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Development, and construct validity and internal consistency of the Grasp and Reach Assessment of Brisbane (GRAB) for infants with asymmetric brain injury

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ABSTRACT

Introduction: Infants with asymmetric brain injury (asymBI) are at high risk of Unilateral Cerebral Palsy (UCP). The Grasp and Reach Assessment of Brisbane (GRAB) was developed to detect asymmetries in unimanual/bimanual upper limb (UL) reach and grasp behaviours in infants with asymBI. This study reports the development of the GRAB and evaluates its construct validity and internal consistency.

Material and methods: Prospective study of twenty four infants with asymBI and twenty typically developing (TD) infants at 18 weeks corrected age (C.A.) in a structured play session. Three different coloured toys were presented at the midline in a block design of six 30-s trials of toy presentation, separated by five 30-s trials of no toy presentation. The number and duration of: (i) unimanual contacts; (ii) unimanual grasps; (iii) bimanual midline grasps; and (iv) duration of other unimanual behaviours (e.g. prehensile movements and transport phase) were measured. An Asymmetry Index (AI) was calculated to determine asymmetries between ULs. Possible AI values ranged from 0 to 100%, indicating proportion of toy presentation time that unimanual behaviours were asymmetric between ULs. Internal consistency of both the Time Phase (TP) and Toy Colour Phase (TCP) test items were determined by calculating Cronbach's alpha coefficients. Each assessment occasion was split into six TPs and two TCPs; whereby one TP comprised one 30-s trial of one toy presentation and one TCP comprised two 30-s trials of the same toy presentation.

Abbreviations: AI, asymmetry index; asymBI, asymmetric brain injury; C.A., corrected age; CP, Cerebral Palsy; GA, gestational age; GMs, Prechtl's Method on the Qualitative Assessment of General Movements; GRAB, Grasp and Reach Assessment of Brisbane; HAI, hand assessment of infants; IRR, incidence rate ratio; IVH, intraventricular haemorrhage; MD, mean difference; mini-AHA, mini-assisting hand assessment; MRI, magnetic resonance imaging; N/A, not applicable; PVL, periventricular leukomalacia; SCPE, Surveillance of Cerebral Palsy in Europe; SD, standard deviation; TP, time phase; TCP, toy colour phase; UCP, unilateral cerebral palsy; UL, upper limb; 95% CI, 95% confidence interval.

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For TP, seven out of nine unimanual behaviours and two out of three bimanual behaviours demonstrated strong internal consistency (Cronbach's alpha coefficients 0.72–0.89). No unimanual activity demonstrated the strongest IC (0.89). For TCP, six out of nine unimanual behaviours demonstrated strong IC (0.73–0.82). Number of unimanual contacts and duration of unimanual prehensile movements demonstrated the strongest IC (0.82). Duration of unimanual contribution to hands at midline and duration of bimanual midline behaviour demonstrated the weakest IC for both TP and TCP (0.46–0.50). For unimanual contacts, the asymBI group were more asymmetric between ULs (mean AI = 50%) compared to the TD group (mean AI = 30%). For unimanual grasps, both groups were similarly asymmetric (both mean AI = 40%). The TD group were almost twice as likely to demonstrate bimanual grasps as the asymBI group (incidence rate ratio IRR 1.9, 95% CI 1.4 to 2.5, $p < 0.001$). Infants with asymBI were less likely to use the impaired UL compared to the unimpaired UL for grasping (IRR 0.6, 95% CI 0.5 to 0.8, $p < 0.001$); and used the impaired UL for a shorter proportion of time compared to the unimpaired UL for grasping (mean difference −9.1%, 95% CI −16.6 to −1.7, $p = 0.02$).

Conclusions: The GRAB is a criterion-referenced research measure that detects and quantifies the presence or absence of unimanual and bimanual reach and grasp behaviours at 18 weeks C.A. in infants at risk of UCP. The GRAB demonstrated moderate to strong construct validity and strong IC within an assessment occasion. There was no toy preference or warm-up effect for TP or TCP for either group; confirming that the GRAB is a consistent measure across toy presentations within an assessment occasion. In this study, the GRAB identified that infants with asymBI demonstrated a paucity of bimanual grasping compared to TD infants; and demonstrated asymmetric unimanual grasping between ULs at 18 weeks C.A.

1. Introduction

Cerebral Palsy (CP[1]) is the most common cause of motor impairment in young children (Surveillance of Cerebral Palsy in Europe; SCPE, 2000), with a prevalence of approximately two to three in 1000 live births (Australian Cerebral Palsy Register; ACPR, 2013; SCPE, 2000). Unilateral CP (UCP) accounts for 18–36% of children diagnosed with CP in Europe (SCPE, 2000) and 38% of children diagnosed with CP in Australia (ACPR, 2013). Infants with asymmetric brain injury (asymBI) are at high risk of developing UCP by the end of their first year of life (Guzzetta et al., 2013). Unilateral impairment results in impaired development of reach and grasp, both of which are necessary for toy exploration. To date, the mini-Assisting Hand Assessment (mini-AHA) is the only validated measure to evaluate the use of the impaired upper limb (UL) during bimanual performance in infants with UCP aged eight to 18 months (Greaves, Imms, Dodd, & Krumlinde-Sundholm, 2013). There is no validated and published measure at present which evaluates asymmetries between ULs during early reach to grasp development in infants with asymBI who are younger than eight months C.A. Early detection of asymmetries between ULs is needed to provide an indication of an emerging hemiparesis in infants at risk of UCP.

At present, the average age in Australia for a diagnosis of CP is 19 months (Morgan, Novak, Dale, & Badawi, 2015). Earlier detection of UCP is needed to enable timely referral to infant-friendly interventions within the critical period of brain development (Boyd, Perez, & Guzzetta, 2013; Guzzetta et al., 2013; McIntyre, Morgan, Walker, & Novak, 2011). Early detection of UCP involves identification of asymmetries in UL reaching (both spontaneous and purposeful), grasp ability and grasp strength (Heathcock, Lobo, & Galloway, 2008). To date, determination of high risk of a later diagnosis of UCP has been identified in infants with perinatal or neonatal stroke using: (i) asymmetries of wrist movements during the fidgety period (nine to 20 weeks post-term) of General Movements (GMs; Guzzetta et al., 2010); and differences between typically developing (TD) infants and infants with stroke: (ii) of bimanual midline toy manipulation (Chen, Lo, & Heathcock, 2013); and (iii) reaching (Chen, Tafone, Lo, & Heathcock, 2015). The first method for detecting signs of asymmetry was the global and detailed analysis of fidgety movements (closing or opening of all digits towards or away from the palm), segmental wrist movements (wrist joint movements such as rotation, palmar flexion and extension, and ulnar or radial flexion), and independent digit movements (such as isolated finger movement, simultaneous finger movement, sequential finger movement, pre-precision grip, and precision grip) (Guzzetta et al., 2010). The second method described behavioural coding to quantify the amount of time that infants (lying in supine) touched or grasped toys (big ring, small ring, and a stick-shaped flower toy) simultaneously in the midline (Chen et al., 2013). The third method described behavioural coding

[1] Abbreviations: ACPR, Australian Cerebral Palsy Register; AI, Asymmetr y Index; asymBI, asymmetric brain injury; C.A., corrected age; CP, Cerebral Palsy; GA, gestational age; GMs, General Movements assessment; GRAB, Grasp and Reach Assessment of Brisbane; HAI, Hand assessment of Infants; IRR, incidence rate ratio; IVH, intraventriclar haemorrhage; MD, mean difference; mini-AHA, mini-Assisting Hand Assessment; MRI, magnetic resonance imaging; N/A, not applicable; PVL, periventricular leukomalacia; SCPE, Surveillance of Cerebral Palsy in Europe; SD, standard deviation; TP, time phase; TCP, toy colour phase; UCP, unilateral cerebral palsy; UL, upper limb; 95% CI, 95% confidence interval.