

Institution: Queen Margaret University, Edinburgh

Unit of Assessment: UoA26 Modern Languages and Linguistics

1. Unit context and structure, research and impact strategy

1.1 OVERVIEW

The **Clinical Audiology, Speech and Language Research Centre (CASL)** is the main organisational hub for this unit of assessment, and it has been under the directorship of Prof SCOBBIIE since 2011. Research Centre status is awarded by QMU on the basis of demonstrated and focused research excellence, making them internally and externally identifiable units for research. Centres are required to meet demanding institutional quality assurance standards and have autonomy over the use of a £10k-£15k annual research and impact budget. Ongoing full membership of a centre is one of the criteria used to identify those staff with a significant responsibility for research at QMU (see Section 2). Full members of the CASL Research Centre therefore are at the core of the submission to the Modern Languages and Linguistics Unit of Assessment, although other members of staff, contract researchers, and PhD students make important contributions to research and impact generation.

CASL is closely associated with the Division of Speech and Hearing Sciences, a multidisciplinary grouping of speech scientists, linguists, speech and language therapists, audiologists, British Sign Language (BSL) interpreters and psychologists. This division, led by Prof BECK, comprises three disciplinary groupings: (a) speech and language therapy (SLT), linguistics, phonetics and psycholinguistics (b) audiological science and rehabilitation, (c) BSL interpreting, a new area since REF14.

It was outputs and case studies from research in the first of these areas (a) which featured overwhelmingly in REF14 (and in previous RAE exercises). In REF21, again, all the staff with significant responsibility for research (SRR) at the census date are in roles principally linked to the pre-registration vocational qualification programmes drawing on the disciplines in (a). Eight members of staff have SRR (6.6FTE) and are submitted with the unit (Section 2).

It is not surprising, therefore, that CASL's research niches in articulatory phonetics and in the clinical applications of speech science, which featured heavily in REF14, are central here. However, other areas of research, entrepreneurialism, and impact creation make an important contribution to the research environment, particularly at doctoral and masters levels, as outlined below and/or exemplified in the submission. Many research areas are closely linked with professional scholarship. Submitted outputs address social factors in language deficits, bilingualism, sociophonetics and other areas. Our impact strategy promotes entrepreneurial and collaborative efforts by staff, the overwhelmingly vocational student body in our programmes, interaction with user networks, and our commitment to public engagement.

Externally funded and established members of staff, PhD students, and visitors are physically located either in our laboratories or in a contiguous area of staff accommodation on the QMU campus in Musselburgh, which was opened in 2010. CASL researchers collaborate with colleagues from other divisions at QMU in research and supervision (e.g., psychology, health sciences, initial teacher education and sociology).

Names in capitals have a significant responsibility for research on the census date.

1.2 RESEARCH THEMES

In 2011, CASL was founded with two main themes, each encouraging interdisciplinarity, and in 2016 we added the third, more explicitly oriented to scholarship, knowledge exchange and impact:

The sounds of words

This theme examines individual consonants and vowels, how they are acquired by children, how their pronunciation is affected by speech disorders, how they are heard and perceived, and how they are formed into words — all in the context of cross-linguistic and sociolinguistic variation, with a view to clinical impact.

Communication and discourse

This theme explores how communication functions to facilitate social cohesion and access to education, work and services. It examines language in all its forms (spoken, signed and written) and in all its linguistic detail, how it is perceived and expressed, and how aspects of communication are influenced by social, physical and psychological factors — also with a view to impact.

Shaping professional practice

This theme has a focus on topics that advance practice and policy in the professions associated with the division of Speech and Hearing Science, particularly Audiology, Speech and Language Therapy and BSL Interpreting. It aims to develop and disseminate best practice in any area of our work, including higher education curricula. It also encompasses collaborations addressing the needs of external partners, primarily in healthcare.

1.3 RESEARCH GOALS (2014, 2021 and beyond)

The guidance for this REF5b report indicates we should provide evidence for the extent to which we achieved our strategic aims during the census period (2014-2020). Therefore we will quote from the REF14 (Environment Template REF5) which set out our goals, below. As indicated, these statements still apply at the time of submission to REF21, with only minor adjustments to specific areas of focus reflecting new developments, since much of our research strategy is consistent with REF14.

“In pursuit of research excellence our overall guiding principle is that **research should lead to greater understanding of issues relevant to clinical need**. To that end, we aim to blend and balance basic/normative and applied/clinical research. We pursue a range of theoretical linguistics research: in one dimension there is a focus on the fields of **phonetics and phonology**; cross-cutting this is a focus on **individual variation**, particularly in **acquisition** and **social variation**. These theoretical interests are partnered by work aiming for **methodological innovations** prompted by technological advances and new theoretical questions. Our most identifiable long-term niche is in **the development and innovative application of speech science technologies**.

We aim to enhance research in these fields through international leadership as follows:

Our **methodological** research in this niche focuses on the development of new and enhanced instrumentation, analytic techniques and experimental methods for the collection, measurement and analysis of speech articulation, speech sounds, and the vocal-tract.

Our **theoretical** research is broader and covers not just speech production processes and linguistic phonetic theory but also areas of speech disorder, child language acquisition, sociolinguistics, individual variation, psycholinguistics, and phonology.

Our **applied** research focuses on the diagnosis, treatment and modelling of speech, language and hearing disorders, with particular interests around the effective use of visual biofeedback in therapy and the role of genetic, social and educational factors in linguistic deficits.”

Therefore, in REF21 it remains the case that CASL aims to bring together talented and enthusiastic researchers and practicing members of the professions that address speech, language and communication needs in an environment where they can benefit from and add to our niche expertise and to grow and support research in complementary areas where opportunities, enthusiasm, collaborations, expertise, professional relevance and chances of impact suggest a potential for success.

Nine specific goals were set out in REF14 to enhance these strategic aims, so we will comment on them in detail here. Major goals are discussed first, in Section 1.4, numbered as in REF14, with text quoted verbatim. Progress against minor goals G4-G8 is evaluated in section 1.5. We cross-refer to sections 2-4 where relevant. Additional aspects of our strategy relevant to 2020 onwards appear in passing. Where items of evidence are applicable to the evaluation of our work under multiple goals, this document largely avoids repetition in favour of focusing on the strongest, clearest lines of evidence.

1.4 OUR CORE, HIGH-LEVEL RESEARCH GOALS (G1, G2, G3 & G9)

G1. *“To continue to develop, enhance and disseminate methodological expertise in articulatory phonetics and to build and lead a growing community of researchers in articulatory phonetics, throughout the UK and internationally.*

G9. *“Establishing CASL as an international leader within our niche area(s)”.*

Articulatory phonetics is still a relatively rare sub-discipline, though it is very encouraging that the international community has grown fast over the census period. Our role in this growth and our methodological influence have been achieved through the following amenities, activities and outputs (expanded further below) specifically in this area (and see also section 4):

- (a) our laboratory, with synchronised data collection equipment
- (b) collaborative relationship with spin-out company Articulate Instruments Ltd
- (c) collaborations with other research institutions
- (d) externally-funded research projects (non-clinical)
- (e) research projects (clinical)
- (f) externally-funded research fellowships, typically for early career researchers
- (g) doctoral theses
- (h) doctoral examination
- (i) written outputs
- (j) keynote talks, oral dissemination, post-graduate courses
- (k) open science corpus
- (l) expansion in the UK HEI sector
- (m) tools for teaching
- (n) a dedicated senior experimental officer.

Detailed evidence relating to these enumerated points is as follows:

- a. We created a laboratory and provided a detailed methodological description of our hardware and data-collection facilities in an open access output. It encapsulates our experience and expresses our view of best practice. It facilitates replication of our methods and supplements the limited methodological information that can be included in outputs which explore more theoretical topics. This facility has been used for sociolinguistic, psycholinguistic, phonetic and phonological research studies, and for collection of data by visiting academics. For the clinical use of these facilities, see Impact Case Study B, where this output is underpinning output [2], and see Section 4 for discussion of our collaboration with Articulate Instruments Ltd. Where space permits, we will enumerate key sources of evidence in italics in this section, thus:
 - *Wrench and Scobbie (2016) Queen Margaret University ultrasound, audio and video multichannel recording facility (2008-2016). (=Impact Case Study B, [2])*
- b. Articulate Instruments Ltd, commercial producer of “Instrumentation & software for visualising speech”, CEO Professor Alan Wrench, remains physically located in QMU adjacent to our laboratories, thanks to continuing institutional investment in infrastructure. It is a thriving SME, and its ongoing commercial success over nearly 10 years was the subject of one of the QMU REF14 Impact Case Studies. This success continues, with its a focus now on ultrasound tongue imaging (section 4). Our integrated approach to research and impact means some QMU work that facilitates G1 by supporting the research community is embodied in our relationship with Articulate Instruments. This makes Wrench a Category C collaborator. Activities include beta-testing of upcoming releases of Articulate Assistant Advanced (AAA)

software by the senior experimental officer, researchers and students, who also provide feedback on current versions. We also provide research drivers, because our research generates ideas for enhancements or new components of AAA software. The submitting unit also provides feedback from researchers and students on the company's tutorial materials and manuals which make the software accessible by its international users. Such ongoing synergistic and collaborative working arrangements provide evidence of the group's achievements in addressing G1. Some specific analytic methods first used in QMU research, such as the Dorsum Excursion Index (DEI) (cf output 0C/03/26 REF2) have been incorporated directly into AAA software. Other analyses such as KT indices (cf underpinning research output [6] in Impact Case Study B) have led to more indirect changes to make them easier to perform. This highly synergistic relationship between QMU researchers and Articulate Instruments is one of the cornerstones of our approach to G1.

1 The Articulate Instruments Ltd website: <http://articulateinstruments.co.uk/>,

2 YouTube channel with methodological training videos:

<https://www.youtube.com/channel/UCENAA96efGbUDjsiGaQ9PqQ>

- c. Key collaborators include Universities of Glasgow (Stuart-Smith), Edinburgh (Turk, Renals), and Manchester (Strycharczuk) plus Strathclyde University (Cleland). Others are mentioned in passing or in section 4.
- d. External funding for non-clinical research projects in articulation, specifically, with an award-holder at QMU comprised the following (titles only, see section 4 for details). Projects [2-4] were ongoing and produced outputs during the census period, while project [7] was awarded and started.
- 1 *Project [1] Seeing the links in the speaker-hearer chain: an investigation of the transmission of articulatory variation using ultrasound tongue imaging*
 - 2 *Project [3] Coarticulation and tongue differentiation in children between three and thirteen years old.*
 - 3 *Project [4] Dynamic Dialects: Integrating articulatory video to reveal the complexity of speech.*
 - 4 *Project [7] Changes in shape, space and time: the impact of position on the spatiotemporal and configurational articulatory properties of liquid consonants.*
- e. External funding for clinical research projects specifically focused on articulation with an award-holder at QMU comprised the following (titles only, see section 4 for details). Project [1] was ongoing and produced outputs during the census period, while project [5] was awarded and started.
- 1 *Project [1] Ultrax: Real-time tongue tracking for speech therapy using ultrasound*
 - 2 *Project [5] Ultrasound Visual Biofeedback Treatment for Speech Sound Disorders in Children.*
- f. Four post-doctoral Research Fellows with external funding were based in the UoA during the census period for periods of up to 3 years, not counting other shorter visits. Only visits of at least 2 months are listed here. They were all early career researchers (ECRs). Two PhD students also completed their studies after an extended visit: Shao (in 2019) incorporated elements of analysis and theory, while King (in 2018) undertook data collection. Some financial details are given of fellowships, where known. Since funding did not come to QMU, these are not listed in section 3 as income. Next destinations of these fellows are also indicated:
- 1 *Dr Patrycja Strycharczuk, for a British Academy postdoctoral fellowship "Contrasts and categories in articulation and perception". £209,502, Sep 2013 to Sep 2016. This ECR was previously in Switzerland and after QMU moved to a permanent academic post in the UK.*
 - 2 *Dr Maria Paola Bissiri, for a EU Marie Curie Intra European Fellowship "The transfer of connected speech behaviours: external sandhi and glottalization in English-accented German". (£221,606, PIEF-GA-2013-623394, Oct 2014 to Sep 2016.) This ECR was previously in Germany, and after QMU moved to a research project in Italy.*
 - 3 *Dr Petroula Mousikou, research visit (funding source and amount unknown, 2016). This ECR was previously in the UK and after QMU moved to a research project in Germany.*
 - 4 *Dr Mai Ohkoku, Sabbatical funding (funding source and amount unknown). This*

- researcher visited from Japan.
- 5 Pertti Palo (QMU-registered PhD student) received approximately £7k funding from Emil Aaltonen charitable fund (Finland) to help support his PhD studies in automated articulatory analysis, 2018.
 - 6 Bowei Chao (2020) "The apical vowel in Jixi-Hui Chinese: phonology and phonetics." PhD, University New Sorbonne, France.
 - 7 Hannah King (2020) "The role of the lips in the production and perception of Anglo-English /r/." PhD, University of Paris, France.
- g. Five doctoral completions during the census period have worked primarily or exclusively in articulatory phonetics and been supervised by staff in the group (SCOBIE, Lawson, LICKLEY, WOOD). Three further students using articulatory methods are currently being supervised, two registered at QMU (QMU bursary funded) and one at Strathclyde.
- 1 Fabienne Westerberg (2020) "An auditory, acoustic, articulatory and sociophonetic study of Swedish Viby-i." Glasgow.
 - 2 Pertti Palo (2019) "Measuring pre-speech articulation. QMU.
<https://eresearch.qmu.ac.uk/handle/20.500.12289/10163>
 - 3 Cornelia Heyde (2019) "An articulatory-acoustic investigation of timing and coordination in the fluent speech of people who stammer." QMU.
<https://eresearch.qmu.ac.uk/handle/20.500.12289/9860>
 - 4 Zoe Roxburgh (2018) "Visualising articulation: Real-time ultrasound visual biofeedback and visual articulatory models, and their use in treating speech sound disorders associated with submucous cleft palate." QMU.
<https://eresearch.qmu.ac.uk/handle/20.500.12289/8899>
 - 5 Claire Timmins (2014) "Articulatory characteristics of sibilant production in young people with Down's Syndrome." QMU.
<https://eresearch.qmu.ac.uk/handle/20.500.12289/7445>
- h. Ten doctoral students working in articulatory phonetics have been examined in the census period. They were registered in France (3), Australia, New Zealand/France, Netherlands, Finland, Sweden, Manchester (2). Examiners were SCOBIE or WOOD.
- i. Around half (9/17) of the outputs selected in REF2 are in articulatory phonetics, but this is just a subset of articulatory work, and under-represents the absolute magnitude of output in the area and its proportion of research overall in the unit. This is due in particular to REF2 not including a representative sample of outputs authored by the three externally-funded research fellowship holders named above under f(1-3) or the three members of staff who were employed on externally-funded research projects listed below in section 3.1 (Cleland, Lawson and Zharkova). None of these six postdoctoral researchers were employed at QMU on the REF21 census date.
- j. Oral dissemination is also evidence of our influence. SCOBIE delivered five invited presentations on articulatory phonetics in France, Brazil, Greece, Switzerland, and Italy, taught mini-courses at postgraduate level (Brazil & Greece), and co-authored over 40 articulatory topic papers at conferences or in seminars.
- k. Unique articulatory data was collected during children's clinical treatment, during ULTRAX, Ultraphonix projects (plus other cases) and it has been shared in an open science initiative (See Impact Case Study B):
- Eshky, et al. (2018) "UltraSuite: a repository of ultrasound and acoustic data from child speech therapy sessions." 19th Interspeech, Hyderabad. [Paper 1736]
- l. Articulatory research is being undertaken in more linguistics universities in the UK than previously, much of it using ultrasound tongue imaging and AAA software (see Section 4).
- m. Two major teaching-oriented sites have been created to aid education in articulatory phonetics. They present free-to-use online audio-visual examples of the sounds of the International Phonetic Alphabet ("Seeing Speech") and examples of vowel systems and words in a range of dialects of English ("Dynamic Dialects"). Seeing Speech had been initially funded by the Carnegie Trust (2011 to 2013, "An online Ultrasound Tongue Imaging resource for Phonetics, Linguistics, and Speech Therapy teaching at Scottish Universities"), and the latter was supported by an AHRC grant (Project [4] in Section 3.2, and item (d), above). The latter grant enabled both Dynamic Dialects and Seeing Speech to be made available on smartphones. We also published a guide to free-to-use articulatory materials as a peer-reviewed open-access

paper aimed at (second or additional) language learning and teaching specialists. This paper has had over 9,500 views and has reached #1 in its journal's list of most downloaded work (50% more than the second most downloaded paper, from 2011). Its Altmetric score of 50 (from tweets & Mendeley) is the journal's highest, and puts it in the top 5% of all the 260k+ articles of a similar age worldwide, and at the 97% centile of Altmetric's 12m outputs.

- 1 Lawson, Stuart-Smith, Scobbie and Nakai, S (2015) *Seeing Speech: an articulatory web resource for the study of phonetics*. Website. <https://www.seeingspeech.ac.uk/>
- 2 Lawson, et al. (2015) *Dynamic Dialects: an articulatory web resource for the study of accents*. Website. <https://www.dynamicdialects.ac.uk/>
- 3 Nakai, S., Beavan, D., Lawson, E., Leplâtre G., Scobbie, J. M., Stuart-Smith, J. (2018) *Viewing speech in action: speech articulation videos in the public domain that demonstrate the sounds of the International Phonetic Alphabet (IPA)*. *Innovation in Language Learning and Teaching*. Vol. 12(3): 212-220. <http://dx.doi.org/10.1080/17501229.2016.1165230>

n. The contribution of our dedicated senior experimental officer Steve Cowen to articulatory research has been acknowledged in dozens of outputs. (He also co-authored underpinning research in Impact Case Study A.)

G2. *To exploit methodological expertise to address fundamental theoretical issues.*

Articulatory methodologies have resulted in theoretical insights in sociolinguistics (SCOBIE and Lawson), in psycholinguistics (LICKLEY, SCHAEFFLER_S, SCOBIE), in speech development (Zharkova, LICKLEY, SCOBIE, Cleland), in motor control (LICKLEY, SCOBIE), in phonology (SCOBIE), in childhood speech sound disorders (WOOD, Cleland, SCOBIE), and in sound change (Strycharczuk, SCOBIE). We have advanced theories of the phonetics/phonology interface, focusing on variation and non-determinism in these areas, where the interface is relevant to speech planning, social or idiosyncratic variation, the use of the vocal tract for speech and non-speech phenomena, feedback, individual or dialectal change, meta-phonology. The theoretical work is pervasive, so evidence of achieving this goal can be found in our REF2 outputs and in the underpinning research for Impact Case Study B.

G3. *To develop new areas to broaden our portfolio of research.*

New areas of research include projects and theses both in the speech and language therapy areas, and in the other disciplinary areas in the division of speech and hearing sciences. At a preliminary stage during the census period, we do not expect these topics to generate material for REF. Our strategy is to generate scholarship and pilot work, and then to focus on those areas which are most likely to lead further. It is important, in our broad-based division, to support research at all levels, though there is no expectation that all this work will lead to prioritised areas where staff have a significant responsibility for research (see section 2). Like QMU generally, our research profile is influenced by our vocational priorities in undergraduate and postgraduate programmes, continuing professional development, knowledge exchange, scholarship and research. This profile provides excellent opportunities for synergy between professional practice, research, knowledge exchange and the curriculum (see section 4).

QMU bursary funding with workload planning led to two PhD completions in Audiology, and external funding has been secured for an ongoing doctoral research project.

- Johnson, Christine (2018) *"The auditory brainstem response in healthy adults and adults with alcohol dependency syndrome."* PhD Thesis, QMU. <https://eresearch.qmu.ac.uk/handle/20.500.12289/10041>
- De Placido, Christine (2016) *"Experiences of acquiring hearing loss: lessons for rehabilitation."* <https://eresearch.qmu.ac.uk/handle/20.500.12289/7444>
- Abbeyfield PhD studentship (~£45k) on hearing loss and dementia in care homes.

In BSL interpreting, a professionally-oriented research project has led to a government report, and research into the pragmatics of politeness in BSL interpreting is ongoing.

- "Scotland's BSL/English Interpreting Profession Landscape Review" fully funded

from a £50K grant from the Equalities Unit within the Scottish Government. 1 December 2018 to 30 November 2019. The primary dissemination of the research was a formal report to the Scottish Government in October 2019.

<http://bs/scotlandact2015.scot/wp-content/uploads/2019/11/Landscape-Review-2019-Executive-Summary.pdf>

In speech science, voice and phonetics, research on voice has been given particular priority in terms of doctoral level development in new areas.

- *Voice in mental health (an ongoing QMU PhD bursary).*
- *Voice and gender (a successful co-application for ESRC funding, and co-supervision, for an ongoing 1+3 PhD bursary registered at Glasgow University).*
- *Voice health care (through support for FitVoice spin out company and a QMU PhD bursary). See Impact Case Study A for new research in technical aspects of voice capture from this research area that underpins aspects of the impact.*
- *Articulatory correlates of voice quality adjustments (an ongoing QMU PhD bursary).*

In articulation and Ultrasound Tongue Imaging, we have new interests in swallowing and tongue biomechanics, in which MA is collaborating with Wrench (Articulate Instruments Ltd) to develop new methods for imaging and analysing relevant muscular and skeletal aspects of vocal tract physiology relevant to swallowing and dysphagia. QMU hosted visiting research fellow Ohkubo from Japan, leading to a paper.

- *Ultrasound International Working Group. MA and Wrench joined a new dysphagia special interest group (“An international group of clinicians & researchers striving towards evidence-based integration of ultrasound into SLT clinical practice”) in 2020.*
- *Ohkubo, M. & Scobbie, J.M. (2019) Tongue shape dynamics in swallowing using sagittal ultrasound. Dysphagia, 34(1), 112-118. <https://eresearch.qmu.ac.uk/5411>*

We refocused our work on social disadvantage and language and communication deficits away from statistical analysis of datasets (cf. outputs in REF14 by Rush and CLARK) towards more linguistic and professionally oriented research. A QMU PhD bursary on the un-met communication needs of male young offenders was completed in 2019. This work has led to an application for a Carnegie Trust PhD bursary which was awarded in early 2020. The work will focus on young women, and the studentship will begin in the academic year 2020-2021, after the end of the census period.

- *Fitzsimons, Dermot (2019) “Pausing mid-sentence: young offender perspectives on their language and communication needs.” PhD Thesis, QMU. <https://eresearch.qmu.ac.uk/handle/20.500.12289/9857>*

Research in sociolinguistics, bilingualism, speech production and psycholinguistics has continued as an area of interest during the census period, often drawing on our articulatory methodologies. In particular, a QMU PhD bursary completion in 2020 on the topic of bidialectal speech perception led to published outputs in fluency (LICKLEY), prosody (SCHAEFFLER_F) and speech rate (SCOBBIIE) being submitted to REF21.

- *Maria Dokovova (2020) “The effects of English proficiency on the processing of Bulgarian-accented English by Bulgarian-English bilinguals”. PhD Thesis, QMU. <https://eresearch.qmu.ac.uk/10628>*
- *Louise Cotton (2016) “Mind the gap: Dysfluency and hesitation phenomena in adults with dyslexia”. PhD Thesis, QMU.*

1.5 SECONDARY RESEARCH GOALS

G4. *To strengthen interdisciplinary links within QMU.*

SCHAEFFLER_F and BECK initiated a collaboration in 2020 with QMU's new Initial Teacher

Education and Home Economics programmes, a cross-school initiative. This link dovetails with the interest of FitVoice interests in voice health in the teaching profession (see section 4). The research goals were to collect baseline data on voice patterns before and during teaching placements, to relate those to findings from teachers within the profession, and to undertake an online survey (2020) of Scottish primary teachers' voice experiences related to voice health, before and during online teaching during COVID.

CLARK has collaborated with the Memory Research Group in a cross-school initiative, in relation to work on evidencing and communication, in association with the Scottish Institute for Policing. This has also involved the creation and delivery of training materials on communication needs.

G5. *To introduce a masters-level capacity in research.*

A new two-year MSc/PGDip programme in Speech and Language Therapy was validated early in the census period, to enable postgraduate students with first degrees in linguistics, psychology or other disciplines to acquire a professional qualification in Speech and Language Therapy (and thereby a license to practice) after two years of study leading to the successful completion of a PGDip. An optional additional research thesis module was also offered, converting the PGDip to an MSc. The first MSc thesis was awarded in 2016, and over 30 research theses have been completed since. This research helps build capacity and experience through supervision, as well as contributing valuable pilot work, case studies and validations to our portfolio of research.

Likewise, an MSc programme in Audiology has helped develop research capacity in this area, with 31 completed theses.

G6. *To re-launch the research centre to give a broader remit.*

CASL was re-launched in 2016, with additional theme of "shaping professional practice" (see section 1.2 above) to complement its more linguistic themes. This adds focus for impact creation, knowledge exchange and capacity building for future research themes.

G7. *To increase quality (rather than quantity) of outputs and grant applications.*

This goal is rather more difficult to quantify or evidence. This strategy can be evidenced in part through the successful grants described in Section 3. However it is also relevant to describe two specific strategic and large scale applications.

- A £5m outline application to the ESRC under the Centres and Large Grants Competition centre (Centre for Speech Production) was developed in 2014, seeking 5 years of funding (2015-2020) to support our research goals in articulation. The research centre would have speeded and broadened the development of research infrastructure in articulatory phonetics and voice production and enabled us to undertake a number of projects, to fund UK-wide training and to support research fellows.
- A £1.4m application to AHRC-EPSRC for a 3-year innovation grant under a call for content creation and consumption in the digital economy was submitted to AHRC-EPSRC in 2016. It was one of 20 (of 100) that was invited to submit to the second stage of the competition, but was unsuccessful. The title was "Talking Heads: Capturing how people really talk for the interactive digital age" and it was a collaboration with three other universities to capture a corpus of naturalistic interactive speech from a socially and geographically varied set of participants, using articulatory instrumentation and gamified mobile phone apps.

These were unsuccessful, but the conceptual development and external links underpinning the applications have led to valuable collaborations and subsequent ambitious (but smaller scale) grants or PhD bursary calls have enabled aspects of the proposed research to go ahead. As for outputs, we remained successful in submitting articulatory phonetics papers to journals such as Laboratory Phonology, Journal of Phonetics and Clinical Linguistics and Phonetics but we also successfully targeted the Journal of the Acoustical Society of America and the Journal of Speech, Language and Hearing Research.

G8. Encourage more PhD students to come to QMU.

It has remained hard to encourage PhD applicants, and our numbers are small, even for a small unit. Most of our doctoral students receive of bursary funding from QMU, and it is important part of our strategy to invest nearly £50k per bursary to attract applicants. We also seek to attract clinically-qualified individuals to doctoral study, because many of our research priorities at doctoral level require a clinical qualification to undertake the research. Our difficulties are not untypical; individuals with both a clinical qualification and a doctorate are relatively rare. Our balance in this regard is healthy. Of our currently registered PhD students, 4 bursary students are speech and language therapists and two more are members of staff with clinical qualifications. Of students who completed a PhD or Professional Doctorate during the census period, 6 were either an SLT or an Audiologist.

To boost our access to external funding, we successfully applied to join the ESRC's Scottish doctoral training centre as a member of the Linguistics Pathway. We joined Edinburgh, Glasgow, Dundee and Aberdeen as a pathway member in the 2017 recommissioning for the doctoral training partnership (DTP). Two Glasgow-registered ESRC students have had joint supervision by QMU; one completed and one ongoing. We are the only research group at QMU to be on a pathway within the ESRC DTP.

We have pro-actively offered support to PhD applicants to seek additional or alternative sources of funding. One of our internal PhD bursaries is funded from a KE source, one is partially funded by the NHS and in 2020 we supported an application to the Carnegie Trust for a PhD bursary: it was awarded during the census period, with the applicant beginning in academic year 2020-2021.

2. People**2.1 Staff**

One element of QMU strategy comes particularly into focus for REF, which is that across the university only those staff who have a significant responsibility for research (SRR) are identified for inclusion in REF, rather than 100% of all academic staff. This is because many undergraduate and postgraduate programmes, including all linked to the unit, are vocational: they deliver a license to practice, and the programmes are time-intensive, both in their curricular elements and in their requirements for placement. Therefore, while some staff do have an SRR, many have other essential responsibilities. Even where research occurs as an expression of scholarship, it need not constitute a significant responsibility. The elements for identifying SRR are applied uniformly at an institutional level and follow QMU's code of practice. One key indicator of SRR is full membership of a QMU Research Centre: all staff in this unit with SRR are full members of CASL.

Moving towards significant responsibility for research is an individual goal and is only relevant for those individuals who want to attain or retain it. Long term development paths for SRR are operationalised within workload planning, as are other related goals, such as attaining a doctorate, or contributing to impact generation. Even if development towards significant responsibility is not part of a development plan, most staff contribute to the research culture through more general research-related activities such as scholarship, supervision, and professional activities. With an equivalent of only 6.6 FTE, it is inappropriate to give specific examples, and instead general staffing strategy can be presented.

With respect to staff development in research which does not involve SRR, we note that three academic staff are currently registered for PhD study at QMU and one externally. All are professionally qualified. One has been appointed to a part-time academic post subsequent to receiving a bursary for doctoral study, while the others were appointed as academic members of staff. During the census period, three completions were achieved by academic members of staff whose doctoral studies were related to their professional roles (one in SLT; two in Audiology). For PhD supervision, all staff supervising PhD students also have SRR, apart from two supervisors in Audiology. Some staff who have doctorates may seek SRR in the future, or may focus on other

goals. Annual research meetings with Centre Director, Dean and head of division discuss all research outputs deposited in eResearch in the previous year with a view to identifying and rewarding organic research activity and developing personal action plans to promote research.

With respect to those with SRR for REF21, all were submitted to REF14, and no current members of staff were submitted to REF14 but not to REF21. There have been no new appointments of staff with SRR. On the contrary, the REF21 FTE (6.6) is appreciably smaller than the 10.7FTE in REF14. One reason is that two full-time members of staff retired, and a part-time member moved back to a full-time role in industry. Another is that all four members of staff on external research funding in REF14 are no longer, or not currently, at QMU. Only one of those researchers was also a Speech and Language Therapist. Two fellows moved to full time academic posts at other institutions, and will be submitted to REF21. Therefore, while there is stability in the submitted staff group and in the research portfolio, the smaller submission and the set of eligible outputs reflects the lack of any independent postdoctoral fellows with SRR in employment on the REF census date. Research grant submissions are currently under peer review which, if successful, would alter this situation to expand the group again, and in 2020 we learned that a new international post-doctoral fellow secured funding to join us from Finland, giving a boost to our post-COVID research culture in 2021.

Indeed, we are proud to have applied the principles of the Concordat to Support the Career Development of Researchers during the census period. And, at the end of October 2019, QMU was in the first cohort of 15 UK HEIs (and was the first Scottish HEI) to publically declare its commitment to the new 2019 Concordat for Researcher Development. In preparation, a working group (including researchers from our unit) developed the institutional action plan, submitting it for publication (to occur after the census period, in October 2020). QMU was also one of the first universities in the UK and Europe to be awarded the HR Excellence in Research Award (September 2010) which was operative during the census period. Despite COVID, in 2020 QMU prepared and applied for a second 10 year Retention of the Award, which is expected to be successful. QMU also contributes to collaborative researcher wellbeing workshops with five other Scottish HEIs.

Journal of Phonetics awarded Best Early Career Scholar's Article of the Year (2017) to a paper arising from Strycharczuk's BA fellowship (REF 2 output 0G/05/26).

With respect to the permanent members of staff, a strategy to integrate KE, research and impact generation has particularly been important for this REF return, resulting in Impact Case Study A, and other related research activity that underlies and complements it. SCHAEFFLER_F was supported with workplace reallocation to develop and pursue commercialisation, KE and research opportunities with BECK, with a 2016 BSc SLT graduate, actor and voice-over artist and with a programmer-engineer. They founded, and incorporated FitVoice as a voice health Community Interest Company (CIC) linked to CASL in 2016, providing smartphone facilitated voice care services for professional voice users. Strategic QMU support for this has included: two bursary-funded SLT-qualified PhD students; two phases of additional KE investment grants (supporting 40% and 20% buyout for 12 month periods); workload reallocation; research and impact funding from CASL (hiring research assistants to support underpinning research). These, together with a Carnegie Trust research grant (Project [6]), have led to a range of activities and outputs, including those detailed in Impact Case Study A. Moreover, FitVoice were finalists in 2015 Converge Challenge and 2016 New Ventures, Scottish Government competitions to support entrepreneurialism in academia (recognising "high-calibre, innovative projects with serious growth potential"). This entrepreneurial/research relationship is also facilitated by QMU's new Intellectual Property policy to let academic staff retain IPRs by default, fostering collaboration and innovation.

With respect to staff development in research, we have provided several part-time roles over the census period, sometime lasting several years. Given our curricula, these tend to be limited to professionally qualified PhD graduates. They primarily contribute to CV building via teaching and learning, but also maintain research links, generating outputs, grant applications, and enhancing our research culture.

With respect to equality and diversity, we seek to balance competing tendencies in research and student recruitment. Analysis of the 8 staff with SRR shows an over-representation of men. However, this reflects the gender imbalance in Speech and Language Therapy, which is a predominantly female profession and our staff group's responsibilities. None of our male members of staff has a clinical or interpreting professional qualification. All professionally qualified staff are female (16 from a total staff complement of 21). The majority of our staff are part-time (and the majority do not have SRR). The three male staff returned to REF with SRR are mostly full time (2.8FTE). While undergraduate recruitment is almost exclusively female, masters-level student admissions have a consistent, but minority, male presence. However, females are in the majority for PhD recruitment and completions.

At an institutional level, QMU has a female majority in teaching and in senior positions, but analysis during REF has shown a pervasive over-representation of men in having SRR. With an Athena SWAN Bronze Award (initially achieved in 2013, and renewed in 2018), QMU is working towards counteracting these historical biases via Aurora leadership training, research capacity building, and mentoring. QMU's future strategy for mentoring includes partnership in the Teaching, Research & Academic Mentoring Scheme (TRAMS) led by St Andrews and Dundee in partnership with Abertay, Glasgow School of Art, the James Hutton Institute, and Trinity College Dublin.

2.2 Doctoral training

We participate in the QMU Graduate School doctoral training programmes leading to a Doctoral Certificate in Researcher Enhancement and Development (SCQF Level 12). SCOBIE participated in advanced training under the "Spring into Methods" programme of the Scottish Graduate School of Arts and Humanities. Also, in June 2020 we were successful in our application for funding to run an advanced doctoral training workshop for students in the Scottish Graduate School of Social Sciences, for "Show-and-Tell: Enhancing your Methods Section with Audio-Visual Walk-Throughs" (to be run in the 2020-2021 academic year).

PhD students have been able to teach on our programmes or take up short-term research posts, sit on institutional committees, participate in impact generation and public engagement, and organise research seminars. We also encourage our doctoral students to publish their research, and support attendance internationally at conferences via a student-controlled £2k research budget as well as access to CASL budgets.

Finally, LICKLEY was awarded a leadership role as research coordinator for the School of Health Sciences for the Graduate School in 2019.

3. Income, infrastructure and facilities

3.1 Externally-funded research projects

Information is provided here for selected projects, and the numbered references are cited elsewhere in the document. Note that for chronologically-earliest projects, most of the research income occurred outwith the census period, and for collaborative grants, some of the funding was awarded to collaborating institutions. Annual income coming to the unit annually within the census period is reported via HESA figures elsewhere in REF. These selected awards are however presented with funded value, not full economic cost. The awards demonstrate our interdisciplinary approach, coming from ESRC, EPSRC, AHRC, CSO, and indicate the scale of our collaboration.

[1] "Ultrax: Real-time tongue tracking for speech therapy using ultrasound". EPSRC Healthcare Partnership research grant EP/I027696/1. (£586,154) Feb 2011 - Jul 2014. Award holders Steve Renals (PI Edinburgh), SCOBIE (QMU), Cleland (QMU), Richmond (Edinburgh). Contributing industrial partner Articulate Instruments Ltd.

<https://qtr.ukri.org/projects?ref=EP%2FI027696%2F1>

[2] "Seeing the links in the speaker-hearer chain: an investigation of the transmission of

articulatory variation using ultrasound tongue imaging". ESRC ES/I036400/1 (£185,059). Aug 2011 – Jan 2014. Award holders Eleanor Lawson (QMU), James SCOBIE (PI, QMU) and Jane Stuart-Smith (Glasgow). <https://gtr.ukri.org/projects?ref=ES%2FI036400%2F1>

- [3] "Coarticulation and tongue differentiation in children between three and thirteen years old". ESRC ES/K002597/1 (£303,763). Oct 2012 to Feb 2016. Award holders Zharkova (PI, QMU), LICKLEY (QMU). <https://gtr.ukri.org/projects?ref=ES%2FK002597%2F1>
- [4] "Dynamic Dialects: Integrating articulatory video to reveal the complexity of speech." AHRC AH/L010380/1 (£185,905). Jan 2014-June 2015. Award holders Stuart-Smith (PI, Glasgow), SCOBIE (QMU), Beavan (UCL), with Lawson (Glasgow) and LePlâtre (Napier). <https://gtr.ukri.org/projects?ref=AH%2FL010380%2F1>
- [5] "Ultrasound Visual Biofeedback Treatment for Speech Sound Disorders in Children". CSO ETM/402 (£138,376). May 2015 – Oct 2016. Award Holders SCOBIE (PI, QMU), Cleland (Strathclyde). <https://www.cso.scot.nhs.uk/outputs/cso-funded-research/etrc/> (see ETM/402)
- [6] "Mobile voice monitoring for occupational voice users" or "VoiceCheck". Carnegie Trust Incentive Grant, Ref 70230 (~£7k). Jul 2015 – Oct 2016. Award Holder SCHAEFFLER_F (PI, QMU).
- [7] "Changes in shape, space and time: the impact of position on the spatiotemporal and configurational articulatory properties of liquid consonants". ESRC award ES/N008189/1 £197,099). Sep 2016 – Aug 2019. P.I. Dr Eleanor Lawson, Co-I Prof Jane Stuart-Smith (Glasgow), SCOBIE (QMU) <https://gtr.ukri.org/projects?ref=ES%2FN008189%2F1>
- [8] "Scotland's BSL/English Interpreting Profession Landscape Review". Commissioned research (£50K) from the Equalities Unit within the Scottish Government. Dec 2018 to Nov 2019. Award holder Mapson (PI, QMU).

3.2 Externally-funded research fellowships

For fellowships, income does not come to QMU, but goes direct to the fellow, so we have presented fellowships as evidence of how we have met our strategic goals rather than in this section as evidence of income. See Section 1, G1.

3.3 Research and Impact infrastructure

Our strategic long-term collaboration with Articulate Instruments is discussed in Section 1 in relation to strategic goal G1 (paragraph b), Section 4 with respect to collaboration, and in Impact Case Study B. The contribution of this spin out company as part of our research/impact infrastructure is a crucial element of our offering.

Our laboratory facilities related to articulatory phonetics are described in Section 1.

Additional research and impact infrastructure arises from the FitVoice collaboration. Its smartphone apps enable secure and high quality voice capture, so are an important tool for data collection for doctoral and other projects. In particular, doctoral analysis of the vocal effects of various mental health conditions has necessitated data capture and management protocols that address the ethical issues relating to security of such sensitive health data. COVID has been an unexpected additional factor highlighting the importance of this type of data collection. Online experimentation is also important (cf Dokovova's psycholinguistic studies of bilingualism and accent variation).

Our on-campus Scottish Enterprise Business Gateway BIZ provides bespoke support for researchers in enterprise creation and collaboration with industry (cf. The Voice Distillery, Case Study A.)

4. Collaboration and contribution to the research base, economy and society

4.1 Doctoral training

Collaboration boosts recruitment, and enables staff to supervise research at other institutions, and we achieved one completion (Westerberg at Glasgow, ESRC-funded) and have two ongoing. One is registered at Glasgow, (ESRC-funded, voice and gender), and one at Strathclyde (bursary-funded, speech sound disorders). (cf. Section 1 G1.)

4.2 Articulate Instruments Ltd and ultrasound research

This strategic partnership benefits the economy as well as the research base. Indeed, the positive economic impact of this company was the topic of an Impact Case Study in REF-14, and it has continued in similar manner during the REF21 census period, though now with more of a focus on ultrasound tongue imaging than on electropalatography. Within the census period the company sold, from an almost zero baseline:

- 43 EchoB systems to 38 institutions. (More advanced Micro systems below have superseded these, and 5 of these institutions have also bought Micro systems.)
- 26 “feedback” Micro systems aimed at real-time biofeedback in clinical or language-learning contexts to 23 institutions worldwide.
- 115 Research Micro systems suitable for articulatory phonetics research to 102 institutions worldwide.
- AAA analysis software has been sold to 148 institutions.

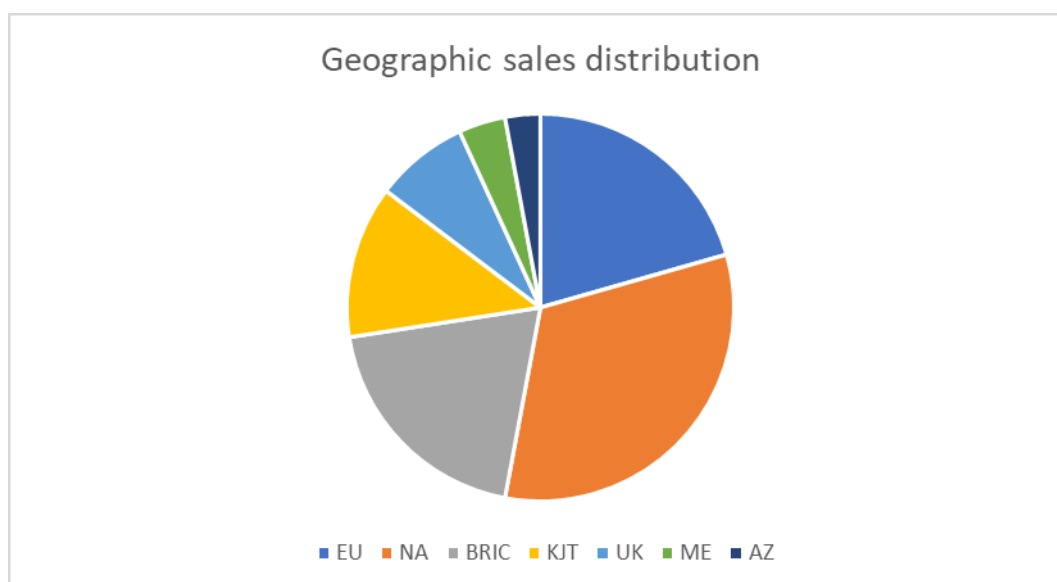


Figure 1. Research Micro system destinations, 2014-2020: EU; North America, BRIC (mostly Brazil and China), KJT (Korea, Japan, Taiwan), Middle East, AZ (Australia and New Zealand)

These micro systems run software on a laptop, and connect to an ultrasound probe by USB, so constitute a huge step forward in technical terms from large medical scanners and desktop machines. Research systems have excellent audio visual properties, but require some extra hardware. The feedback systems are simpler to set up but have slightly less precise audio-ultrasound synchronisation. They open the way for a wider adoption of UTI in clinics, given their ease of use. The company also has new 3D-printed stabilisation headsets specifically designed for children in clinic.

We have maintained a symbiotic and supportive relationship with this company, and Prof Alan Wrench (CEO and Category C collaborator) for nearly two decades. Throughout the census period we have been beta-testing Articulate Instruments’ new generation of highly portable ultrasound hardware-software, based on consumer-grade laptops linked to USB ultrasonic scanners. For clinics or the language-learning classroom, such simplified, cheap portable equipment is essential, along with suitable easy-to-use software. Projects such as Ultraphonix (2015-2016) have been fundamental in the development of software and clinical protocols suitable for real world use (see

Impact Case Study B). Our links with Articulate Instruments facilitate impact and drive research. (Note, the more recent developments in developing portable ultrasound systems are not claimed to be QMU research, nor to underpin impact in Case Study B, but do evidence our ongoing strategic collaboration.)

4.3 Other Ultrasound collaborations

Collaborations with local clinicians resulted in corroboration statements in Impact Case Study B. We funded a long-term loan of an Echo-B and then a feedback Micro System to a local unit. The unit took an autonomous role in developing their own approach to integrating ultrasound into clinical practice, which resulted in co-produced research questions for future development. We note the conflict of interest in corroboration, which is a feature of collaboration, even “at a distance”.

Ongoing collaboration with Cleland at Strathclyde benefits both parties in the development of clinical ultrasound. The continuing production of co-authored outputs and mutual PhD supervision are evidence of this strong strategic relationship.

4.4 Other articulatory impact-generation activity

We founded a treatment oriented articulatory clinic on campus in 2018 to facilitate impactful activity. WOOD, as a Speech and Language Therapist, leads this initiative to provide ultrasound electropalatography supported therapy for children and young adults. Thanks to collaboration with Wooden Spoon charity, we refurbished a clinic room, developed protocols, purchased equipment and bought EPG palates for clients and staff. Unfortunately, activity was halted by the COVID pandemic in March 2020.

For the Ultrasuite corpus, see section 1.4 (k) and Impact Case Study B.

4.5 FitVoice and voice research

Various collaborative activities by BECK and SCHAEFFLER_F relate to Impact Case Study A and to voice health research associated with the spin out Fitvoice Community Interest Company (CIC).

- *Planning workshop for “DELAD”, a Disordered Speech Databank (Linköping Sweden, October 2015), alongside 12 participants from Sweden, Spain, Netherlands, Canada, Germany, England, Finland, Norway, Ireland and Croatia.*
- *Exhibitors at “One Voice” conference: public engagement with voice-over industry, collecting data on occupational voice problems.*
- *Voice analysis training for the Netherlands Forensics Institute (July 2019).*
- *“Examining articulatory settings using MRI”: BECK was an expert MRI participant for this University of York project (August 2019).*

4.6 Public Engagement and outreach

SCOBIE was a Beltane public engagement fellow (2015-2016), resulting in a number of events (listed), including a week-long stint at the Edinburgh International Science Festival in 2017. He also wrote for The Conversation, the Scotsman, and appeared on The One Show (BBC) and is on the steering group for ASCUS Arts & Science (2015-2020), donating an ultrasound scanner to their engagement hub in Edinburgh. Public understanding of science events were often branded as “Seeing Speech, Hearing Tongues” and involved other members of CASL, particularly post-doctoral fellows and PhD students, but also BECK and Wrench.

- British Academy Summer of Science 2019, London (BA funding to Strycharczuk, and incorporating citizen science, data-collection of articulatory data from over two dozen participants).
- Royal Society Summer Science Exhibition 2016, London, (invited, RS funded).

Unit-level environment template (REF5b)

- Science Outreach in phonetics events at Glasgow Science Centre 2015.
- Explorathon European Meet-the-Scientist Night (National Museum of Scotland, Leith Labs), 2014-2016.
- Digging into Data Showcase, Glasgow, 2015.
- ASCUS-Lab (Arts-Science-Lab) Advisory Board, 2015-date.
- Glasgow Science Festival, 2015-2016.
- ASCUS-Lab event, 2016.
- Community Engagement, the Humble Hub, 2016.
- Glasgow School of Art collaboration (student hosting and evaluation of ultrasound-based industrial design projects), 2017, in advance of their “Ultrasonic Glasgow” exhibition, 2019.
- Edinburgh International Science Festival Experimentarium, 2017.
- NCCPE (National Coordinating Council for Public Engagement) Engage Conference, 2018.

4.7 Conference organisation

QMU was a co-organiser of the 18th ICPHS in Glasgow in 2015 as part of a Scottish consortium (Glasgow, Edinburgh, Strathclyde, QMU). This is the prestige international conference for phonetics sciences with a prestigious (double-blind) peer reviewed proceedings. 978 delegates attended from 46 countries, and 774 papers were presented. It was the first time it had been held in the UK for 40 years.