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How a passionate for linguistics struggled with and exploited such things as synapses, mismatch negativity, magnetic field, source, plasticity, fMRI, etc: Diaries from the 2017 Helsinki summer school of Auditory Cognitive Neuroscience

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Abstract

Although I knew that accounts on bilingualism, language transfer and second language acquisition would need to base on neurological footing for a holistic treatment, my desire to go for a neuroscience course was more motivated by curiosity about the brain as modular entity. Even though I tried to enter the course with a linguistics tabula-rasa, the whole set of my linguistics expertise was being activated and referred to, not only as I found the neuroscience stuff explanatory, but as I got to know that the brain per se sounds language-determined. This article shares my learning experience at the 2017 Helsinki summer school of auditory cognitive neuroscience, held from 8th to 19th August. In so doing, a modified and polished version of the diaries I drafted is laid out. The diaries inform mainly of what I found uncharted, interesting or surprising, and relevant to my area of expertise.

Keywords: Neuroscience; brain research methods; source distribution; auditory stimuli; bilingualism; magnetic resonance.

Introduction

The course consisted of seven lectures and five lab demonstrations of brain research methods. The lectures were meant to consolidate and familiarize with conceptual prerequisites. Generally, lectures revolved around two core points: First, the scope, operation and principles of brain methods and, second, the correlation between a number of variables, such as language development and musical training; auditory impairment and language disorder; plasticity and the generation of magnetic field. It is also worth noting that lectures implied allegiance for the practice of informing language research via capturing neural activity when responding to auditory stimuli. Participants were given pre-material to read for discussion at the openings of lectures. Two poster sessions were devoted for participants to discuss their current or future research with diverse degrees of relatedness to the truck of auditory cognitive neuroscience. As students from diverse disciplines were made eligible to the course, the class contained students from the domains of neuroscience, psychology, linguistics, music, etc. As an assessment policy, course organizers asked participants to submit a diary for each lecture and lab visit. It was emphasized that the diaries do not provide a summary of sessions but reflect what students find interesting, surprising, and relevant. The diaries were made accessible for comments through MOODLE learning platform.

Diary 1 (first brush)

Lecture: Introduction to brain research methods (part 1)

I expected some background on neuroscience as a way to establish common reference, especially that applicants possess relative knowledge and expertise on the field as we come from different specialties. That is why I think that the presentations were a bit abrupt. There seems to be a lack of contextualizing within a thematic context. The status quo of brain research should have been linked to previous principles so that one perceives and examines the changing trends and convictions. I might say this is central as it allows to reflect on whether current neuroscience adds novel ideas or just verifies assumptions which could not be verified in the past. Although I am novice in this level of neuroscience, I could presume several assumptions.

Source and sensitivity distribution appear central issues in the field as they embody the state of current reception and as they embody significant markers of signals. Another important issue seems what kind of source is likely to create magnetic field. What I liked most about the lecture is that it informs about several relations between several variables: location and strength of the source; use of reference electrode, noise level, and current strength as caused by postsynaptic potential. At the same time, many questions came to my mind: Why is sensitivity concentrated under the sensor? Is having a strong source the only reason why a signal can be revealed? What are the brain areas in which we can see signals most and why?

Diary 2

Lecture: Introduction to brain research methods (Part 2)

Because the lecture is about brain research methods, I expected an in-depth analysis into common scrutiny in the field. I can say this lack of precision in terms of what to search and how to search it is what has been rendering the field of neuroscience less goal-oriented. Currently, this practice might have included a review of some research questions that triggered a method or are relevant to a specific method. I say this because I firmly believe that it is the quest for a given knowledge that shaped research instrument or method. I also believe that some methods have to be linked to a specific scope or specific informative potential (Dornyei, 2007). Besides pertaining mainly to the operation of research methods, the lecture emphasizes two points: First, the creation of magnetic resonance and, second, the current-magnetic field reciprocity. But the latter point, while apparently interesting, was not further elaborated. What is it that creates this relation? Can this dynamism be altered? Adding to this, I guess it would have been better if the lecturer further demonstrated or illustrated how the research methods are deployed to address specific research questions, for this would position research scope and interest, and help researchers critically build on previous research.

Diary 3

Lecture: Methodologies in developmental music studies

I was very eager about this lecture as I wanted to know its relevance to the entire course, especially that I was unaware of the correlation between music and language ability. I was expecting an account on the brain activity involved in responses to musical stimuli, but I then realized that what triggered this talk is the common ground between musical ability and linguistic one. For this, I say that the lecturer should have reasserted this banality. This practice applies to other lectures, where it was not clear how relevant a given talk is to the general title of the course. It was very interesting to know, first, that music is not restricted to instruments use and, second, that parental speech can be very effective for enhancing musical ability. This brings me back to Stephen Krashen's theory of second language which predicates on the effectiveness of parental speech to devise an approach where a language teacher is supposed to have the same interactive and corrective behavior characteristic of parental interaction with children during the process of acquiring mother tongue (Krashen 1981, 1982, 2013). Since musicality associates, here, with change and variation in patterns, I will try to understand what makes a sequence of sound more musical than the other.

Diary 4

Lecture: Auditory neurocognition and its development

This was a lecture where I could activate a lot of prior knowledge as I am into the issue of mother tongue influence on second language learning. Interestingly, the lecturer gave evidence for an infant's ability to differentiate between the sound clusters of his mother tongue and those of another language. This does reassert the idea that mother tongue influence is an issue that warrants attention in linguistics and language pedagogy (Odlin 1989; Cordor; 1983; Kellerman 1983). I do now have a strong argument for the uniqueness and deeply rooted nature of mother tongue system as compared to whatever language system. The infant's sensitivity to mother tongue sounds can be made a case against advocates of comparability between mother tongue and second language (see Krashen, 1982). It also was interesting for me that crying marks a linguistic difference among infants.

But how can we prove that the acquisition of a crying sequence typical of mother tongue is attributed to the operation of auditory skills during pregnancy? What does this have to do with Chomsky's innateness theory? After all, I tend to treat this ability as a property of first language acquisition, which further reasserts the typical nature of the process and downplays the advocacies positing that first and second languages undergo the same developmental mechanisms.

Diary 5

Lecture: Training the brain with speech and language

I really appreciated the lecture partly because of its informativity and partly because I am into linguistics and psycholinguistics. Frankly speaking, the idea of language tasks as intervention for dyslexia was very attractive for me, especially the account on the link between sound repetition in a second language and the circulation of matters and plasticity in the brain. I was thinking that the audiolingual method of language teaching has an attraction in this sense as it emphasizes repetition and drills. The principles of the method could be exploited in language and brain research. Perhaps a comparison of students taught using drills with another group can say much about the effects of repetition tasks. However, there has to be an assessment of the treatment variable so that difference in the post-treatment can be fairly attributed to that variable. I also learnt that language deficits are mainly attributed to auditory impairments, but this was given insufficient ground in the lecture. How does specific auditory impairment lead to a specific language impairment counterpart? In fact, this made me more aware about the importance of auditory cognitive neuroscience in linguistics and language learning research. Also, the lecture consolidated and refined my previous knowledge about the merits of bilingualism as researched by Ellen Bialystok (see Bialystok 2001; Bialystok & Stephen 2005). I also liked the fact that the lecturer ventured into methodological issues in brain research.

Diary 6

Lecture: Reward and learning in the brain

I was expecting this lecture to tackle the issue of music and language from another perspective. The lecture reasserted some ideas made and postulated in the previous one, namely the correlation between music and the treatment of a given language deficit. Interestingly, I learnt about the link between music and dopamine level. Before this lecture, I had no idea that the decrease in the amount of dopamine can be healed by music. However, the lecturer did not explain this in depth. I could not also understand the motivation behind this sort of intervention. In other words, what are the findings and convictions that have led to the testing of this hypothesis? What I found strikingly interesting is the idea of pleasure and music. Yet, a much more specific account on this seems missing. The fact remains that I will be interested to further explore this relation between pleasure, music, language, and mismatch negativity. My concern, however, is to what extent animal models can be applicable or analogous to humans, especially that human's production and reception of language is arguably unique. How reliable is it to construct hypothesis about music and language on the basis of a model that is essentially different?

Diary 7

Lecture: Speech and music (Part 1 & 2)

This is the most enjoyable lecture—this does not mean others are boring. This is mainly because it offers many insights to my interest in linguistics. It was very interesting for me to know that one more property of human language is the possession of language-related genes. This seems complementary to existing taxonomies of human language which lack this neurological account. This latter, I guess, is pervasive in the distinction between human and non-human language as it entails the remainder of differences. The idea that language does not fossilize makes me more convinced about Chomsky's innateness theory. In addition, it sounds accountable to explain the uniqueness of human language by the need for neural activity and the deeper position of organs. I will be incorporating these insights to my teaching of linguistics. At another level, it was interesting for me to know that activity touches on the frontal lobe when processing speech.

But how can we explain this interrelatedness between neural activity and cognitive functioning? How and to what extent frontal lobe activity affects cortical receptivity? Is this property strong with musicians? Where do we position the variable of affect in auditory cognitive neuroscience? I think that this apparently overriding variable is missing in research.

Diary 8

ANS lab visit

Before the lab visit I was wondering how the practice is linked to the lectures. I was expecting the demonstration to be more guided by purposeful, goal-oriented selection and measurement decisions. I also expected to see models of ANS-based research so that to establish what the measurement is suitable most for. In ANS lab visit we learnt the uses of several measurements, namely the electro dermal activity that is used to assess arousal, surprise, and significance. However, it was not clear why we do this and what enquiry can be satisfied by the measurement. I was thinking that this method can be exploited to investigate whether there are commonalities in responses to speech or newly learnt words as reflected in common or frequent surprise to a given language segments. At the same time, I find a problem in terms of whether to interpret signals as surprise or as significance. Then how similar or analogous is the effect of balloon popping to other effects resultant from unfamiliarity, unexpectedness or significance. Because concepts are overlapping, likelihood of confusion and measurement error seems greater. For this, it seems vital to tighten what signals really mean. This could be done through comparative research, where activity in surprise is, for instance, compared to activity to another variable. The initial group difference could be ensured via a questionnaire or interview.

Diary 9

fMRI lab visit

I came out with the impression that this is one of the highly demanding measurements. We have been shown an example of how to obtain functional magnetic resonance in the brain. It was not clear for me how to exploit knowledge about resonance and its variation in research. I really benefited from the insights about precautions of magnetic treatment, as well as the way in which responses to stimuli are analyzed and interpreted. But does brain activity only manifest in movements or lightings up of cortex? I remember that we were told in one of the lectures that processing is not necessarily reflected in signals because sources may not be strong. How much representativeness one might allocate to fMRI or perhaps to any other method? I might be asking about some banalities in auditory cognitive neuroscience, but those are the questions which come to my mind. I did not get enough understanding about what is specific to the use of fMRI measurement compared to other measurements. Are there some enquiries that can be best conducted with fMRI and not with other methods? Does fMRI help verify some assumptions made on the basis of other methods? What are some identifiable downsides with fMRI?

Diary 10

EEG lab visit

Because of my unfamiliarity with measurements, I was expecting the EEG to be radically different from ANS, perhaps used to measure different things, or specifically designed to answer specific research question. I did not expect to find this variation in terms of electrodes placement or in terms of recording and analyzing data. For this I started to advance that the measurements do either verify or complement each other, where it is not proper to treat a single measure as modular. It is here where I realized the significance of combining methods in brain research. I was not aware of that when mentioned in the lecture about brain research methods. In EEG lab visit we learnt the uses of several electrodes to track signals of responses to auditory stimulus. But how reliable is to trace filters in the data to distracters rather than to an integral part of processing? What is the brain activity associated with specific processing or specific non-processing. How can we judge that processing is or is not taking place? Is there a model for the imaging of specific filters? What are the research questions associated with a given dataset, a given electrode type, or any other specificity in the tools. How can we make a connection between eye tracking and processing in the analyses?

Diary 11

MEG lab visit

I tried to understand MEG with reference to what I saw in fMRI, ANS and EEG. In MEG lab visit we were given a brief introduction into the nature and mechanics of the measurement. I established that Finland is leading in this sort of measurement. What was most interesting for me as a linguist is that the measurement tells how fast something is processed in the cortex. For me this is vital in language and prediction research as it tells how linguistic segments are processed and if processing relates to the structure and shape of the word or to the extent to which a model that predicts the word or the concept is already constructed. The tools and software seem less informative than those in other measurements, which might render MEG-based research less certain. It also seemed that MEG has some overlaps with EEG in the sense that both measurements record and present data in relatively the same way, but the placement of electrodes appears less demanding with MEG. We were informed that, while it is easy to elicit a model or dataset, there is a problem with interpretation and directing the enquiry into an isolated research question. For example, it is not certain what exactly triggers activity in the brain in a reading task given the multitude of possibly interfering variables.

Diary 12

TMS lab visit

I have been so eager to attend the TMS demo as I was wondering how depression can be healed and how changes in perception can be effected through this measurement. This idea of triggering activity to alter perception was very attractive for me. However, the demonstration did not satisfy this level of curiosity, dealing only with recording signals and capturing images. I could not get why, unlike other measurements, there should be three symmetrical landmarks, two on both head sides and one on the nose. This gave me the impression that, perhaps, the link between position and signals is well tightened in this method. That is why, I think, there was no search for which electrode gives signal. We saw a demo of induced electric field of hand movement. The measurement seems quite fitting for bilingualism and processing research given the precise insights it may offer about speed of processing and activity. Reaction to input from different languages, for instance, can tell much about the bilingual or multilingual mind and the neurological basis of cognitive control system. I referred to this connection between language and music, and I was like “this might be of great help to further reassert the music-language analogy, and to verify whether transcending musical training to language is due to transfer or to common ground between the two entities.

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