

Institution: University of Leeds
Unit of Assessment: UoA4
Title of case study: Case Study 3: A novel tool facilitating objective identification of children with motor control difficulties for timely treatment and support
<p>1. Summary of the impact</p> <p>The 'Clinical Kinematic Assessment Tool' (CKAT) is an innovative system that detects the 5% of children with motor control problems who, as a result, experience academic and social disadvantage - which increases the likelihood of educational difficulties, anxiety and depression. CKAT's development is led by Mon-Williams at the University of Leeds (UoL), in partnership with the University of Aberdeen. Since 2012, CKAT has been used in 88 primary schools in Bradford. All Reception Year children (aged 4-5 years) are CKAT screened (~4,000 children annually) with teachers using this information to prompt further assessment and additional classroom support. CKAT is now being commercialised via a licensing deal (2012) with a Scottish SME.</p>
<p>2. Underpinning research</p> <p>The abundance of motor skills that must be mastered in the course of childhood (e.g. dressing, washing, feeding oneself, writing legibly) makes it clear that motor coordination is a keystone of a child's developmental progress. The consequences of impairment in motor ability are profound. A wealth of research has shown that many of these children with motor deficiencies have poor health and educational outcomes if they are not identified in the early school years. Nonetheless, these children are often missed or identified too late for optimal remedial action. Current clinical practice guidelines produced by the European Academy of Childhood Disability identify an urgent need for early identification of children with developmental motor coordination difficulties (at 5 years of age) and it is known that treatment is effective if children are identified early. Unfortunately, large numbers of these children do not receive attention because existing methods to measure motor skills rely on the subjective evaluation of specialists using time consuming tools (Sugden, D.A. (2005). Development Coordination Disorder as a Specific Learning Difficulty. <i>ESRC report</i>. Retrieved from http://www.dcd-uk.org/images/LeedsConsensus06.pdf).</p> <p>In response to this, a collaborative effort led by Mon-Williams (Professor of Cognitive Psychology, UoL, 2009-present) and Williams (University of Aberdeen) resulted in the development of the CKAT battery; a system capable of detecting at risk children so that they can receive intervention - IP protected by patent [A]. This system presents visuomotor tasks whilst simultaneously recording responses via interactions with a tablet screen using a pen-like stylus. CKAT uses sophisticated processing algorithms (previously only available in research laboratories) to generate outcomes describing the behaviour.</p> <p>Since 2009, the UoL has led the physical development of CKAT. The software [1] was written and developed by Culmer (School of Engineering, UoL, 2003-present), supervised by Mon-Williams and employed on grants held by Mon-Williams [i-iii] and UoL academics are authors on all underpinning research [1-6]. The tasks presented within the CKAT battery were conceived and designed by Mon-Williams and implemented by Flatters (PhD student, UoL, 2009-2013), supported by a grant to Mon-Williams [iv]. Data were collected and analysed in Leeds (2010-present) to ensure that the system was capable of detecting differences in motor skill acquisition and these data have been published recently [5]. This constitutes the first objective data detailing differences between learning to generate a novel shape as a function of training regime (copying versus tracing). The usefulness of the device in measuring performance and motor strategies in young and old adults has also been established, extending CKAT's impact to adults [6]. These activities were supported by grants to Mon-Williams: Wellcome Trust (Anderson, Research Fellow, UoL, 2011), a Biomedical and Health Research Centre grant (BHRC) [iv] and MRC post-doctoral fellowship [v] to L.Hill (Research Fellow, UoL, 2011-present). To support rolling out of CKAT in schools (2012), a system to provide feedback to teachers was designed and included as part of the software by Flatters (funded by a grant to Mon-Williams [vi]). Since 2012, Culmer and</p>

Flatters have been working with a Scottish SME to produce a system for commercial use.

3. References to the research

[1] Culmer*, P.R., Levesley*, M.C., **Mon-Williams***, M., & Williams, J.H.G. (2009). A new tool for assessing human movement: The Kinematic Assessment Tool. *Journal of Neuroscience Methods* 184, 184-192. doi: 10.1016/j.jneumeth.2009.07.025

Article detailing the software architecture designed to present and deliver the CKAT battery.

[2] **Wilkie***, R.M., Johnson*, R.L., Culmer*, P., **Allen***, R.J., & **Mon-Williams***, M. (2012) Looking at the task in hand impairs motor learning. *Journal of Neurophysiology*, 108, 3043-3048. doi: 10.1152/jn.00440.2012

Demonstrates that distortions in the visual feedback provided by CKAT affect the rate of learning for a manual task using a stylus.

[3] Snapp-Childs, W., **Mon-Williams***, M., & Bingham, G.P. (2013) A sensorimotor approach to the training of manual actions in children with developmental coordination disorder. *Journal of Child Neurology*, 28(2), 204-212. doi: 10.1177/0883073812461945

Demonstrating haptic robotic training improving manual control in children with movement problems, as indexed by measuring performance after training on a CKAT handwriting task.

[4] Williams, J.H.G., **Mon-Williams***, M., Culmer*, P., Casey, J., & Braadbaart, L. (2013) Kinematic measures of imitation fidelity in primary school children. *Journal of Cognition and Development*. doi: 10.1080/15248372.2013.771265

Presents a novel method for measuring imitation accuracy in children using CKAT.

[5] Gonzalez*, C., Anderson*, J., Culmer*, P., **Burke***, M.R., **Mon-Williams***, M., & **Wilkie***, R.M. (2011) Is tracing or copying better when learning to reproduce a pattern? *Experimental Brain Research*, 208 (3), 459-465. doi: 10.1007/s00221-010-2482-1

Presents manual control data collected via the CKAT system and details the differences in producing a novel shape when copying versus tracing (as required in handwriting acquisition).

[6] **Raw***, R.K., Kountouriotis*, G.K., **Mon-Williams***, M., & **Wilkie***, R.M. (2012). Movement control in older adults: does old age mean middle of the road? *Journal of Experimental Psychology: Human Perception and Performance*, 38(3), 735-45. doi: 10.1037/a0026568

Demonstrates CKAT battery scores related to performance and strategy in older adults.

Key funding and grants

[i] Department of Health NEAT Programme. (2008-2010). *Novel Interactive Peer Group Therapeutic Activities System for Children with Cerebral Palsy*. Levesley*, M., Bahkta*, B.B., **Mon-Williams***, M., Cozens, J.A., Richardson*, R.C., Sugden*, D., & Clarke*, M. £449,000.

[ii] Scottish Government (Scottish Enterprise). (2005-2007). *A standardised tool for the assessment of neurodevelopmental disorder*. Williams, J.H.G., & **Mon-Williams***, M. £178,672.

[iii] Scottish Government (Scottish Enterprise). (2007-2008). *A standardised tool for the assessment of neurodevelopmental disorder*. Scottish Government (Scottish Enterprise). Williams, J.H.G., & **Mon-Williams***, M. £68,510.

[iv] BHRC Problem Solving Grant. (2012). *Evaluating the benefits of gamma knife surgery for patients with trigeminal neuralgia*. Pavitt*, S., Phillips*, N., & **Mon-Williams***, M. £21,980.

[v] Medical Research Council Centenary Fellowship. (2012). *The effects of physical activity and motor coordination on child development*. £45,000. **Hill***, L. (**Mon-Williams***, M. supervisor).

[vi] EPSRC Bridging the Gaps Fund. (2011). *Haptic Enhancement of Learning Processes*. **Mon-Williams***, M., Hewson*, R., Culmer*, P., & Clarke*. M. £28,145.

Note: All UoA4 researchers in **bold**; *research conducted by academics at the UoL.

4. Details of the impact

Public policy and services

CKAT is the only available system that can provide an objective assessment of manual control within classroom settings – as indexed by the granting of a patent [A]. CKAT is impactful because

it screens manual motor control in large populations of children (in classroom settings), with far more detail than previous assessment tools have allowed, thereby facilitating objective identification of children with difficulties for timely treatment/support. This innovation has, in terms of public policy, resulted in a regulatory authority changing its practices by adopting a new method (i.e. services) for screening educational difficulties within school settings [B]. Children in Bradford are now screened for motor deficits and provided with an intervention if problems are detected. Specifically, since 2012 the City of Bradford Metropolitan District Council's Education Department is offering primary schools within its area the opportunity to participate in the 'Starting School' screening programme. This programme includes assessing every participating child during their first year of school on CKAT. Results of individual children's CKAT assessments are provided to participating schools and teachers then use this information to guide additional investigation and support children identified as being at risk of motor deficit. The local educational authority view this initiative as being of great benefit as CKAT is:

"...giving our teachers the ability to augment their professional judgements with detailed objective assessments that allow them to make properly informed judgements about how best to support their students. Results are also aggregated and given to schools that work together in a Local Area Partnerships (LAPs), helping us in our strategic planning as well." Strategic Director, Children's Services, Bradford City Council [B].

Practitioners and children's health & welfare

In 2012/13, 43 schools participated in the first year of the programme (~2,500 children), with 88 schools (~4,000 children) committed for this current year (i.e. 2012-13). This represents approximately 70% of the 125 schools in the city of Bradford. This widespread screening of children for motor deficits has in turn affected practitioners, influencing practices and the level of support provided in school for children with motor difficulties. Evidence of impact comes from:

- Teachers receiving new training:

"In response to the CKAT assessments we have run Continuing Professional Development (CPD) sessions for teachers to provide them with information and ideas on what to do to help children with motor learning difficulties in their classrooms...This has led to teachers adopting certain lesson plans to include motor learning as an embedded element within them...the assessments have raised awareness of the importance of motor learning as a foundation for other aspects of learning." Advisor, Bradford Schools Linking Network [C].

- Children identified as needing evaluation for a statement of special educational needs:

"... these assessments have confirmed teacher's professional judgements and led to further more detailed assessments being conducted, as we attempt to ascertain the specific challenges each child faces." Advisor, Bradford Schools Linking Network [C].

- Schools providing additional in-school support to children identified as having difficulties:

"... assessments have also prompted us to seek innovative ways of intervening to support motor-learning. For example, we are using school resources to develop an after-school club designed to support children with movement problems." Advisor, Bradford Schools Linking Network [C]

"... provided clarity to teachers about the children who need particularly focussed support. The value of having objective measures like this to support teacher's professional judgement is considerable... In certain cases, we have been able to put in place additional support for those that need it most. In such instances the assessments have guided us in how we tailor our support to the individual student's needs." Head Teacher, Bradford Primary School [C].

In summary, Bradford Educational Services are using CKAT to identify children with problems in order to provide additional support – i.e. the Regulatory Authority has been convinced to change practice [B]. CKAT also has direct impact on health and welfare benefits for children, enabling

them to gain more timely and effective access to the support they need. It increases the efficiency with which the referral system operates in identifying children requiring additional support and treatment for movement problems, ensuring their difficulties are mitigated as early as possible:

“CKAT assessments have focussed our attention on an important issue which can be overlooked in mainstream education (i.e. the development of fine motor skills) and given us the detailed objective tools we need to monitor motor skill development in our students and then act to have an impact for the students that need it most.” Advisor, Bradford Schools Linking Network [C].

“These snapshots of children’s initial ability levels provide us in the Education sector with crucial early indicators of which children may require additional support and in what specific areas...and help identify at an early age which children might usefully benefit from referral for additional support.” Strategic Director, Children’s Services, Bradford City Council [B].

For these reasons, CKAT is being used in the US (Indiana) to identify children with motor problems so they can receive robotic therapy for handwriting problems. Research has shown that children with motor problems can improve their performance with robot therapy and CKAT allows identification of those children who benefit from this intervention [D]. Moreover, CKAT is being used as the clinical trial outcome measure within a National Institutes of Health (NIH) \$800,000 funded project [E] investigating the efficacy of the robotic treatment and has been implemented by clinicians at the University of California, Los Angeles (UCLA), USA to measure post-surgical motor outcomes for people following neural surgery. For example, the UCLA team has recently evaluated manual dexterity before and after cervical spinal injection for pain in over 30 of their patients [F].

Impact on commerce

CKAT has been commercialised via a licensing agreement [G], which the UoL and the University of Aberdeen signed with Mulraney Group in 2012. Royalties are split based on Aberdeen’s revenue-share model (Leeds is entitled to a 39% share of overall royalties). This license demonstrates commercial impact, as evidenced by job creation and revenue generation by Mulraney Group in 2013:

“The Mulraney group have identified CKAT as a significant commercial opportunity. The development of this system has generated jobs within our company and enhanced our financial prospects. We anticipate further job creation (FTE = 20) and an increased turnover of £3,000,000. Moreover, the Mulraney Group believe that we are now in a position to further capitalise on the investment...” Chief Executive, Mulraney Group [H].

5. Sources to corroborate the impact

[A] Patent details: **Mon-Williams, M.**, Williams, J.H.G., Plumb, M., & Wilson, A. ‘Apparatus and method for the assessment of neurodevelopmental disorders’. (PCT/GB2007/001931). European Patent No. 07732951.4; USA Patent No. 12/302174. Retrieved from <http://patentscope.wipo.int/search/en/WO2007135441>

[B] Testimonial from the Strategic Director of Children’s Services, Bradford City Council (21.10.13).

[C] Testimonials from the Headteacher at Allerton Primary School, Bradford and the School Curriculum Advisor who also acts as Advisor for the Schools Linking Network (21.10.13).

[D] Testimonial from a child health expert based in the US corroborating this statement (25.10.13).

[E] NIH documentation of grant with **Mon-Williams** as named consultant providing CKAT expertise (14.1.13).

[F] UCLA testimonial corroborating the use of CKAT to measure post-surgical motor outcomes (25.10.13).

[G] Legal document evidencing licensing agreement between the UoL and Mulraney Group.

[H] Testimonial from the Chief Executive of Mulraney Group (25.10.13).