Institution:
University of Cambridge

Unit of Assessment:
UoA4

Title of case study:
Neuroscience of reading and dyslexia: impacts on policy and practice

1. Summary of the impact (indicative maximum 100 words)

Professor Usha Goswami's research on reading development and dyslexia and in the relatively new field of educational neuroscience has gained her international renown as an expert in this field that brings together research in neurobiology and education. Her literacy research, which she and her group have undertaken in the Departments of Education and Psychology in the University of Cambridge, has focused on cross-linguistic factors underpinning reading development and developmental dyslexia, producing innovative data. She has also been an influential critic of the Government's focus on 'synthetic phonics'. During this REF impact period, Professor Goswami's work has had significant impact on UK Government educational and other public policy, on public debate and understanding about reading and dyslexia, and on practitioners and services concerned with written material in every language.

2. Underpinning research (indicative maximum 500 words)

Professor Usha Goswami was a University Lecturer in the Department of Experimental Psychology between 1990 and 1997, when her research concentrated on reading by analogy in early childhood (undertaken with a group of young researchers, and funded by MRC [1994-7] and Spencer Foundation [1996-8] grants). This research established the developmental importance of higher-order consistencies in English spelling based on rhyme (e.g., fight-light-night), and led to the identification of the basic cognitive factors underpinning rhyme analogy.[1] At the same time, she commenced cross-language studies via collaborations with international academic visitors to her laboratory (German, French and Greek;[2]), illustrating that rhyme analogies are particularly important in English, a non-transparent writing system and a spoken language with complex phonology.

Following a period at UCL (1997-2003), Goswami returned to Cambridge in 2003 as Professor of Education and began a major programme of cross-language research on dyslexia, supported by further ESRC (2004-7), Nuffield (2010-12) and MRC (2005-15) grants and Visiting Fellows from overseas This cross-language empirical work tested a novel auditory theory, concerning the sensory basis of the onset-rhyme division of the syllable upon which rhyme analogy theory is based, studying children with dyslexia who are native speakers of English, French, Finnish, Spanish, Hungarian, and Chinese. A cohort of 120 children were tested in England (MRC funding), with smaller cohorts (~60 children) assessed in the other countries (by Visiting Fellows and colleagues). This research led to a new theory of reading development and dyslexia across languages based on psycholinguistic "grain size" (syllable, rhyme, phoneme),[3] and demonstrated how different phonologies affect orthographic learning in transparent and deep orthographies. The key insight of the research was that a common framework based on psycholinguistic processes can be applied to understanding reading acquisition and developmental dyslexia across languages, despite surface differences in writing systems and phonological structure. It also led to a novel theory of dyslexia based on auditory processing of amplitude modulations in the speech envelope, which are relevant to hearing the onset-rhyme division of the syllable, and has also been applied across languages.[4,5] This developmental framework has specific implications for remediation in dyslexia based on rhythm and auditory timing.[6] Goswami showed for the first time that affected children are impaired at perceiving speech prosody and syllable stress. Subsequently, research studies linking speech and music via manipulation of the amplitude envelope and perceptual rhythm by Goswami and her group (post-docs Tim Fosker, Martina Huss, Odette Megnin, Alan Power and Ruth Cumming; research assistants Lisa Barnes, Anji Wilson and Natasha Mead) led to the further key insight that the basic auditory processing of coarse-grained temporal structure (at the syllable grain size, reflecting slower temporal modulations in speech <10 Hz) is critical for literacy development across languages, and that impairments in neural mechanisms that support "slow temporal" auditory processing may be the brain basis of developmental dyslexia.[5,6]

3. References to the research (indicative maximum of six references)

1. Goswami, U. (1993). Towards an interactive analogy model of reading development: Decoding vowel graphemes in beginning reading. *Journal of Experimental Child Psychology, 56*, 443-475 DOI: 10.1006/jecp.1993.1044 [Google 218, WoS 116] DOI: 10.1006/jecp.1993.1044 [Google 225, WoS 117]

2. Wimmer, H., and Goswami, U. (1994). The influence of orthographic consistency on reading development: Word recognition in English and German children. *Cognition, 51*, 91-103. DOI:10.1016/0010-0277(94)90010-8 [Google 339, WoS 159]

3. Ziegler, J., & Goswami, U. (2005). Reading Acquisition, Developmental Dyslexia, and Skilled Reading Across Languages: A Psycholinguistic Grain Size Theory. *Psychological Bulletin, 131 (1),* 3-29 DOI: 10.1037/0033-2909.131.1.3 [Google 962, WoS 499]

4. Goswami, U. (2006). Neuroscience and Education: From Research to Practice? *Nature Reviews Neuroscience, 7,* 406-413. [Google 236; WoS 81]

5. Goswami, U., Wang, H-L., Cruz, A., Fosker, T., Mead, N., & Huss, M. (2011). Language-universal sensory deficits in developmenta dyslexia: English, Spanish and Chinese. *Journal of Cognitive Neuroscience, 23,* 325-337. [Google 49; WoS 23]

6. Goswami, U. (2011). A temporal sampling framework for developmental dyslexia. *Trends in Cognitive Sciences, 15* (1), 3-10. DOI:10.1016/j.tics.2010.10.001 [Google 84, WoS 28]

4. Details of the impact (indicative maximum 750 words)

Goswami's theoretical work contextualising the role of grain sizes in early phonics teaching has had impact in several ways;

1. Practitioners and services: Her work has influenced the way that teachers approach reading instruction. For example, her 2008 papers critiquing synthetic phonics and emphasising the importance of a cross-language analysis including rhyme[1] in Literacy and the British Educational Research Journal have been downloaded over 1500 times; and many teachers now use analogies in teaching reading. Impact is on-going following the inclusion of the work on rhyme analogy in the UK National Literacy Strategy (1997; 2003), the research also formed the basis for a Primary Reading Scheme from the Oxford Reading Tree (Rhyme & Analogy, OUP); 1996-2012.[2]

2. **Public policy and services:** Additionally, the Teaching and Learning Research Programme (TLRP) was a major ESRC initiative focusing on educational research for the improvement of teaching and learning, which ran from 1999-2009. Goswami's research was directly responsible for her being invited to sit on the Steering Group for the TLRP Seminar Series in Neuroscience and Education; the Group's 2007 report for teachers on 'Neuroscience and Education: Issues and Opportunities',[3] in which Goswami wrote the section on neuroscience and developmental disorders, continues to have impact and has been downloaded over 605,000 times since publication[4] (figures from James O'Toole Institute of Education via Cambridge Digital Services, continuing impact demonstrated by 169,000 hits in 2013 alone).

Professor Goswami's research on child learning led to her being consulted by Sir Jim Rose for his 2009 Independent Review of the Primary Curriculum commissioned by the UK Government.[5] Goswami was also asked by Tania Byron (now Professor and Chancellor of Edge Hill University, Lancashire) to prepare one of three literature reviews (on child development) to underpin the Byron Review: Children and New Technology (DfES, 2008).[6]

Also, Goswami co-wrote (with Peter Bryant, Emeritus Professor at Oxford) the child development strand of the Cambridge Primary Review (funded by the Esme Fairburn foundation, and published as a research report in December 2007, with the main report published in 2009),[7] which

summarises the processes of learning, thinking and reasoning in pre-school and primary school-aged children, and suggests how educational frameworks can best support these (Final Report Part 2 Section 7; covered in The Guardian, The Independent, The TES, The Telegraph, December 2007).

In addition, at the request of the then Chief Scientist, Professor Sir David King, Goswami was asked by the UK Government to lead the 'Learning Difficulties' strand of the Foresight project on *Mental Capital and Wellbeing*.[8] The report describes the prevalence and impact of common learning difficulties in children; defines a conceptual model of typical and atypical learning development; and considers the multiple factors that influence the outcomes of learning difficulties at an individual level. It also suggests possible approaches to the identification and treatment of learning difficulties over the next 20 years. The Report's recommendations are of such significance that they were drawn to the attention of policy makers and professionals and researchers working in the field of childhood development and learning difficulties, see One Year Review.[9] For example, Goswami was asked personally to present the developmental messages from the work to the Senior Leadership Team (December 2008) and the Chief Scientist and the Director of Child Wellbeing (April 2009) at the (then) Department for Children, Schools and Families. The One-Year Review of the Foresight project (2009) lists a range of impacts on government, academia, third sector and business, for example on the Learning Revolution White Paper (DIUS, 2009).

With respect to Goswami's Foresight work on learning difficulties (2008), the report was also drawn to the attention of both the Children's Workforce Development Council and the Training and Development Agency. The former were reported to be taking into account the findings in their work on early years practitioners, and the latter reported that 'many providers adapted their provision to take into account recent research in neuroscience as an element of their approach to the study of the development of children and young people.' Since approximately 7% of children are affected by developmental dyslexia, these recommendations for changes to treatments that have a positive effect have significant impact. Goswami's report also had an impact in China, leading to a Ministry of Education-funded research initiative (c£1.5 million, 2010-2013) involving Chinese and UK academics to explore 'children's learning difficulties and social withdrawal behaviour'. The Chinese Ministry of Education also organised a group to study how to apply the Foresight findings to the Chinese national education strategy for 2010-2020 (correspondence from Jon Parke, UK Government Office for Science, to UG).

3. S**ociety, culture and creativity / public debate and understanding**: Goswami was interviewed by both BBC Radio and TV for high-profile programmes (e.g., Melvyn Bragg for In Our Time, March 2010; David Baddiel for Horizon, March 2009; Michael Morpurgo for Radio 4, March 2012; Lauren Antrobus for Growing Children, August 2012; for example see[10]). Her research on music, rhythm and dyslexia is impacting public debate and understanding (e.g. talk at Cheltenham Science Festival, 2008, on dyslexia; TES article on rhythmic interventions for dyslexia, public debate following R4 appearances[11]).

The innovative way in which Goswami's work on the neural basis of developmental dyslexia combines cognitive developmental psychology and mechanisms of neural processing and representation has led to invitations to open programmes and centres for educational neuroscience in other countries, for example the Educational Neuroscience Programme at the University of Granada (2009), and the Leiden Institute for Brain and Cognition (2010). The value that practitioners place on her research and its implications is illustrated in the many invitations to speak at professional meetings in order to provide information that can change approaches to treatment.[11] In recognition of her impact on practitioners, Goswami was awarded the 2011 New York Academy of Sciences Aspen Brain Forum Senior Investigator Prize for her 'ability to translate discoveries from cognitive neuroscience into innovative curricula and tools that enhance learning inside or outside of the classroom'.[12]

5. Sources to corroborate the impact (indicative maximum of 10 references)

1. Wyse, D., & Goswami, U. (2008). Synthetic phonics and the teaching of reading. *British Educational Research Journal*, 34(6), 691-710. Downloads **>1,500) DOI:**

10.1080/01411920802268912

2. Oxford Reading Tree “Rhyme and Analogy”; OUP April 1996; discontinued 2012.

3. Neuroscience and Education: Issues and Opportunities: www.tlrp.org/pub/documents/Neuroscience%20Commentary%20FINAL.pdf

4. Daniel Parry* (Digital Services, Cambridge University Library): 2009: 47388 gets from 2577 distinct IP addresses; 2010: 72494 gets from 4008 distinct IP addresses; 2011: 84025 gets from 3354 distinct IP addresses; 2012: 232186 gets from 7864 distinct IP addresses; and 2013 so far: 169708 gets from 6144 distinct IP addresses

5. Rose Report: Independent Review of the Primary Curriculum, 2009. www.education.gov.uk

6. Goswami, U. (2008). *Child Development*. Research review for the *Byron Review on the Impact of New Technologies on Children*. Department for Children, Families and Schools.

7. Goswami, U., & Bryant, P.E. (2007). *Children’s cognitive development and learning*. Primary Review research survey 2/1a, for the Cambridge Primary Review, University of Cambridge.

8. Cooper, C.L., Field, J., Goswami, U., Jenkins, R., & Sahakian, B.J. (2009) (Eds.). *Mental Capital and Wellbeing (The Foresight Report)*. Oxford: Wiley-Blackwell.

9. The Foresight One-Year Review (October 2008-November 2009). Government Office for Science. http://www.bis.gov.uk/assets/foresight/docs/mental-capital/mcw_oyr_180410_final.pdf

10. http://www.bbc.co.uk/programmes/p00xlw95

11. *The Science of Dyslexia.* Invited keynote speaker, Cheltenham Science Festival, Cheltenham, UK. 8 June 2008.

12. Aspen Brain Forum Prize announcement: http://aspenbrainforum.com/abf-prize.html