

CONVENTION DE REVERSEMENT**Relative à l'action « FELLOWSHIPS 2018 » de l'IDEXLYON****IDEX/FEL/2018/04**

Vu la convention attributive d'aide n° ANR-16-IDEX-0005 signée le 29 décembre 2017 entre l'Etat, l'Agence Nationale de la Recherche (ANR) et l'Université de Lyon,

Ci-après désignée par la « **Convention de financement** »,

Vu le règlement relatif aux modalités d'attribution des aides au titre de l'appel à projets « Initiatives d'excellence » du premier Programme d'Investissements d'Avenir et de l'appel à projets IDEX/I-SITE du deuxième Programme d'Investissements d'Avenir, en date du 1er décembre 2017,

Ci-après désigné par le « **Règlement financier** »,

Vu le dossier déposé et la décision du Comité exécutif de l'IDEXLYON en date du 26 juin 2018,

Vu la convention de site 2016-2020 signée avec le CNRS le 26 juin 2018,

Entre

L'Université de Lyon,

Etablissement Public à Caractère Scientifique, Culturel et Professionnel,

Dont le siège est situé 92 rue Pasteur - CS 30122 – 69361 LYON cedex 07,

N° SIRET 130 021 363 00010, Code APE 85.42Z,

Représentée par son Président, Monsieur Khaled BOUABDALLAH,

Ci-après désignée par « **UdL** »,

D'une part,

Et

L'Université Lumière – Lyon 2,

Etablissement Public à Caractère Scientifique, Culturel et Professionnel,

Dont le siège est situé 86 rue Pasteur - 69635 Lyon cedex 07,

N° SIRET 196 917 751 00014, code NAF 803Z,

Représentée par sa Présidente, Madame Nathalie DOMPNIER,

Ci-après désignée par « **UL – Lyon 2** »,

Et

L'Université Claude Bernard – Lyon 1,

Etablissement Public à Caractère Scientifique, Culturel et Professionnel,

Dont le siège est situé 43 boulevard du 11 novembre 1918 - 69622 VILLEURBANNE Cedex,

N° SIRET 196 917 744 00019, code NAF 85.42Z,

Représentée par son Président, Monsieur Frédéric FLEURY,

Ci-après désignée par « UCBL »,

D'autre part,

Ci-après désignées collectivement par « les Parties » ou individuellement par la « Partie ».

L'UL-Lyon 2 et l'UCBL sont ci-après désignés collectivement par « Etablissements gestionnaires ».

ETANT PREALABLEMENT EXPOSE QUE :

Dans le cadre des programmes Investissements d'Avenir (PIA), l'UdL a proposé le projet IDEXLYON en réponse à l'appel à projets Initiatives d'excellence, dit IDEX. Le projet a été retenu par l'Etat, en février 2017, donnant l'autorisation à l'ANR de contractualiser sur le projet, dans le cadre de l'action « Initiatives d'excellence ».

Le Comité exécutif IDEX a lancé le 18 décembre 2017 un appel à projets visant à recruter sur le site des scientifiques de haut niveau en leur donnant des moyens significatifs pour développer leur programme de recherche, environner leur installation et leur permettre de structurer une équipe en vue d'une implantation durable sur le site à l'issue de trois années du soutien IDEXLYON.

En date du 26 juin 2018 le Comité exécutif de l'IDEXLYON a retenu le Projet intitulé « *Variation, Change and Complexity in Linguistic and Health-related Behaviours (V2C) Variation at all levels: from genes to language universality, complexity and diversity* » porté par Monsieur Dan DEDIU, responsable scientifique du Projet, et lui a attribué un soutien de 1 195 822,00 € (un million cent quatre-vingt-quinze mille huit cent vingt-deux euros) pour sa réalisation, ci-après désigné par « PROJET ».

IL EST CONVENU CE QUI SUIT :

ARTICLE 1 : Objet

La présente convention et ses annexes ont pour objet de définir les conditions de reversement par l'UdL aux Etablissements gestionnaires d'une partie de la subvention ANR perçue au titre de l'IDEXLYON pour le financement du PROJET ainsi que les conditions d'exécution du PROJET.

La convention définit les rôles de l'UdL, des Etablissements gestionnaires et du responsable scientifique.

ARTICLE 2 : Rôle de l'UdL

L'UdL est l'Etablissement coordonnateur. A ce titre, elle porte la responsabilité académique et est l'interlocuteur privilégié de l'ANR pour les aspects administratifs et financier.

L'UdL est destinataire des crédits ANR destinés à la mise en œuvre du Projet et elle assure la coordination de la stratégie globale du PIA (Programme d'Investissements d'Avenir) sur le site Lyon Saint-Etienne.

ARTICLE 3 : Rôle des Etablissements gestionnaires

L' UL – Lyon 2 et l'UCBL sont les Etablissements gestionnaires. A ce titre ils s'engagent à :

- accompagner la mise en œuvre du PROJET ;
- ce que les sommes versées selon les modalités prévues à l'article 8 soient exclusivement dédiées au PROJET tel que décrit dans l'annexe 1 et selon le budget joint en annexe 2 ;
- assurer le suivi administratif et financier du PROJET ;
- informer le plus rapidement possible l'UdL de toute difficulté de gestion de leur part du Projet et de tout changement concernant leur situation (ouverture d'une procédure collective, changement de coordonnées bancaires,...) ;

- fournir à l'UdL, dans un délai de trente jours ouvrés après demande écrite, tous les éléments en leur possession permettant de répondre aux éventuelles demandes de l'ANR concernant le PROJET.
- réaliser le PROJET dans les délais définis à l'article 10 de la présente convention, et en cas de difficultés dans le respect de ces conditions, ils s'engagent à en informer l'UdL le plus rapidement possible ;

ARTICLE 5 : Rôle du Responsable scientifique

Le Responsable scientifique du Projet est Monsieur Dan DEDIU. A ce titre il s'engage à :

- mettre en place le PROJET, tel que décrit dans l'annexe 1, au sein du Laboratoire Dynamique Du Langage (DDL UMR 5596) et de l'EA HESPER de l'Université Lyon 1
- participer aux réunions de suivi du PROJET et aux opérations de communication organisées par l'UdL ;
- suivre le PROJET et produire les rapports scientifiques sur demande des Etablissements gestionnaires ou de l'UdL ;

Monsieur Dan DEDIU devra réaliser son PROJET pendant la durée mentionnée à l'article 10 ci-dessous. La non réalisation du projet entraînera la résiliation de la convention telle que prévu à l'article 11 ci-dessous.

ARTICLE 6 : Accord de consortium

Toutes les clauses de l'Accord de Consortium conclu conformément à la Convention de financement s'appliqueront au PROJET.

ARTICLE 7 : Communication

Toutes les publications et les communications réalisées dans le cadre du PROJET devront faire apparaître la mention suivante : « Ce travail a été réalisé grâce au soutien financier du Projet IDEXLYON de l'Université de Lyon dans le cadre du Programme Investissements d'Avenir (ANR-16-IDEX-0005) ».

ARTICLE 8 : Modalités financières

8.1 : Montant du soutien

L'UdL s'engage à reverser aux Etablissements gestionnaires le montant de l'aide allouée au titre du PROJET soit la somme maximale de 1 195 822,00 € (un million cent quatre-vingt-quinze mille huit cent vingt-deux euros).

L'aide allouée n'entre pas dans le champ d'application de la TVA conformément à l'article 4.4 du Règlement financier.

8.2 : Répartition du financement

L'UdL s'engage à verser aux Etablissements gestionnaires les sommes correspondantes aux dépenses éligibles selon le Règlement financier. La répartition prévisionnelle de la contribution de l'UdL par Etablissement gestionnaire est décrite en Annexe 2.

8.2.1 – Modalités des versements à l'UL-Lyon2

L'UL – Lyon 2 percevra 3 versements :

- **Un premier versement** à signature de la présente convention d'un montant de 283 712,40 € (deux cent quatre-vingt-trois mille sept cent douze euros et quarante centimes) sur présentation d'un appel de fonds libellé de la façon suivante « *convention IDEX/FEL/2018/04 – part UL-Lyon 2 - 1er versement* ».
- **Un deuxième versement** d'un montant de 283 712,40 € (deux cent quatre-vingt-trois mille sept cent douze euros et quarante centimes) à compter du 29 février 2020 sur présentation par l'UL – Lyon 2 :
 - o d'un rapport d'avancement ;
 - o d'un relevé de dépenses intermédiaire signé par l'Agent comptable de l'UL – Lyon 2 ;
 - o d'un appel de fonds libellé de la façon suivante « *convention IDEX/FEL/2018/04– part UL-Lyon 2 - 2^{ème} versement* ».
- **Le versement du solde** d'un montant maximal de 141 856,20 € (cent quarante-et-un mille huit cent cinquante-six euros et vingt centimes) sur présentation par l'UL – Lyon 2 :
 - o d'un rapport scientifique final ;
 - o d'un relevé final consolidé des dépenses signé par le représentant légal et l'Agent comptable de l'UL – Lyon 2 ;

- d'un appel de fonds libellé de la façon suivante « *convention IDEX/FEL/2018/04 – part UL-Lyon2 - versement solde* ».

8.2.1 – Modalités des versements à l'UCBL

L'UCBL percevra 3 versements :

- **Un premier versement** à signature de la présente convention d'un montant de 194 616,40 € (cent quatre-vingt-quatorze mille six cent seize euros et quarante centimes) sur présentation d'un appel de fond libellé de la façon suivante « *convention IDEX/FEL/2018/04 – part UCBL - 1er versement* ».
- **Un deuxième versement** d'un montant de 194 616,40 € (cent quatre-vingt-quatorze mille six cent seize euros et quarante centimes) à compter du 29 février 2020 sur présentation par l'UCBL :
 - d'un rapport d'avancement ;
 - d'un relevé de dépenses intermédiaire signé par l'Agent comptable de l'UCBL ;
 - d'un appel de fonds libellé de la façon suivante « *convention IDEX/FEL/2018/04 – part UCBL - 2^{ème} versement* ».
- **Le versement du solde** d'un montant maximal de 97 308,20 € (quatre-vingt-dix-sept mille trois cent huit euros et vingt centimes) sur présentation par l'UCBL :
 - d'un rapport scientifique final ;
 - d'un relevé final consolidé des dépenses signé par le représentant légal et l'Agent comptable de l'UCBL ;
 - d'un appel de fonds libellé de la façon suivante « *convention IDEX/FEL/2018/04 – par UCBL - versement solde* ».

En cas de trop perçu, l'UdL émettra un titre de recettes à l'encontre des Etablissements gestionnaires qui s'engagent à rembourser l'UdL des sommes indûment perçues dans un délai de 30 jours à compter de la réception du titre.

En cas de résiliation (art. 11) et au plus tard dans les trois mois après la date de fin du PROJET ou de la date effective de résiliation, les Etablissements gestionnaires doivent fournir un état récapitulatif des dépenses acquittées couvrant la durée globale du PROJET, validé et signé par leur Agent comptable ainsi qu'un rapport scientifique final.

8.3 Coordonnées bancaires

Les versements se feront sur les comptes bancaires des Etablissements gestionnaires dont les coordonnées sont précisées ci-dessous :

| | | |
|-----------|------|-----------------------------------|
| UL-Lyon 2 | IBAN | FR76 1007 1690 0000 0010 0433 266 |
| | BIC | TRPUFRP1 |

| | | |
|------|------|-----------------------------------|
| UCBL | IBAN | FR76 1007 1690 0000 0010 0433 072 |
| | BIC | BDFEFRPPXXX |

Les versements interviendront dans les 30 jours à compter de la date de réception des appels de fonds qui seront adressées à l'attention du service PIA de l'Université de Lyon, 92 rue Pasteur - CS 30122 - 69361 Lyon cedex 07, sous réserve du versement préalable des fonds par l'ANR à l'UdL.

ARTICLE 9 : Eligibilité des dépenses

9.1 : Période d'éligibilité des dépenses :

Les dépenses éligibles sont celles prévues par le Règlement financier.

Les dépenses sont éligibles du 1^{er} septembre 2018 au 31 décembre 2021 à l'exception des dépenses relatives aux salaires des doctorants qui sont éligibles jusqu'au 30 septembre 2022 et ce, conformément à l'article 5.3.2.1 du Règlement financier.

La date prise en compte est celle du service fait.

Dans le cas où une dépense engagée par les Etablissements gestionnaires au titre de cette convention ne serait pas jugée éligible par l'ANR, les Etablissements gestionnaires s'engagent à reverser la part de subvention correspondant à cette dépense, ainsi que les frais de gestion y afférant, à l'UdL dans un délai de trois mois après que l'UdL en ait fait la demande.

Les Etablissements gestionnaires s'engagent à respecter les procédures de justifications annuelles des dépenses mises en place par l'ANR. L'UdL s'engage à fournir au plus tôt aux Etablissements gestionnaires les informations relatives à ces procédures.

9.2 : Frais de gestion

Les Etablissements gestionnaires pourront faire figurer parmi les dépenses éligibles des frais de gestion selon les modalités fixées par le Règlement financier. Ces frais de gestion devront être inclus dans le budget du PROJET et ne viennent pas en supplément.

Ces frais ont un caractère forfaitaire et sont plafonnés à 8 % du coût total des dépenses réalisées.

ARTICLE 10 : Durée

Le PROJET se déroule du 1^{er} septembre 2018 au 31 décembre 2021.

La présente convention entre en vigueur à compter de sa date de signature et prendra fin le 31 octobre 2022 sous réserve des dépenses éligibles dont les modalités sont définies à l'article 9.1 des présentes.

ARTICLE 11 : Résiliation

Cette convention peut être résiliée par l'une des Parties en cas de non-exécution, par une ou plusieurs Parties, de ses engagements. Cette résiliation ne devient effective que dans un délai de trente jours à compter de la notification de son manquement, par lettre recommandée avec accusé de réception, à toutes les Parties, et après bilan financier des versements effectués et des dépenses justifiées.

ARTICLE 12 : Loi applicable - litige

La convention est soumise au droit français.

En cas de difficulté sur l'interprétation ou l'exécution du Contrat, les Parties s'efforceront de résoudre leur différend à l'amiable par l'intermédiaire de leurs autorités respectives. Au cas où les Parties ne parviendraient pas à résoudre leur différend dans un délai de deux (2) mois à compter de la survenance du différend, notifiée par la partie plaignante aux autres parties, le litige sera définitivement tranché par les tribunaux compétents.



Fait à Lyon, en trois exemplaires, le 10 octobre 2018

Pour l'UdL,

Le Président,
Khaled BOUABDALLAH

Pour l'UL – Lyon 2,

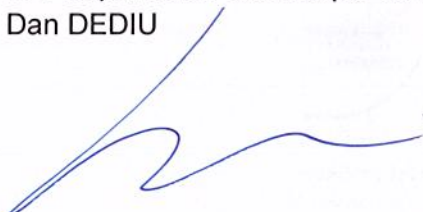
La Présidente,
Nathalie DOMPNIER



Pour l'UCBL,

Le Président,
Frédéric FLEURY

Le Responsable scientifique du Projet
Dan DEDIU



Annexe 1 : Description du Projet

Introduction. Language is one of the most important aspects of our uniqueness and evolutionary success. It is a *complex dynamical system* evolving at the intersection between *culture, society, environment* and *biology* (Dediu et al., 2013; Dediu, Janssen, & Moisik, 2017; Lupyan & Dale, 2016). While the first two are relatively well studied (Lupyan & Dale, 2016; Meyerhoff, 2015) and the third is generating a lot of interest (Everett, Blasí, & Roberts, 2016; Maddieson & Coupé, 2015), the biology of the speakers is usually considered only as a universal factor, identically shared by all “normal” humans (Gick, Wilson, & Derrick, 2013; Ohala, 2005). However, recent advances have uncovered unexpected inter-individual variation at all levels, from the genetic, to the anatomical and physiological, and to the cognitive and psychological, with language perception, learning, processing and production being no exception (Dediu et al., 2017). Based on these insights, my research proposes that *variation* between individuals – *Homo loquens*: the acquirers, users and transmitters of language – is not only a topic of scientific interest, but one without which we cannot understand language, its origins and evolution (Dediu, 2007; Dediu et al., 2017; Dediu & Levinson, 2013). The project proposed here, *Variation at all levels*, will develop this research program in three inter-related directions: (a) variation in the speech organs affects linguistic diversity, (b) dynamic communicative networks are built from non-identical individuals, and (c) inter-individual variation is a driver of linguistic diversity, complexity and robustness.

Background: Inter-individual and inter-group variation. Racism, stereotyping and discrimination (Fredrickson, 2002; Lippert-Rasmussen, 2014) are categorically contradicted by modern science, especially genetics and anthropology (Barbujani & Colonna, 2010; Jobling, Hollox, Hurles, Kivisild, & Tyler-Smith, 2013). Due to our recent origins, migrations and population bottlenecks, we are genetically more uniform than other species (including the great apes), but we are no clones. The bulk of these differences is distributed among individuals from the same group, with relatively little between human populations (even across continents), most of it being gradual, continuous and spread across multiple genetic loci. DNA extracted from past populations helps paint a complex picture of history as a palimpsest, showing overlapping and constant population movements and interbreeding (Hellenthal et al., 2014; Jobling et al., 2013). Thus, there are statistical, continuous and gradual differences between groups in the distribution of quantitative traits, and not the sharp, discrete boundaries that racial classifications try to postulate.

Variation in the speech organs affects linguistic diversity. There are currently about 7,000 languages (Hammarström, Forkel, Hasepalmath, & Bank, 2016) differing in many ways, strikingly so in their speech sounds and the rules that govern them (Moran, McCloy, & Wright, 2014) – the domains of *phonetics* and

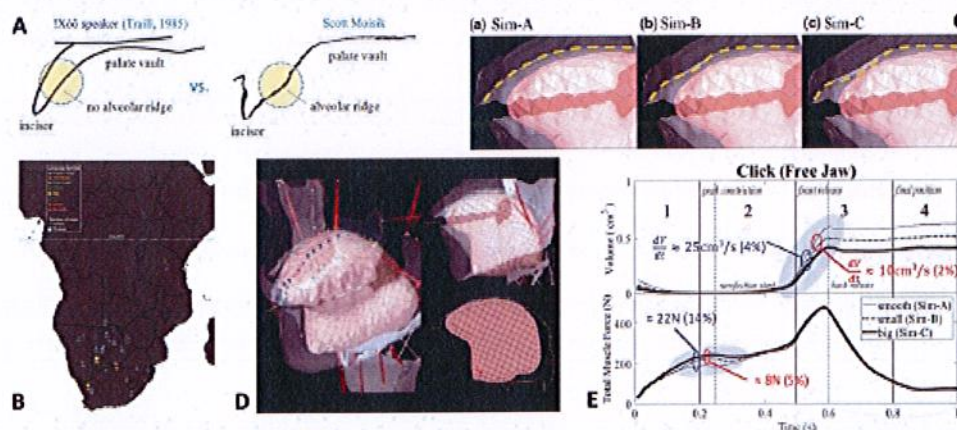


Figure 1. Biomechanical modelling of the influence of the anterior hard palate (the alveolar ridge) on click production. Panel (A): alveolar ridge size for a click language speaker and a Canadian of European descent. Panel (B): distribution of click languages in Africa with number of clicks. Panels (C) and (D): three alveolar ridge size conditions and a frame from the simulated articulation of a click. Panel (E): main results showing that a smaller alveolar ridge results in better volume change (proxy for acoustics) and less overall muscle effort (Moisik & Dediu, 2017).

phonology. I have proposed that one explanation for this diversity may be the statistical, metric, gradual variation between individuals and populations in the *anatomy of their speech organs* (Dediu et al., 2017), including structures such as the larynx (or the voice box), the lips, the tongue, the hard palate (the bony roof of the mouth) and the soft palate (or the velum). During my *Genetic biases in language and speech (G[a]bils)* project (2012-2017), funded by the Netherlands Organisation for Scientific Research (NWO), we used MRI and high-resolution 3D intra-oral optical scans in 90 participants from four geographical populations, to show that there is variation in almost every aspect of the speech organs (Dediu & Moisik, submitted; Moisik & Dediu, 2018). We have shown that some of this variation may affect the successful articulation of several speech sounds between our participants, including the click consonants – famously restricted to some indigenous languages of southern and eastern Africa (Dediu, Moisik, & Levinson, in preparation; Moisik & Dediu, 2018) and the North American “r” (Dediu & Moisik, submitted). Using a complementary approach, we built a realistic biomechanical 3D model of speech production in ArtiSynth (Lloyd, Stavness, & Fels, 2012), which shows that the shape of the anterior part of the hard palate influences the muscle effort needed to articulate clicks (Moisik & Dediu, 2017) and that the way the lower and upper jaw meet (the “edge-to-edge bite”) affects the production of sounds such as “f” and “v” (Blasi et al., under revision). Based on a widely-used computer model of the speech organs that can also produce actual speech sounds (VocalTractLab 2.1; (Birkholz, 2013)), we developed a mathematical model of the shape of the hard palate with Bézier curves (Janssen, Moisik, & Dediu, 2018) and we showed that variation in hard palate shape subtly affects the articulation of vowels, effects that are nevertheless amplified by the repeated use and transmission of language across generations (Janssen, 2018). Finally, through collaborations with archeologists, we have shown that we can reconstruct aspects of the hard palate and lower jaw in historical populations from their archeological remains (Baetsen, 2016; Bosman, Moisik, Dediu, & Waters-Rist, 2017), and we are currently collaborating with geneticists to uncover, in large samples of more than 3,000 participants, the genetic and developmental bases of normal variation in the speech organs.

During the *Variation at all levels* project, I will expand on this cross-disciplinary work, as follows. (1) building on my previous experience, I will streamline the experimental design to allow the collection of data on anatomical variation and speech production in samples of hundreds of participants, allowing us to reach the statistical power

needed to clearly quantify the weak influences of anatomy on speech we expect to exist. (2) I will investigate a wider class of non-native speech sounds using a learning-to-criterion paradigm, that should allow a much better transfer of our results to actual language acquisition. (3) I will improve the biomechanical and geometric computer models, allowing finer anatomical, articulatory and acoustic details, coupled with the much better simulation of the

actual communicative behavior of humans (described in the next section). (4) I will continue and expand the investigation of the genetics and development of the speech organs in larger samples, and also investigate changes later in life, especially due to the normal and pathological aging. (5) anatomical variation is but one non-linguistic factor affecting language, and I will connect this to other such factors, including the physical environment. Subprojects (1–3) will build on my existing network of international

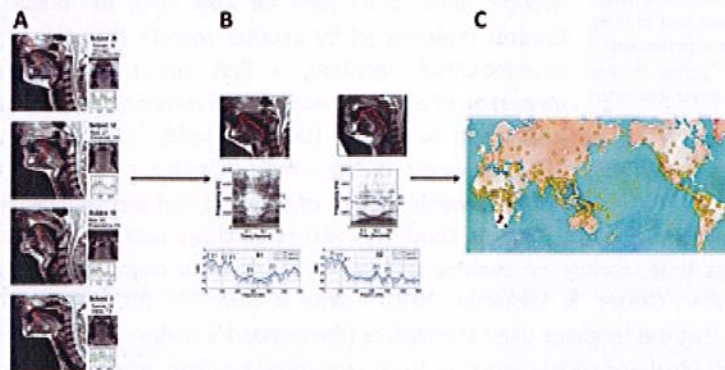


Figure 2. From inter-individual variation in VT anatomy to cross-linguistic diversity. The ubiquitous variation in VT anatomy between speakers (panel A) is not fully compensated, resulting in slight articulatory and acoustic effects (panel B) that can be either directly picked up and reinterpreted by hearers/acquirers or indirectly affect sound change by altering patterns of co-articulation. These processes of differential sound change may lead, across generations, to a patterned distribution of linguistic diversity. For details see (Dediu et al., 2017; Moisik & Dediu, 2017, in preparation).

collaborations, involving mainly Dr. Scott Moisik (Linguistics and Multilingual Studies, Nanyang Technological University, Singapore), Prof. Didier Demolin (Laboratoire de Phonétique et de Phonologie, Paris 3), the Max Planck Institute for Psycholinguistics (MPI) and the Donders Institute, in Nijmegen, but also local collaborations with the Laboratoire Dynamique du Langage (DDL), the Institut des Sciences Cognitives Marc Jeannerod, and the Faculté d'Odontologie, University Claude Bernard Lyon 1. Subproject (4) will build on my collaborations with the MPI, Donders Institute and the Cognomics Project in Nijmegen (especially Prof. Simon Fisher and Dr. Clyde Francks), the Vrije Universiteit (VU) Amsterdam (Prof. Dorret Boomsma), Dr. Susanne Fuchs (Leibniz-Zentrum Allgemeine Sprachwissenschaft in Berlin) and Prof. Peter Birkholz (Institute of Acoustics and Speech Communication, Technische Universität Dresden), and I will also investigate new collaborations with centers in France and Europe. Subproject (5) will be a close collaboration with DDL (especially Dr. François Pellegrino and Dr. Christophe Coupé), but also Prof. Balthasar Bickel, Dr. Steve Moran and Dr. Damian Blasi (University of Zürich), Prof. Gerhard Jäger and Dr. Christian Bentz (University of Tübingen), among others.

The amplification of linguistic biases in heterogeneous, dynamic and structured communicative networks.

The kind of variation in the speech organs discussed above may affect spoken language by generating *biases* for or against certain speech sounds. However, such biases may emerge from other properties of the speakers and hearers. These biases are usually weak and must be *amplified* to become manifest at

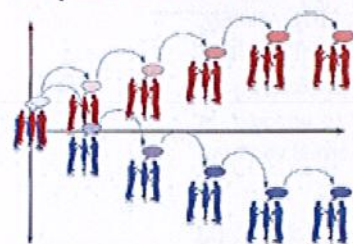


Figure 3. Weak bias amplification by repeated language use and acquisition. Highly simplified depiction of a weak bias present at different frequencies in two populations (red vs blue), that might be amplified across generations. It affects language change and “pushes” the two languages towards different states that reflect the variation in bias. If the bias is shared by all humans, it results in universals and universal tendencies (Dediu, 2011; Dediu & Ladd, 2007).

the level of the language, depending on processes and properties of whole communicative networks and speech communities. A personal anecdote (Levinson & Dediu, 2013) might help: despite having had some speech therapy as a child, I still cannot produce the alveolar trill [r] (as in Spanish or Scottish English) that is the standard of my native Romanian, instead using a postalveolar approximant [ɹ] (that sounds like the North American English “r”); while the frequency of such deviant speakers like myself is low, what would “our” frequency, social status and position in the communicative network need to be (and for how long) to “nudge” Romanian towards replacing [r] by another sound? Thus, given a bias with inter-individual variation, a first approximation concerns the proportion of biased individuals in a community for the community’s language(s) to change (Dediu & Ladd, 2007; Levinson & Dediu, 2013). However, reality is more complex, as linguistic communities are not shapeless pools of speakers, but are structured as *dynamic*

networks with node-level properties (such as centrality) and *connectivity patterns* (e.g., being small-world), varying across time, containing evolving communities and echo chambers (Aggarwal, 2011; Fagyal, Swarup, Escobar, Gasser, & Lakkaraju, 2010; Holme & Saramäki, 2013; Zollo et al., 2015). Moreover, I propose that the language users themselves (the network’s nodes) are not interchangeable units, but differ in individual and social properties (such as working memory, anatomy of speech organs, and social status) that interact and affect language change (Dediu & Moisik, submitted; Hickey, 2003; Yu, 2013). Complementing a long tradition in sociolinguistics (Milroy & Milroy, 1985) and innovation spread (Valente, 1995), modern network theory (Newman, 2010) has recently been applied to big data generated by social networking platforms, such as Facebook and Twitter (Aggarwal, 2011; Kadushin, 2012). Moreover, there is a growing literature on weak bias amplification, computationally (Dediu, 2008, 2009; Thompson, Kirby, & Smith, 2016) and experimentally (S. Kirby, Cornish, & Smith, 2008), but combining individual-level biases and network-level properties has received little attention (Dediu, 2009; J. Kirby & Sonderegger, 2015), and almost none to also considering inter-individual variation (Dediu et al., 2017; Kemp, Perfors, & Tenenbaum, 2007).

Within the *Variation at all levels* project, I aim to build a multidisciplinary framework that integrates the inter-individual variation between language users with the communicative network in which language is used, framework which may advance our understanding of one of the most fundamental problems in modern linguistics, namely how and why languages change (Sóskuthy, 2015; Yu, 2013). There are three broad classes of independent variables to consider: *network structure* (such as connectivity patterns and node degree distribution), *node heterogeneity* (the way biases differ among nodes), and *temporal dynamics* (in both structure and node heterogeneity). There are also three dependent, emergent network-level properties, concerning the spread, the patterning and the temporal dynamics of the effects of the biases. And I propose to use three complementary approaches: computer simulations, computational and statistical analyses of large datasets, and controlled experiments with human participants. Importantly, these questions, methods and results are very general, given that many types of information spread in networks, including health behaviors (Centola, 2010), happiness (Fowler & Christakis, 2008) and terrorism (Medina, 2014). Simulations are excellent for complex problems, and I will use agent-based models where agents capable of acquiring and using languages have biases and other properties (such as status) that can be precisely controlled, and these agents interact and communicate with each other through a (static or dynamic) network. Thus, we can compare random graphs with more realistic network topologies inspired from real data (scale-free, small-world, loosely-connected communities and hubs). We will build on my previous experience with agent-based modelling of populations of biased language users (Dediu, 2008, 2009), of agents with realistic models of the speech organs that produce speech (Janssen, 2018; Janssen et al., 2018), and on the ongoing collaborations with Dr. Bill Thompson (Computational Cognitive Science Lab at UC Berkley) and Dr. Christophe Coupé (DDL). The analysis of large data generated by online social networking platforms (such as Twitter and Facebook) and mobile carriers (among others), might offer invaluable insights into the amplification of biases, in language and beyond; here, I envisage close collaborations with the [SoSweet project](#) (an interdisciplinary ANR project studying synchronic variation and diachronic evolution of French on Twitter led by Lyon; ICAR). Finally, we will use experimental investigations, inspired from the iterated transmission and interpersonal interaction in language (Tamariz & Kirby, 2016) and social psychology (Martin et al., 2014), but focusing on the structure and heterogeneity of the communicative network: we will use artificial languages with well-defined biases, while manipulating the communicative network's size, structure and the placement of the biased nodes. Together with Limor Raviv (MPI Nijmegen), Dr. Shiri Lev-Ari (Royal Holloway, University of London), Dr. Tomas Lehečka (Universität Basel) and Dr. Bill Thompson (Computational Cognitive Science Lab at UC Berkley), I have designed a pilot project to investigate the feasibility of such designs, and I am exploring the possibility of running it at the DDL. I will also interact with the group in Edinburgh that pioneered the iterated learning paradigm, especially Prof. Simon Kirby, Dr. Kenny Smith, Dr. Jennifer Culbertson and Dr. Monica Tamariz.

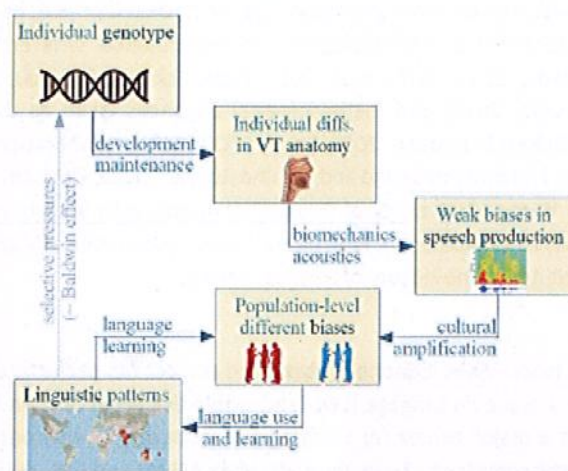


Figure 4. Establishing causality across levels, timescales and scientific disciplines. The complex causal chain and feedback loops connecting human genetics to cross-linguistic diversity and involving (here) molecular genetics, developmental biology, phonetics, historical linguistics and typology, among others (Dediu, 2017; Dediu et al., 2017).

Linguistic diversity, complexity and robustness: issues in the inference of causality. Recognizing variation was probably Darwin's most fundamental insight that revolutionized biology, and we might be now in the midst of a similar shift within the language sciences. My suggestion is that *variation at all levels*, from utterance-to-utterance to between individuals to between languages, will allow us to better explain not

only how languages differ, but also their shared properties, including their robustness and complexity. I suggest that precisely because language must ensure efficient communication in face-to-face interactions (Pellegrino, Coupé, & Marsico, 2011), in ambiguous, complex and noisy contexts (Dingemanse et al., 2015), bridging gaps between mental representations (Dor, 2015) and individuals (Dediu et al., 2017) in varying environments (Everett et al., 2016), language has adapted and evolved strategies to increase its resilience. As in the biological world, this resulted in *modular, canalized, plastic, complex and diverse* systems. During the project, I will explore these issues theoretically (building on insights from evolutionary biology and linguistics), statistically (by analyzing the distribution of linguistic complexity and its determinants), and experimentally (through computer models and artificial language learning studies). I have used (and created) databases and statistical methods to understand various aspects of linguistic diversity (Dediu, 2011, 2018; Dediu & Cysouw, 2013; Dediu & Ladd, 2007; Dediu & Moisik, 2016), and I am currently collaborating with Dr. François Pellegrino and Dr. Christophe Coupé (DDL) on analyzing a large cross-linguistic database pertaining to linguistic information transmission rate, putting the bases for future studies. This direction brings together the other components of the project, and raises fundamental questions about establishing causality in such multi-disciplinary and multi-level settings, where we must rigorously and convincingly connect genetics, development, environment, society, culture and language, while considering methodological and philosophical differences between the scientific disciplines involved (Dediu, 2017; Dediu et al., 2017; Ladd, Roberts, & Dediu, 2015). I will integrate both theoretical (Illari & Russo, 2014) and methodological advances (such as directed acyclic graphs and Bayesian networks; (Nielsen & Jensen, 2009; Pearl, 2000)) with collaborations with experts in linguistic complexity (such as Dr. François Pellegrino and Dr. Christophe Coupé, DLL), Dr. Kenny Smith (University of Edinburgh), Dr. Bodo Winter (University of Birmingham), and with evolutionary thinkers such as Prof. Kevin Laland (University of St. Andrews), Prof. Peter Turchin (University of Connecticut), and Prof. Jürgen Renn (Max Planck Institute for the History of Science, Berlin).

Local insertion in the Lyon – Saint-Étienne context. The project fits perfectly within the research agenda of the laboratoire Dynamique du Langage (DDL) and within the wider academic environment in Lyon and in France. The DDL is a major center for studying the influence of environmental factors on linguistic diversity and of linguistic complexity. Lyon, through Labex ASLAN and DDL, and also initiatives such as IXXI (Institut rhônalpin des systèmes complexes), SoSweet, and the EvoLyon conferences, offers an excellent intellectual environment bringing together expertise in multiple relevant fields. Through my ongoing joint work with Dr. Christophe Coupé and Dr. François Pellegrino, coupled with the EURIAS fellowship at the Collegium de Lyon (since October 2017), I have come to discover and appreciate the vibrant intellectual environment in Lyon, and to identify academic connections in the language sciences and beyond. Among the collaborations I expect to develop, are with the medical sciences (especially maxillo-facial surgery and dentistry, to further the study of vocal tract anatomy and physiology), the Institute Marc Jeannerod (neuro-cognitive variation in language processing), and the study of social networks (IXXI, SoSweet).

Of note is also my involvement with the analysis and processing of *medical and health related data*: my wife, Dr. Alexandra Dima (Marie Curie Postdoctoral Fellow, HESPER, Université Claude Bernard Lyon 1), and myself have developed an *open-source package* ([AdhereR](#)) for the statistical environment R. It implements, in a transparent and open manner, multiple ways of computing and plotting adherence to medication from large databases. Despite its recent publication (Dima & Dediu, 2017), it has generated a lot of interest in the wider community, with several extensions being planned, one Postdoctoral fellow (funded by the Swiss National Foundation) already coming to Lyon (18 months starting in March) to specifically work with us on AdhereR, and several other centers (e.g., in Barcelona, Geneva and Stockholm) expressing interest in well-defined collaborations. This represents an important direction in the health sciences and a potentially very fruitful collaboration between multiple centers in Lyon.

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IDEXLYON Fellowship Project Extension: Health Data Science and Computation

Two of the main goals of the IDEXLYON Fellowship 2018 call are to promote **bridging projects** that bring together several groups and priority directions within the Lyon academic landscape, and to offer incentives for **excellent international scientists** with a track record of initiating, managing and successfully concluding such projects to move to Lyon.

My education and research profile are interdisciplinary *par excellence*, covering from the language sciences, to human genetics and human evolution, and to the health sciences, all connected by a quantitative, data science and computationally-driven approach. These twin goals of IDEXLYON fit perfectly my profile and future plans, and to better highlight this fit, I decided to restructure my initial IDEXLYON project proposal "*Variation at all levels: from genes to language universality, complexity and diversity*" by highlighting the *health data science* and *biomedical* component of my research profile, bringing it to the fore from being only implicitly mentioned in the original proposal.

More precisely, due to my work on the genetic bases of language, its evolution and diversity, I have used methods, concepts and findings from bioinformatics, biostatistics, epidemiology and genetics since at least 2005; this is shown by my publication record (e.g., I wrote the first introduction to genetics for language scientists, and I have publications jointly with geneticists) and by my membership in the Language and Genetics Department at the MPI Nijmegen (headed by Prof. Simon Fisher). During the past three years, this has also included a keen interest in analyzing and exploiting *medical databases/electronic health records* using statistical and computational approaches, which resulted in the *AdhereR* project.

The *AdhereR* project is a joint endeavour with Dr. Alexandra-Lelia Dima that has already produced the first *open source* implementation of a standardized set of procedures for computing the adherence to treatment from electronic medical databases, freely available as a package (<https://cran.r-project.org/web/packages/AdhereR/index.html>) for the widely-used statistical environment R. Due to its success (the initial release of the package in April 2017 was accompanied by a PLoS ONE paper), we already had a researcher visiting us in Lyon in March 2018 to work on making *AdhereR* accessible to STATA users, and we are currently co-supervising a postdoctoral researcher from Basel who is in Lyon (hosted by HESPER/Lyon 1) on a Swiss Science Foundation fellowship grant (March 2018 – October 2019) to explicitly extend *AdhereR* in several strategic directions (including polypharmacy and the temporal dynamics of adherence). In my view, *AdhereR* is much more than the analysis of adherence to treatment but embodies a new, massive data-driven approach to the health sciences, built on the foundations of open science and open source. Moreover, this naturally links multiple

components of the academic landscape in Lyon and builds on an existing working connection I have with HESPER.

Therefore, I propose to make explicit this component of my IDEXLYON Fellowship project through the following:

- The explicit introduction of three positions: a *Senior Research Fellow* (in charge of this component), a *Postdoctoral Researcher* and a *PhD student*; the “language sciences” component has been restructured to include one *Postdoctoral Researcher* and two *PhD students*;
- The explicit introduction of data collection and computational infrastructure sections in the non-personnel budget.

The component will concern the development and implementation of *Clinical Decision Support Systems* (CDSS) based on medical databases/electronic healthcare records, which can be further specified into the development and validation of regimen-specific algorithms, the analysis of decision-making processes in usual care, the integration of algorithms into practice software and the development of interventions to test and adopt these CDSS in the clinical practice. I will personally be directly involved both at a high level (i.e., strategic decisions) and also at the ground level (i.e., co-supervision of the PhD student, statistical analysis and computer code implementation) at the level of 25% of my budgeted project time (the remaining 75% would be dedicated to the “linguistic” component of the project, teaching and other administrative tasks).

I believe that this extension will not only allow me to better express and develop my multifaceted research interests and skills, but also to advance an extremely important and “hot” topic in the health sciences, allowing the Université de Lyon to position itself as a world leader in this fastly advancing and crucially important field. Concretely, this will allow an order-of-magnitude increase in the development of these methods and their faster and more impactful uptake by the relevant actors in the academia, as well as stakeholders from different public and private organisations participating in health care.

Annexe 2 : budget prévisionnel

| Estimated expenditure | Equipment & Operational costs | Personnel | Equipment & Operational costs | | | | Personnel | | | | Location |
|---|-------------------------------|----------------|-------------------------------|--------|--------|--------|-----------|--------|--------|--------|---------------|
| | | | 2018 | 2019 | 2020 | 2021 | 2018 | 2019 | 2020 | 2021 | |
| | Entire period | Entire period | | | | | | | | | |
| IDEX fellow (6600*36 mo) | | 237 711 | | | | | 19 809 | 79 237 | 79 237 | 59 428 | 0 Lyon 2 |
| Senior Research Fellow (6300*30 mo) | | 189 670 | | | | | 0 | 56 901 | 75 868 | 56 901 | 0 Lyon 1 |
| Postdoc 1: phonetics, linguistics, experimental design and data collection (3261*30 mo) | | 97 830 | | | | | 0 | 29 354 | 39 129 | 29 347 | 0 Lyon 2 |
| Postdoc 2: health data science (3261*24 mo) | | 78 266 | | | | | 0 | 9 790 | 39 129 | 29 347 | 0 Lyon 1 |
| PhD 1: computational modelling, data science (2486*36 mo + 2516 extras) | | 92 000 | | | | | 0 | 7 667 | 30 667 | 30 667 | 22 999 Lyon 2 |
| PhD 2: phonetics, experimental design (2486*36 mo + 2516 extras) | | 92 000 | | | | | 0 | 23 000 | 30 667 | 30 667 | 7 666 Lyon 2 |
| PhD 3: health services research (2486*36 mo + 2516 extras) | | 92 000 | | | | | 5 111 | 30 667 | 30 667 | 25 555 | 0 Lyon 1 |
| Research Assistant 1: health services research (1800*6mo) | | 10 800 | | | | | 3 600 | 7 200 | 0 | 0 | 0 Lyon 1 |
| Stagiaire 1: internship computational modelling (14 weeks) | | 2 000 | | | | | 0 | 2 000 | 0 | 0 | 0 Lyon 2 |
| Computer infrastructure, intra-oral scanner, ultrasound | 42 000 | | 0 | 42 000 | 0 | 0 | | | | | Lyon2 |
| | 2 500 | | 1 500 | 1 000 | 0 | 0 | | | | | Lyon1 |
| Data collection costs (e.g. participants, MRI, field trips, other) | 36 200 | | 0 | 9 700 | 18 500 | 8 000 | | | | | Lyon 2 |
| | 35 000 | | 0 | 13 000 | 11 000 | 11 000 | | | | | Lyon 1 |
| Dissemination (conferences 2500*7*3, workshops, open-access publications 3*7*2000, etc) | 57 000 | | 3 000 | 20 000 | 17 000 | 17 000 | | | | | Lyon 2 |
| | 42 265 | | 265 | 15 000 | 13 500 | 13 500 | | | | | Lyon 1 |
| Total Lyon 2 per category | 135 200 | 521 541 | | | | | | | | | |
| Total Lyon 1 per category | 79 765 | 370 736 | | | | | | | | | |
| Total per category | 214 965 | 892 277 | | | | | | | | | |
| Total Lyon 2 | 656 741 | | | | | | | | | | |
| Total Lyon 1 | 450 501 | | | | | | | | | | |
| TOTAL excluding overhead | 1 107 242 | | | | | | | | | | |
| Total overhead Lyon 2 | 52 540 | | | | | | | | | | |
| Total overhead Lyon 1 | 36 040 | | | | | | | | | | |
| TOTAL expenditure | 1 195 822 | | | | | | | | | | |

Adresse de localisation du matériel si achat d'équipement :

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