

Workshop: „Multilingual Brains and Individual Differences: a neuropsycholinguistic perspective“

1. Preliminary programme:

S. Reiterer & J. Festman 14:00-14:15: short introduction to the topic

N. Golestani 14:15-14:45

E. Wattendorf 14:50-15:20

15:20-15:50 COFFEE BREAK

M. Macedonia 15:50-16:20

C.S. Prat 16:25-16:55

QUESTIONS AND PLENARY DISCUSSION 17:00-17:30

N.B. Instead of singular questions after each talk, there should be a more substantial plenary discussion at the end of the whole workshop. The audience will be invited to write down their questions as they arise during the talks on special sheets of paper (prepared by the organizers) and ask these only in the plenary discussion. Usually, a plenary discussion is more lively than single questions asked under time pressure between talks.

2. Abstracts of the invited speakers:

I) **“SFB 833-LECTURE”** (lecture sponsored by the SFB (collaborative research centre of linguistics “the constitution of meaning”, SFB 833 at the University of Tübingen)

“The brain and multilingualism: Individual differences and expertise”

Narly Golestani ^{1,2}

¹ Functional Brain Mapping Laboratory, Dept. Fundamental Neuroscience, University Medical School, Geneva, Switzerland

² Institute of Cognitive Neuroscience, University College London, UK

In previous work on language and the brain in adults, we have shown that there are large normative individual differences in foreign speech sound learning, and such individual differences are accompanied by both functional and structural brain differences. Evidence for structural differences is especially striking since brain structure can be assumed to be more ‘stable’ (i.e. less malleable) than brain function, which can be expected to change, or be ‘plastic’, after only short periods of training / learning. This leads to the question of the relative influences of pre-existing, possibly ‘innate’ brain structural differences between individuals which might predict domain-specific language capacities, and of experience dependent plasticity following systematic differences in learning. In a recent brain imaging study, we found complimentary evidence for both experience-dependent structural plasticity in phonetics experts, and aspects of brain anatomy that likely pre-date the expertise training. We also present longitudinal evidence for experience-dependent plasticity in a different group of language experts: simultaneous language interpreters in training. Our results suggest that *both* pre-existing, possibly innate factors and environment influences (learning) play a role in brain structure and in specific language- related skills, with different relative contributions in different brain areas. More generally, innate factors and the environment likely interact in that the environment itself is partly selected based on genetically influenced preferences.

II) “BRAIN PRODUCTS-LECTURE” (lecture sponsored by “Medizinelektronik (MES)”, Brain Products, München)

FMRI on sentence processing in early and late multilinguals

Elise Wattendorf ^{1,2}

1 Department of Medicine University of Fribourg, Fribourg, Switzerland

2 Department of Neuroanatomy, University of Basel, Switzerland

elise.wattendorf@unifr.ch

Behavioral studies have shown that early acquisition of a second language influences the development of language abilities and cognitive functions. We used functional magnetic resonance imaging (fMRI) to investigate the impact of early bilingualism on the organization of the cortical language network in adults during sentence processing. Two groups of adult multilinguals, proficient in three languages, were tested on a narrative task; early multilinguals acquired the second language before the age of 3 years, late multilinguals after the age of 9. All participants learned a third language after 9 years of age. Comparison of the two groups revealed substantial differences in language-related brain activity for early as well as late acquired languages. Most importantly in early multilinguals activity increased in a left-lateralized, fronto-striatal network but decreased in the supramarginal gyrus. These cortical regions have been previously shown to mediate control functions in bilinguals to avoid interference. Thus, it appears that early bilingual language acquisition changes control functions engaged to manage multiple languages. These findings extend the current understanding of control functions in multilinguals by demonstrating the impact of the early developmental time.

III) “JUNG STIFTUNGS-LECTURE” (lecture sponsored by the „Jung Stiftung für Wissenschaft und Forschung, Hamburg“)

Neural correlates of high performance in foreign language vocabulary learning

Manuela Macedonia^{1,2}

¹ Department of Neuropsychology, Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany

² Magnet Resonance Unit, Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany

Manuela@macedonia.at

Learning vocabulary in a foreign language is a laborious task which people perform with varying levels of success. Here, we investigated the neural underpinning of high performance on this task. In a within-subjects paradigm, participants learned ninety-two vocabulary items under two multimodal conditions: One condition paired novel words with iconic gestures, and the other with meaningless gestures. Memory performance was assessed through single word translation tests. High performers consistently learned more items than low performers, regardless of the training condition, the time and the difficulty of the task. Brain activity measured upon word recognition using fMRI was parametrically related to the behavioural data. High performance correlated with activity in the left angular gyrus (BA 39) and in the right extrastriate cortex (BA 19). These cortical areas mediate integration of information across different modalities as well as memory processes. Thus, high performance in vocabulary learning seems to depend on individual capacities to integrate and associate a word's semantics with sensorial stimuli.

IV) “DE GRUYTER-MOUTON-LECTURE” (sponsored by “Mouton de Gruyter” publishing house, Berlin)

Individual Differences in Language Experience and Working Memory Capacity in the Dynamic Brain

Chantel S Prat^{1,2}

¹ Institute for Learning and Brain Sciences and Psychology, University of Washington, Seattle, USA

² Center for Cognitive Brain Imaging, Carnegie Mellon University, Pittsburgh, USA

csprat@uw.edu

Individual differences in cognitive capacities are present and prevalent throughout the lifespan, and must ultimately be underpinned by differences in brain functioning. Understanding differences in language comprehension abilities involves accounting for complex interactions between individual characteristics, such as language experience and working memory capacity, and task characteristics. My research focuses on the dynamic, network-level properties of brain function, proposing that skilled performance is related to the fluency with which the activity of various brain regions is recruited and coordinated on an “as needed” basis. Such biological mechanisms are proposed to lie at the heart of the fluidity of human thought. During language comprehension, these dynamic mechanisms are manifested in at least three ways: (1) recruitment of the right hemisphere (RH) homologues of dominant left hemisphere (LH) language areas when task demands outstrip the resources available to the LH; (2) network adaptability (changes in cortical activation patterns with changing task

demands); and (3) synchronization of activation between brain areas. My research using fMRI and DTI to investigate the functional and structural underpinnings of reading experience and working memory capacity has shown that these three measures provide characteristic indices of comprehension abilities. More generally, relating various individual differences at the cognitive level to the neural substrate is providing a valuable approach for relating mind to brain.

3. Description of Workshop

“Multilingual Brains”: Individual differences in multilinguals – a neuro-psycholinguistic perspective.

Susanne Maria Reiterer^{1,2}

¹ Centre for Integrative Neuroscience and Department of Neuroradiology

² Centre for Linguistics, Universität Tübingen,

Susanne.Reiterer@med.uni-tuebingen.de

Julia Festman

Otto-von-Guericke-Universität Magdeburg

Institut für Psychologie / Neuropsychologie

Julia.Festman@Nat.Uni-Magdeburg.de

Until now, individual differences in multilingual language acquisition have been largely neglected or even ignored, although already far back in history some individuals (polyglots and hyperpolyglots) demonstrate extraordinary language abilities in the acquisition of all or some of the subsystems of language (e.g. phonological, semantic, lexical, syntactic domain). However, maybe due to the technical advances in imaging techniques (for example, functional magnetic resonance imaging, fMRI; Electro- and Magneto-encephalography, EEG+MEG), and growing interdisciplinarity within the “cognitive sciences”, individual differences in multilingual language acquisition, or put differently, “multilingual brains” recently started to attract more and more attention.

Although more studies were conducted on multilingual participants, their grouping and descriptions and consequently the findings could not entirely satisfy linguists who had tried to characterize multilinguals on many levels based on information from language acquisition history, language backgrounds, current language use, language proficiency tests, etc. To give just one example, multilinguals are not necessarily bilinguals, but much of the imaging literature uses bilinguals as an umbrella term for speakers of more than one language (ignoring the fact that more languages might be mastered, even at a very high level of proficiency and have a strong impact on language processing).

This colloquium has the aim of bringing together second language acquisition researchers from linguistic backgrounds and brain researchers of “Bi- and -Multilingualism” who are working within the framework of a neuroscientific background.

The papers in this colloquium will present cutting-edge research on the topic of individual differences of multilinguals, which have been observed in age of onset, proficiency level in different language skills and language components (e.g. lexicon, syntax, etc.), aptitude, executive functions, exposure/experience, manner of acquisition, etc. The papers will make use of a variety of techniques to address this question, such as fMRI, EEG. General introductions to imaging techniques will be provided and papers will be presented in a way that the “general” audience (without specific imaging methodology background) will be able to easily follow the talks and understand the findings.

We believe that good neuroscientific studies on “multilingual brains” need to take into account current findings on individual differences of multilinguals and best include

researchers on multilingualism for example to give advice regarding the different crucial factors to be considered in subject selection/matching and stimulus material as well as contribute to the theoretical implications of the findings for multilingualism from a linguistic point of view. Thus, this workshop aims at bringing together both researchers on multilingualism as well as brain scientist interested in the processing mechanisms of a multilingual brain. A platform for exchange of knowledge as well as concerns should be provided in this workshop with the intention to further the understanding of the workings of both sides as well as to unify the terminology and concepts.