vision, could easily compensate for poor texture perception—vision is known to contribute to the perception of roughness.[29] Motor tests used in this study allowed the use of vision, and thus some compensation for texture perception may have occurred.

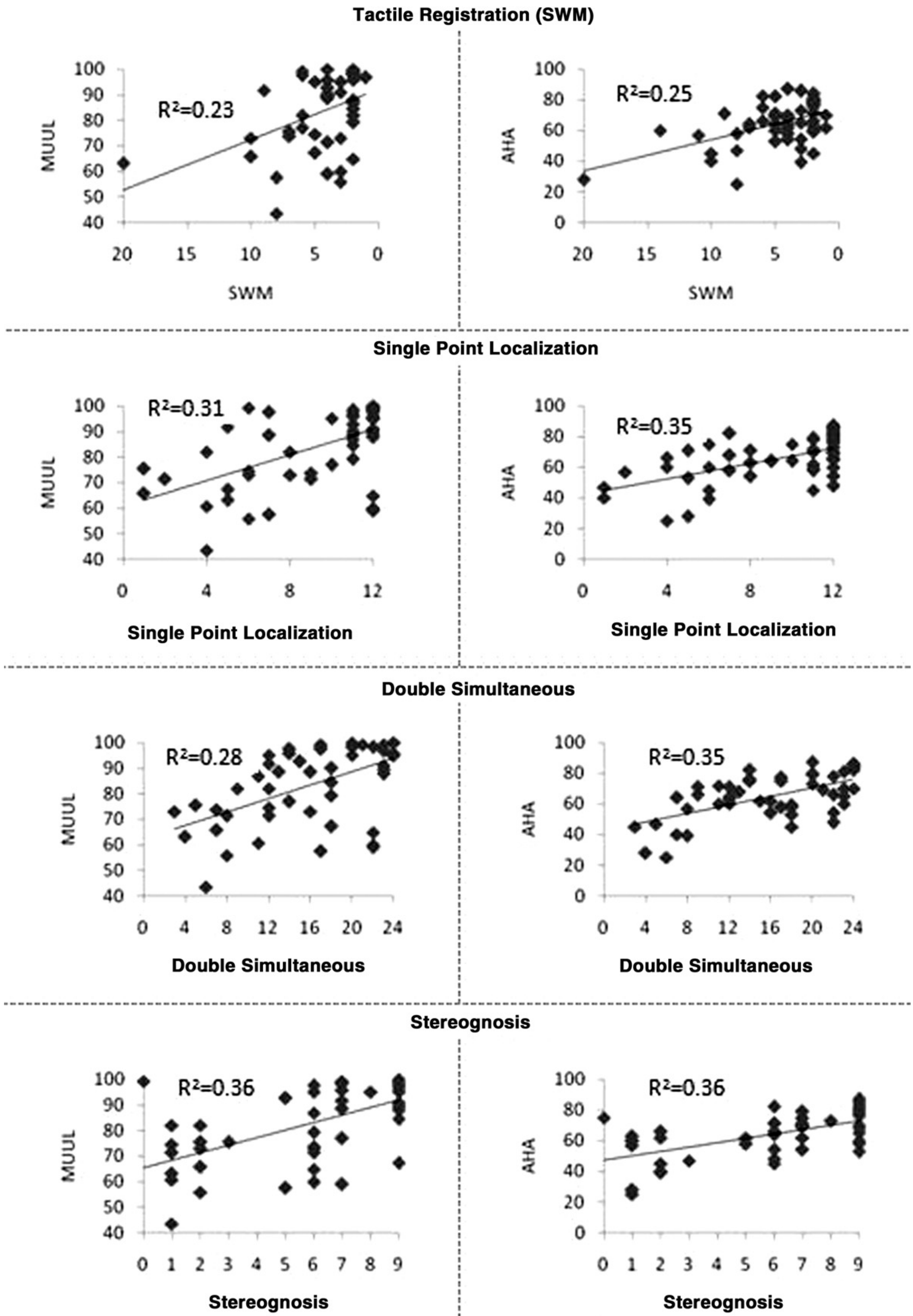

Fig 1. Scatterplots showing the relationship between tactile variables and unimanual capacity and bimanual performance. Each data point reflects a single participant.

Table 2: Relationships Between Tactile and Motor Performance Variables in Children With Unilateral CP Using Linear Regression*

Tactile Assessments	MUUL		JTTHF (impaired side)		AHA	
	β	R^2	β	R^2	β	R^2
Registration (SWM)	–0.48	0.23	0.40	0.16	–0.50	0.25
Single point localization	0.55	0.31	–0.53	0.28	0.57	0.35
Double simultaneous	0.53	0.28	–0.46	0.18	0.59	0.35
Static 2PD	–0.45	0.21	0.48	0.23	–0.51	0.26
Moving 2PD	–0.47	0.23	0.48	0.24	–0.53	0.29
Stereognosis	0.59	0.36	–0.50	0.25	0.60	0.36
AsTex	–0.24	0.05	0.20	0.04	–0.10	0.01

NOTE. The reported beta coefficient is the regression coefficient obtained after standardizing all variables to have a mean of 0 and an SD of 1.
*For all measures, $P<.005$, except AsTex, where $P=.92$ (MUUL), $P=.18$ (JTTHF), and $P=.47$ (AHA).

Previous studies in children with unilateral CP have shown that somatosensory function is crucial for anticipatory control and appropriately calibrating grip force for fine hand movements.[4,12] Texture perception, which combines the fine spatial and temporal qualities of a stimulus, may have a more significant role in calibrating forces to control fine precision grasp. The motor assessments used in the current study did not specifically measure the finer aspects of grip and force control, so these clinical tests may not be sufficient to detect an underlying relationship between texture perception and upper-limb motor function. Motor assessments that examine grip force and other tactile assessments currently used in the adult stroke population to measure texture perception[30] may help to further elucidate the relationship between texture perception and functional upper-limb activity in children with unilateral CP.

The importance of spatial tactile perception is further highlighted by the finding that approximately 30% of the variance in both unimanual capacity and that bimanual performance can be explained by spatial tactile perception. There are many potential contributors to motor function, for example vision, proprioception, cognition, attention, muscle strength, and motor control. As such, finding that tactile function accounts for 30% of the variance in motor performance when both vision and proprioception are available highlights the significant role that tactile function plays in motor performance. This further supports the notion that action and perception are closely linked, that they probably share common neural correlates in the cortex, and that they, therefore, cannot be divided into discrete functional compartments.[31]

The findings that unilateral tactile function is important to unimanual capacity and that bilateral tactile function is important to bimanual performance emphasize the need to assess both unilateral and bilateral tactile spatial perception and motor performance in children with unilateral CP. While the lack of statistical collinearity supports all tactile tests remaining in the assessment framework as they assess different aspects of function, results suggest that single point localization and double simultaneous, both items from the Neuro-sensory Motor Developmental Assessment,[23,g] should be prioritized due to their proven relationships to unimanual capacity and bimanual performance, respectively.

We contend that treatments that target both unilateral and bilateral spatial tactile perception should be implemented in children with unilateral CP because of the impact they may have on motor performance. Treatment of tactile dysfunction has not been a significant focus for children with unilateral CP, but given that it contributes approximately one third of the variance in motor performance, it would seem essential that it become an important aspect of therapy for these children.

Study Limitations

There is the risk that our study suffered from selection bias—only 59 out of 253 potential participants volunteered. Our results may have been strengthened if we had access to structural magnetic resonance imaging data, but magnetic resonance imaging scans have only recently become a routine part of care for children with unilateral CP in Queensland. Because most of the current cohort did not have scans on file, exact location of their brain lesion is unknown. Evaluation of cortical reorganization, assessed by transcranial magnetic stimulation, and the inclusion of motor tests that remove the confounder of vision or that require carefully calibrated grip forces, may have assisted the interpretation of our results but would have also increased the burden on our cohort to unreasonable levels. The current work builds the important platform on which such studies can be undertaken.

Our study may have been underpowered to detect other independent variables that truly contributed to the primary outcome variables. As a general rule of thumb, at least 10 cases per independent variable are required to ensure the power of the regression to detect all true predictors (eg, Wright[32]). Our sample had about 7.5 cases per independent variable, which, importantly, does not place at risk the legitimacy of the regressions in supporting the hypotheses, but it does reduce the power to detect all the true contributors to the model. That is,

Table 3: Results of Multiple Regression Analyses for Tactile Function Against Each Motor Assessment

Assessments	β Coefficient	t	P	95% CI for β	r^2
MUUL					
Single point localization	2.50	4.63	<.001	1.41 to 3.59	0.29
JTTHF					
Single point localization	−30.60	−4.16	<.001	−45.42 to −15.77	0.26
AHA					
Double simultaneous	1.38	5.14	<.001	0.84 to 1.92	0.33

Abbreviation: CI, confidence interval.

our study had an increased risk of false negatives, but not false positives.

CONCLUSIONS

This study reports a comprehensive investigation of multiple components of tactile function and how they relate to both unimanual capacity and bimanual performance in children with unilateral CP. Children with unilateral CP demonstrated a significant relationship between tactile registration using the SWM test and both unimanual and bimanual motor function as assessed by the MUUL, JTTHF, and AHA. Spatial perception was strongly related to unimanual capacity and bimanual performance in children with unilateral CP, while texture perception was not. Unilateral and bilateral spatial tactile perception accounted for approximately 30% of the variance in unimanual capacity and bimanual performance, respectively, emphasizing that tactile domains make a major contribution to upper-limb function. Differences in the relative contributions of tactile function to motor ability highlight the importance of using a comprehensive tactile test battery and suggest the need for further work to tailor interventions to improve tactile function for children with unilateral CP.

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