Reflections on different aspects of interdisplinarity in a research career

Interdisplinarity: where to start?

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Amongst several things that are believed to advance the quality of our education and subsequent career development, „interdisplinarity" has come to be one of the most promoted ideas in academics. Nowadays people from all kinds of profession would likely agree that the diversity of disciplines involved in a field of work is necessary, and mostly an advantage. Having carried out my doctoral research in a similar scenario, and now examining this concept from several perspectives, I will present here my experiences and reflections on this particular idea. Especially of interest are the challenges, the means of overcoming them to facilitate productive work, and the gains after such learning experiences that may be useful or generalizable to any further pursuit. Indeed my experiences and points of view might be limited to my specialization in experimental psychology and cognitive neuro-science (which is itself a knowingly multidisciplinary domain). Nevertheless, I expect that overlapping principles exist in this regard when we talk about any other combination of subjects.

What exactly does it mean to work – or for that matter, to have to achieve anything – in the context of interdisplinarity? A common understanding of „interdisplinarity" is that a project, or a work environment, engages more than one field of topic, and thus more than one field of expertise. This typically entails the collaboration amongst people coming from somewhat different domains of knowledge and training, in the hope that in combining multidimensional expertise, each of them will contribute optimally to a specific part of the task, hence facilitating efficient and satisfactory output. A further benefit expected of such an environment, which is no less important than accomplishing the work itself, is the exchange of expertise amongst the colleagues. This should ideally lead to a synergistic accumulation of knowledge in each person, which could then be applied in subsequent tasks required in other projects. Indeed, in the age of specialization, this is a very attractive idea, although the benefit of interdisplinarity is not achieved without efforts and challenges along the way. In the following sections, I will first introduce briefly the background of my chosen research, followed by the two main different scenarios across disciplines I have encountered during my doctoral research, in which different barriers had to be overcome in order to achieve successful work.

Between Music and Science

To understand human music perception scientifically

I have been engaged in a field of research – cognitive psychology and neuroscience – that can be approached from several different disciplines, ranging from psychology, neurology, computational science, and sometimes even philosophy. It is indeed a field that desirably combines all these aspects of expertise in an attempt to understand how certain behaviors – perception and action – are performed in humans, what principles govern these behaviors, and what underlying neural mechanisms may be involved in the brain. Specifically, I was (and still am, and probably will always be) interested in a specific aspect of music cognition in humans: musical rhythm perception. This choice of topic has understandably originated from my life-long passion for music, one of the great domains of artistic expression that are unique to human. Needless to say, the appreciation of music, as well as the eagerness to understand what it does and how it makes us feel when we listen to it, is shared by many, possibly the majority of human society across all cultures. At first glance it would appear that, by solving the puzzle of human music cognition with an experimental approach, we are cutting between two very distant endeavors: „music", which typically belongs to the domain of art and humanity study, and can not be examined analytically, and „science", which is all about logics, reasoning, and problem solving. However, as humans' relation to music can be examined from many points of view, scientists are, after all, just a branch of those who are in

search of the answer to the same question. They may just intend to share their side of the story, as musicologists or musicians would do.

The communication between music and behavioral science poses one good challenge, especially if you are at home in both. I was trained in cognitive and experimental psychology, which it enables me to approach a perceptual or cognitive phenomenon, such as music perception, in an analytical manner. This entails treating the brain as a kind of computational black-box, which receives input (such as what we see and what we hear) from the outside world. The brain processes the often complex sensory information by means of breaking it down into smaller elements, each of which can then be analyzed, or computed, by certain brain areas before being sent forward for further processing and re-assembling until, as an outcome, our cognition comes to realize what we have perceived. This is of course a simplified illustration of what is really going on in and out of the „black-box", but it gives an idea of how we experimental psychologists habitually approach a phenomenon. In the context of music perception, as in the perception of other complex sensory stimuli, we typically identify several features or parameters that can and should be processed separately in our system, as is also evidenced by neurophysiological studies. This means, for example, the temporal aspect of the music – its rhythm – needs to be investigated separately from the pitch aspect of the music – its melody. Such an approach seems to present a discrepancy to that adopted by a listener, a musician, or even a composer: When a piece of music is created, performed, or listened to, surely both the rhythm and the melody belong to the same total-ity that is meant and perceived as something that is „music" to us. If we took one parameter out and left only the other, what resulted could hardly be recognized as music. As an example: Imagine a Bach fugue piece without its melodic procession, which would then only be a train of repetitive, monotonic notes based on its temporally defined pulse. The other way around would be equally true: The procession of pitches unfolding over time without a defined musical meter to organize their temporal occurrences could rarely be felt as musical to the ears.

Now the reader may start to see the conflict between music and the behavioral science that is applied to investigate music. To understand music as a form of art, which I do every day, it seems rather undesirable to break it down to its components (meter, pitch, amplitude, micro-timing, etc.), and one may even argue that unless all the parameters are combined as a whole, it is not the music as is meant to be, and nor is it the music that we perceive. However, as a cognitive psychologist who strives to understand how humans perceive music as complex auditory input, reasonable experimental paradigms have to be designed in a bottom-up manner, each paradigm targeting a specific and defined parameter in the music that is being processed. As such, an experiment may be designed to investigate exclusively

how – as in the case of my research – the temporal domain of music (i.e., its rhythm) is processed, without regard to the pitch domain (i.e., its melody). Even within the temporal domain, several hierarchical aspects that can contribute to the perception of „rhythm" have to be identified, e.g. pulse, beat, and meter, each of which may be first investigated individually before we proceed to examining their relation with one another. Consequently, the kind of lab-generated auditory stimuli employed in a rhythm test battery typically consist of (short) sequences of very simple tones, in which one of the afore-mentioned parameters is manipulated in a particular way. The result of participants' performance in such a battery would then elucidate how a specific parameter from the stimulus influences our perception of auditory rhythm and in which specific way.

Is it music? Or is it science?

An intuitive and yet valid question can arise from here, challenging the attempt to bridge music and psychology/brain science: How generalizable are such lab-generated settings and its results with regard to a real-life scenario, where music is complex and anything but simple tones? From our own listening experiences, it is hard to agree that music, and thus our perception of it, should be the mere sum of all the components perceived.

I still recall that one of the most frequently asked questions from the participants I recruited in my experiments was the following (or its variations): „Are these stimuli music?" (Indeed, most participants did not readily experience a simple sequence of tones as music.) or „Why do you not use real music in the experiment?" Similarly, when I talked to musicologists or musicians, they had a hard time relating such „sterile" lab stimuli to what they know as music, and thus they repeatedly questioned whether it was „music perception" that was being studied here. As explained in the previous section, simple stimuli instead of complex, real-life music should be employed in an experimental paradigm because it is the reasonable way to pin down specific perceptual mechanisms our system uses to process each specific part of a complex scene. A ready piece of music would encompass more aspects than can be examined at the same time. For example, if we were to take a segment from a Beethoven symphony and a segment from a Brahms symphony in an attempt to compare how we perceive them differently, we would have a hard time making any logical conclusion simply because there are too many variables that differ between these two pieces (or any other two ready pieces), e.g. rhythmic structure, melodic contour, tempo, instruments present at any point in time, loudness, and so on. Thus, any difference in the perceptual outcome may have been a result of some or all of these variables. Then we must ask – a question that is very important in all sciences: what exactly is being studied here that should have an effect on the measured outcome? Without manipulating only one or two specific variables while

excluding the effect of the others, we can not conclude anything from an experiment, and consequently will not advance any understanding of (in this case) music perception.

Our knowledge of how complex visual or auditory scenes are processed should best be gained by adding up pieces of precise and valid findings. Indeed, the logical approach that constitutes the basis of science may appear to contradict the very principle that underlies the meaning of art. This is a barrier shared by cognitive scientists in many domains[1]. And yet, it is the responsibility of a scientist, out of genuine fondness and respect for a certain form of art, to investigate it logically and experimentally. It is the one truthful way to bring forth new knowledge about something as beautiful as music that can be shared by many who enjoy it. For me it has always been this belief – besides my love of music – that drives me forward in my work, the belief that science can unveil certain mysteries and further our understanding about music. Furthermore, when conducted properly and reported truthfully, research in this field may help generate more interest in the population in their appreciation of music. Some might wonder whether examining a musical phenomenon with an analytical eye would destroy its beauty. Quite the contrary, as J. Keats put it, „Beauty is truth, truth beauty". In this regard, science and music do converge, as both are a pursuit of truth.

Between psychology and computational science

The need to understand the computational language (at least a little bit)

Having discussed the challenge in bridging science and music, the topic will now be steered to a different scenario I have experienced and still encounter fairly often: between psychology and computational science. Psychology as a discipline – even when we experimentally investigate human cognition, perception, or action – tends to be bordered between science and humanity. That is, it is typically not considered a „hard science" as one would refer to math, physics, or engineering. The inter-discipline boundaries notwithstanding, such stereotypical classification is somewhat unjustified. Any science that is based on logic and reasoning shares a general common ground with others of the same nature. While the topic

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[1] *The most investigated sensory function belongs to vision. There one could imagine a similar dilemma: A participant performing a task involving some simple colored bars on a computer screen is not likely to relate it to how they watch a video or view a painting. However, the investigated mechanisms serve the bases that contribute to how we process complex visual input in real life.*

and the methodology may differ, the same logic-based principles must always hold. That is, however, not to say that it should be easy to cross the boundary between these disciplines.

Although experimental psychologists are not required to be experienced programmers, more often than not programming skills are a big plus – I am a big advocate for that, speaking from my own experience. If you know to some extent how to make use of certain programming languages, you will get along well with software in which experiments are implemented, and you can also employ similar softwares to carry out data processing and statistical analysis. Programming skill thus makes you flexible and independent in many ways regarding research. That said, I was rather naive and inexperienced at the beginning of my research. It had not occurred to me immediately that this was a skill I should particularly acquire. However, through a collaboration, I got to spend some months in an informatics lab. Perhaps due to the awareness that everybody there, with a background in informatics or engineering, seemed to be engaged in some kind of programming work, I was afraid that without a basic understanding of this routine, I would appear constantly lost. And so I decided to acquire this skill little by little through trial and error, which I continued later on in a self-taught manner all the way through my doctoral research. It turned out to be a hugely useful skill for my work, and I have conducted all my studies using such tools.

The open-mindedness required when different disciplines communicate

The stay in this lab was my first significant learning experience in a largely computational environment. Just as their skills and expertise appeared quite different from mine, now in retrospect, I suppose the topic I had in mind must have appeared equally foreign to them („rhythm perception in music, uh?"). Indeed, as I was still new in my research, I was not very clear about all the concepts and terminologies commonly employed when we talk about certain things. Nevertheless, exactly this 'talking about certain things' seemed to be an even trickier part for me when I communicated with the informatics people. Although I believe all logic-based sciences share basic problem-solving principles, the approach or the ways of thinking can be quite divergent across fields. This difference – sometimes a difference in focus when dissecting the same issue – might have emerged as a result of training. When cognitive psychologists talk about music and how humans perceive music, they may refer to what rhythmic or pitch patterns are processed by the listeners. Specifically, when I contemplate the temporal aspect of music, I have a strong preference to think in terms of its rhythm. That is, I am treating each sound (e.g. a musical note) as an auditory event, and the temporal pattern evolves as the intervals between successive sounds. When the same topic „temporal aspect of music" is communicated with the informatics specialists, however, they may be thinking in terms of more fundamental aspects of the acoustic signals, such as each

individual sound wave, which indeed also consists of a certain temporal pattern[2]. Thus, at times it could feel as though the ideas are not coming across because they were traveling in two parallel lines, each line representing a level of focus on the same issue. This is somewhat frustrating in the beginning, especially if you are used to being in a more convergent learning environment. After all, psychologists could more easily understand the take on an issue amongst one another, while engineers could discuss with each other with less confusion. The same can be said about any discipline, and the same difficulty can arise from any combination of two disciplines.

Nevertheless, it is not as overwhelming as it may seem. Very often it simply requires that each specialist first explain their idea or background in a more common-sensical way, using plain words (to be discussed more in the next section). What might be helpful in communicating with an expert from a different field – but might be the intimidating part for many – is this: admit (if it is true) your lack of experience in a certain subject that the other professes, and be open to approach their subject or perspective by asking for a little introduction from them. It shows the other person your interest in taking in their points of view, which usually leads to a two-way exchange of ideas or opinions. I have always found this a good start, as it equips me with a basic understanding of the diverse backgrounds involved in a discussion, so that I can either try to incorporate their perspectives while dissecting an issue, or at least not be taken aback when an utterly different view comes along. As I believe scientists from all disciplines are equipped with the ability to acquire new skills and to carry out logical and analytical thinking regarding a new subject, it should be plausible to comprehend a specialist from a different discipline to some extent, with sufficient motivation and perhaps a bit of time.

One obstacle in the aforementioned approach might be that, if we see ourselves as an expert in something, we tend to feel awkward if we do not understand another expert, even if it is indeed a different specialization from ours. We are afraid to appear more naive than we think we should be. As such, sometimes we might be too stubborn to readily admit our failure to grasp something new, and might consequently become insistent on our own take on an issue. This actually contradicts the meaning of a multi-disciplinary or multi-expertise environment. The point is not so much whether we will end up being as good as the other expert in his/her specialization (which is probably hardly the case), nor whether one

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[2] *This is not to say that rhythm research is not conducted on the level of sound wave analysis. Quite the contrary, several groups of auditory engineering specialists are dedicated to such analyses and modeling. It is simply a matter of choice of the focus on a topic, which is naturally a result of the chosen specialization.*

expertise should win over the other in approaching a topic; after all, science benefits hugely from a variety of research dimensions. Rather, it is the broadening of our scope, as well as the constant accumulation of new skills and ideas (even if it is not obvious at the time), that will continue to be useful and rewarding in our further pursuit. Such was my story with programming: I have never become an expert programmer, but the skills I have acquired, as well as the knowledge of how informatics experts work their way around a question, has been helpful in various ways, e.g. in applying the skill on my research, or in applying the experience to working with other computational scientists. Interestingly, even after my doctoral research, I keep having the chance to work with computational people, as they constitute a significant branch of cognitive and behavioral science. It would have been unforeseeable to me back then, but now I am grateful for the circumstances that brought me some steps closer to this discipline. I suppose the same could be true when we cross the boundary to any field that should appear new to us.

The willingness to explore a somewhat different „language"

Another potential difficulty in communication between disciplines, also related to the training-dependent difference, resembles the challenge people face when they speak a different languages. This might be a strange comparison, but is not so far from truth; it can be present between any two different disciplines, and perhaps to a lesser degree between any two persons in the same field. Just recall how often you have heard or have made such a comment yourself, „Gee, I have no idea what he/she is talking about!"

It almost seems as if each specialist carries a subject-related „vocabulary" with him/her (i.e., words and terminologies they typically adopt to describe the content of their work), and through their training have developed a way of thinking that could be seen as a kind of „grammar" employed to connect their thoughts. As such, often before we even get to the real point of discussion, we might be lost already in the confusion of words. The further away from each other the two disciplines are, the greater difference may exist between their „languages". It was indeed one initial barrier to overcome when I communicated with the informatics people, and now from time to time I still have to be reminded of such differences when communicating with any others. (Through experience, however, I have learned to be less intimidated about it.) In situations like this, one good attitude is always to be honest in expressing any incomprehension of words, concepts, or reasoning the other is sharing, and to willingly learn about their meanings. What often happens in cross-discipline communication, stragely enough, is that we might be talking about the very same thing without knowing it. This happens either because we are using different terminologies, or because one has a special term/phrase for something while the other does not. In a sense, it is sometimes

a barrier of language, not of the concept that is being communicated. A simple example: It took me long enough to discover that what programmers meant by „debugging" was actually what I (as a non-systematically-trained programming person) was doing all the time, namely „fixing the script I've written until it works", as I would call it in my own plain words. It took some time until my realization of such a simple thing („ah ha, so that is what you call ‚debugging'!") because I had been too embarrassed to ask for the meaning of a word that all the others seemed to consider self-evident. In the end it was not the task itself I did not know about, but its label. Again, the lesson here is clear: ask whenever necessary, and no need for embarrassment.

That said, it is equally important to reflect on ourselves in such a scenario, as each of us is used to our subject-specific languages, and may take it for granted that the words we apply are just as self-evident to others. There might be times when we are the one who is using arcane languages and wondering why the others simply do not get it. Thus, if you are under the impression that you are communicating with someone not so familiar with your topic, it is always desirable to explain the ideas in very plain words, using examples most people can relate to. This is not to say it is an easy job; quite the contrary, it might be one of the most difficult tasks for a specialist. After all, regardless of discipline, each of us has the responsibility to spread the knowledge and information not just to other specialists, but to the general population, the majority of whom may not have any clue of all those specific phrases or terminologies we have in mind. Therefore, training to convey our ideas to our cross-discipline colleagues might provide a good start.

Interdisplinarity: not just boundaries

Now that I have reflected on my experiences in situations involving more than one discipline, there are just couple of points I find equally worth sharing. Certain challenges or conflicts might be inevitable when we bring together experts from different fields; however, I also believe that the success and satisfaction of collaborative work relies just as much on each person's basic training in logical and analytical thinking, as on the similarity of their disciplines per se. That is, it does not necessarily (and not solely) depend on the subject of one's specialization. As suggested earlier, acquisition of new topics is not the biggest obstacle for any trained academic, providing sufficient time and motivation. I have seen people from humanity studies who, without experience in empirical work, were able to raise critical and relevant questions during the discussion of an experiment. On the other hand, sometimes those who work in a supposedly similar field may have great difficulty sharing each other's point of view, due to differences in their reasoning. The point here is that, to some extent, the challenges we encounter in a multi-discipline situation, along with our

strategies to cope with them, can as well be applied to working with any other individual. At the same time, we do not have to enter a multi-discipline environment or project with mere anticipation of boundaries. Sometimes the commonality underlying two seemingly distant fields can surprise us, while the discrepancy *within* the same field may require just as much effort to overcome. In other words, the difference between disciplines is not necessarily greater than that within the same discipline. Thus, the insight and the open-mindedness gained from an interdisplinarity experience may well be applied to any other task involving diverse people and work dynamics. I will end this essay here with a quote from Malcolm Forbes, which nicely captures the essence of my discussions: „Diversity: the art of thinking independently together."

Curriculum Vitae

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