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„What Does It Mean to Become an Interdisciplinary Researcher in Cognitive Science?"

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Declaration of Originality

I declare that this thesis is my own work except where there is clear acknowledgement or reference to the work of others. This work has not been submitted for any other degree or professional qualification.

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Eventually, your son graduated :)

Abstract

This thesis elucidates how interdisciplinary practice and the professional identity of the interdisciplinary researcher in cognitive science are best understood from the perspective of students in the pursuit of an academic career in cognitive science. These topics frequently cause confusion among students and are neither adequately addressed in the introductory literature on cognitive science nor in the literature on interdisciplinarity in cognitive science. Furthermore, the thesis provides a clear answer to the question of what it means to become an interdisciplinary researcher in cognitive science by studying the Middle European interdisciplinary master's program in Cognitive Science (MEi:CogSci) at the University of Vienna. The thesis thus contributes to improving the quality of education and reducing the duration of studies and drop-out rates of students by managing expectations.

Contents

Table of Figures

Index of Tables

1 Introduction

1.1 Topic Area and Research Question

This investigation is concerned with *interdisciplinary practice in cognitive science*. In particular, it takes the perspective of potential (i.e., interested) and first-year students of interdisciplinary cognitive science study programs and condenses the topic into the question: *What does it mean to become an interdisciplinary researcher in cognitive science?*

Initially, this question may appear innocent, but I would like to highlight its following explicit and implicit aspects, which I regard as neither obvious (no need for explanation) nor trivial ('just look it up') from the perspective of potential or first-year students:

- On an explicit level, it is a question about professional identity *in the sense of a specific academic job profile and the skills and competences such a profile requires*[1]
- Implicitly, it is a question about
  - the identity of cognitive science as an interdisciplinary enterprise
  - the specific difference between the disciplinary researcher and the interdisciplinary researcher (in cognitive science)
  - the educational goal(s) of cognitive science study programs and the corresponding pedagogical means

1.2 Target Audience and Purpose

The primary target audience for this work are stakeholders of the Middle European interdisciplinary master's program in Cognitive Science (MEi:CogSci) jointly offered by the Comenius University in Bratislava, Eötvös Loránd University Budapest, University of Ljubljana, and University of Vienna & Medical University of Vienna. In particular, the present thesis may be of interest for:

- Directors of studies and the international steering committee
- Program coordinators and administrators
- Lecturers, course instructors, assistants and tutors

1 I use the term 'professional identity' throughout this thesis in this sense. This implies that employment as a 'cognitive scientist' (job title) is neither a necessary nor sufficient criterion to identify a cognitive scientist in the context of this thesis.

- Project/thesis supervisors
- (Potential) students
- Members of the Centre for Cognitive Science at the Comenius University in Bratislava, the Center for Cognitive Science at the University of Ljubljana Faculty of Education and the Vienna Cognitive Science Hub at the University of Vienna

The present work is based on the experience gained in the MEi:CogSci over eight years.[2] It is nevertheless of general interest for (potential) stakeholders of other interdisciplinary cognitive science study programs (or programs with similar professional orientations), if the question of what it means to become an interdisciplinary researcher in cognitive science from the student perspective has not been a topic for reflection yet. The following questions might help to decide whether this thesis could be of interest for stakeholders of other interdisciplinary study programs:

- Is there consensus among local stakeholders of the interdisciplinary study program about the professional identity (i.e., in the sense of a specific academic job profile and the skills and competences such a profile requires) of the *interdisciplinary researcher* (in contrast to the disciplinary researcher)? Is/was this even a topic?
- Are first-year students *explicitly* introduced to a clear concept of the professional identity of the interdisciplinary researcher (in cognitive science)? Is/was this even a topic?
- Are students trained in the theory and process of interdisciplinary research as well as it best practices? Is there awareness that there exists a body of knowledge on these topics?
- Is the overall pedagogy of the interdisciplinary study program based on a clear concept of the professional identity of the interdisciplinary researcher and is it also geared to and fostered by the local research environment? Has this ever been considered or reviewed?
- Are students explicitly or implicitly using a concept of the professional identity of the interdisciplinary researcher to orient themselves, plan their studies and develop their own professional profiles? If so, which one? Is/would it be important for them?
- Can graduates articulate a substantial understanding of their professional identity as interdisciplinary researchers? If so, is it a realistic conception with respect to an academic career?

2 It mainly focuses on its implementation at the University of Vienna, which is also the central international coordinating partner for the joint program, i.e., for coordinating activities between the different partner universities.

If most of these questions have never been asked or can be answered with 'no', the reader might learn from this thesis about the confusions which can arise for students when such questions are not thoroughly considered or tackled at all. Furthermore, the reader might find answers or inspiration to efficiently address these or related issues to improve the educational quality for students of interdisciplinary study programs. From the perspective of the university administration and reduced to two key figures for assessing study programs, at stake are the duration of studies and the drop-out rate of students.

1.3 Background and Motivation

The research question is motivated by my own experience over the last eight years in my different roles as student, tutor, student assistant, and, in particular, as international program coordinator of the two-year Middle European interdisciplinary master's program in Cognitive Science (MEi:CogSci) at the University of Vienna.[3]

1.3.1 The MEi:CogSci and the Challenge of Interdisciplinarity

The MEi:CogSci is a joint master's program offered by the Comenius University in Bratislava, Eötvös Loránd University Budapest, University of Ljubljana, and University of Vienna (together with the Medical University of Vienna as a local teaching partner). The same cognitive science curriculum (i.e., its essential structure and components) is implemented at each of the joint partner universities.[4] The partner universities coordinate their joint program related activities through an international steering committee and a dedicated international program coordinator. Furthermore, the program is organized by local program coordinators across several departments at each partner university and other local universities and non-university research institutes. On the one hand, the study program's design is research-based and offers a broad range of areas for specialization via project work and thesis supervision in its cognitive science research environments. On the other hand, the program particularly highlights team work and its interdisciplinary character, which manifests in its curriculum architecture and its pedagogical principles.[5] Only small cohorts of up to 25 students start the program each year at each partner university. The program is fully taught and assessed in English and attracts applicants from all over the world.[6] Applicants are admitted in equal numbers from the five broad areas of cognitive science, formal sciences, humanities, natural sciences and social sciences to maximize disciplinary diversity among cohorts. As an essential

3 See https://www.meicogsci.eu/.
4 Modules/courses of local curricula are mapped to the structure of the general MEi:CogSci reference curriculum.
5 See https://www.meihtcogsci.eu/mei-cogsci.html and https://senat.univie.ac.at/fileadmin/user_upload/s_senat/konsolidierte_Masterstudien/MA_CogSci.pdf.
6 At the University of Ljubljana the first year of the program is currently taught in Slovene.

part of the joint program, MEi:CogSci students study (at least) one semester at a different partner university.[7] A unique feature and highlight of the program is the annual international MEi:CogSci Conference, where students from all the partner universities come together and present their research to their peers.

The complex organizational structure of the MEi:CogSci, which spans across multiple departments, universities and even countries, and its interdisciplinary orientation (in the sense of offering courses and project work from different academic disciplines and at different locations) poses diverse challenges (professional, organizational, personal) for students as well as for course instructors and administrators. The challenge of pivotal interest within the context of this thesis, is to find orientation within the vast interdisciplinary research landscape of cognitive science as a student. This pertains to the issue of developing one's own individual academic profile as an *interdisciplinary researcher* in cognitive science.

Although the study program is initially very demanding for first-year students, the joint universities can be proud of many highly successful MEi:CogSci alumni over its fourteen years of existence (in 2020).[8] Nevertheless, there is also a number of students who struggle with finding orientation in cognitive science and developing a professional identity as interdisciplinary researchers in cognitive science. There may be various reasons why this poses a problem, especially when the focus is on students as individuals, taking into account their different backgrounds, personalities, interests, expectations, etc. However, based on my different perspectives on the MEi:CogSci from my different roles, I claim that there is also a common denominator which creates confusions about becoming an interdisciplinary researcher in cognitive science: The concept of interdisciplinarity is at the root of most of these troubles.

1.3.2 Confusions Caused by the Concept of Interdisciplinarity

The concept of interdisciplinarity may initially appear inconspicuous, because the basic idea is easy to grasp: Interdisciplinarity is about collaboration (or cooperation) between researchers from different academic fields on a common topic or problem, or integrating knowledge from two or more academic disciplines (Arnold, 2013). In particular, with regards to specifics of interdisciplinary practice, it can appear like there is not much to say about it – or rather, no need for it –, because best practices may be considered problem-specific.[9] For instance, there is typically no explicit introduction to interdisciplinarity in any course of the MEi:CogSci which goes beyond referring to collaboration and communication, combining methods and knowledge from different disciplines, or the difficulty of interdisciplinary work. It could be argued that an interdisciplinary study program in cognitive science is 'permeated'

7 See https://www.meicogsci.eu/mei-cogsci.html for more details.
8 For a sample see https://www.meicogsci.eu/after-mei-cogsci.html.
9 See Szostak (2013b) on "Skepticism about Best Practices" about interdisciplinary research and his response.

with interdisciplinary practice by the very nature of its subject, the design of the curriculum and its didactics. Therefore, no explicit introduction is required. Students learn about it during their studies and in the context of their own research projects.

I think that there are several reasons for doubting such a view. On the one hand, interdisciplinarity has become a buzzword used in almost all kinds of academic and research contexts: for events like workshops, lecture series, conferences and symposia; and from research designs, projects, subjects, degrees, individual researchers or teams, to research clusters, departments or even whole universities.[10] Indeed, despite the large body of research on various aspects of the topic over the last four decades,[11] it seems like the buzzword character still persists (e.g., S. French, 2018, pp. 1–2). As a result, almost every academic may be interdisciplinary in a superficial sense today (e.g., Klein, 2010, p. 6; Szostak, 2013b, p. 45). As the philosopher Robert Frodeman points out in his introduction to the second edition of *The Oxford Handbook of Interdisciplinarity*, "interdisciplinarity is most commonly used as a portmanteau word for all more-than-disciplinary approaches to knowledge" (Frodeman, 2017, p. 4). The concept is thus rather uninformative. On the other hand, developing a deeper understanding of interdisciplinarity turns out to be challenging (MacLeod et al., 2019; Porcelli & Teller, 2019). As soon as one dives deeper into the subject, the concept appears to be complex and controversial. This situation is concisely summarized in the abstract of the research article "The 'Problem' of Interdisciplinarity in Theory, Practice, and History" (Graff, 2016):

> Interdisciplinarity is among the most talked about but most misunderstood topics in education on all levels today. Seen as the savior of research and teaching, especially in universities, and of society, or the seeds of destruction, interdisciplinarity's proponents and critics talk past each other. Seldom do they seek common terms; typically, they mean very different approaches when they refer to interdisciplinarity. They erroneously dichotomize disciplines and interdisciplines, confuse specialization and synthesis, and misconstrue 'integration.' (Graff, 2016, p. 775)

To get an impression of what this means for doing some initial research on the topic from a student perspective, the almost 30 pages chapter on literature review from David Morrison's PhD thesis on interdisciplinarity in the context of undergraduate higher education is revealing (Morrison, 2015). He reports about the painstaking task – in his own words, "a perhaps Sisyphean effort" – of getting an overview of the literature to clarify the nature of interdisci-

10 For instance, see the description on the webpage of the recent "Interdisciplinarity Revisited" symposium by the Volkswagen Stiftung in October 2019 at the Humboldt Forum in Berlin, Germany, https://www.volkswagenstiftung.de/interdisciplinarity-revisited.

11 Research on interdisciplinarity has been done especially from the perspectives of sociology, education research, management research, science policy studies, governance studies, STS (science, technology and society) studies, cognitive sciences, philosophy of science, social epistemology and scientometrics (Baalen & Boon, 2019, p. 6; MacLeod et al., 2019, p. 545; Mäki, 2016, p. 327; Mäki et al., 2018, p. 2).

plinarity, its methods and the history of research on it (Morrison, 2015, p. 21). Not only was he confronted with a large body of literature explicitly focusing on interdisciplinarity per se, but with an even larger and more diverse one on the meaning of 'interdisciplinarity' within different disciplines. Furthermore, he encountered more or less identical concepts, which were not explicitly qualified as interdisciplinary. He also expresses doubt about the utility and empirical foundation of various extensive classification systems intended to clarify the diverse aspects of interdisciplinarity and related concepts like multidisciplinarity, cross-disciplinarity, transdisciplinarity, etc. (Morrison, 2015). To get started, he organized the literature into "historio-theoretical research of interdisciplinarity", "scholarship of interdisciplinary teaching and learning", "research of interdisciplinary research" and "educational research of interdisciplinarity" (Morrison, 2015, p. 22).

One might be inclined to think that the situation is quite different as soon as the focus is on interdisciplinarity in the context of a specific scientific enterprise. However, at least in the case of cognitive science, it initially appears far from obvious how interdisciplinarity should be understood more comprehensively after consulting different cognitive science encyclopedias, handbooks, textbooks, or review articles. Cognitive science is characterized as *interdisciplinary* (e.g., Thagard, 2019), *multidisciplinary* (e.g., Núñez et al., 2019), *cross-disciplinary* (e.g., Frankish & Ramsey, 2012b, p. 1), *transdisciplinary* (e.g., Walter & Stephan, 2013, p. 1), as a *discipline* (e.g., Dawson, 2013, pp. 4, 6), as a *collaborative discipline* (Kolak et al., 2006, p. 2), as an *emergent discipline* (Chipman, 2017, p. 2), and in the plural as *cognitive sciences* (e.g., Li & Sobel, 2013). To find the same scientific field characterized with a multitude of different technical terms or descriptions can certainly be confusing for first-year students. One the one hand, disregarding this terminological plurality by remarking that, for the most part, these terms all just mean the same thing, would mean to fall back on a superficial understanding of interdisciplinarity. On the other hand, pointing out that all these different characterizations are true to some extend, i.e., from their respective theoretical perspectives, would just reaffirm the complexity of the topic.

1.3.3 Consequences of the Obscurity of Interdisciplinarity

It could still be objected that cognitive science students do not have to become experts in the theory of interdisciplinarity and just need some working knowledge relevant for their studies to bootstrap their future academic careers. After all, they study a cognitive science program to become cognitive scientists and not scholars of interdisciplinarity. In the course of their studies they will develop an understanding of the key characteristics of cognitive science as an interdisciplinary research enterprise, of interdisciplinary research in cognitive science and, thus, of what it means to become an interdisciplinary researcher in cognitive science.

Yet, from my own practical experience as a student as well as in my other roles as tutor, student assistant, and, especially, as international program coordinator (which included acquiring 'field reports' from students, tutors, student assistants and professors/lectures) of the MEi:CogSci, I noticed that even after studying this master's program in cognitive science for two years, a significant number of students find it still difficult to explain what cognitive science and interdisciplinarity are about. The problem, as I see it, is not about 'reciting' definitions or giving brief summaries of different cognitive science research programs, which students learn about in their theoretical cognitive science courses – these things can be learned by heart. Rather, the problem is about reconciling (or making sense of) the experienced *mismatch* between the theoretical knowledge students acquire about cognitive science and interdisciplinarity in their dedicated cognitive science courses with their own experience of what is presented as cognitive science research and interdisciplinary practice at their universities without having a guiding conceptual framework or narrative for orientation. In other words, it is about explaining how the different cognitive science disciplines represented by disciplinary research groups and experts interact *in practice*: how knowledge from different disciplines is brought together, integrated or synthesized in real-world interdisciplinary research projects *in practice*, i.e., *how to do* interdisciplinary research. To express the issue with a borrowed slogan: "Doing interdisciplinary differs from 'talking' interdisciplinary." (Graff, 2015, p. 236)

Since it is not clear for some students how to understand interdisciplinary practice in cognitive science beyond keywords and phrases,[12] it is also not clear how to understand the professional identity of the interdisciplinary researcher in cognitive science.[13] As a consequence, even excellent MEi:CogSci students sometimes fail to develop a professional identity as cognitive scientists. When asked, "Do you identify as cognitive scientist?" (in the sense of the relevant skills and competences), advanced students and recent graduates of this program often hesitate to answer. This should be thought-provoking since it is one of the dedicated educational goals of the MEi:CogSci for students to "develop their own voice in the scientific community" by "enabling the shaping of a personal cognitive science profile" (Zimmermann et al., 2010, pp. 151, 154).

Whether interdisciplinary practice is a crucial issue for students often depends on their initial motivations for choosing an interdisciplinary study program and their associations with the word 'interdisciplinarity'. Some students are mainly attracted to the MEi:CogSci due to the particular specializations available at the MEi:CogSci partner universities, the flexibility of the curriculum and disciplinary diversity of courses, or the small number of students in

12 Such as, 'communication', 'collaboration', and 'the combination of methods from different disciplines'.
13 See Lange (2019) on the connection between interdisciplinary practice and the identity of the interdisciplinary practitioner.

the program and the individual attention they can get. This is often the case for students who prefer to work and study on their own and already have a clear idea of what they want to specialize in or quickly find a path to specialization. In such cases, questions about interdisciplinary practice may not become an issue for students, because their research practice is guided by an expert or an experienced research group in the specific area of specialization. In other words, a specific research topic or area is the main 'driver'.

However, there are also students, who are particularly attracted by the 'interdisciplinary part' of cognitive science. These students often associate interdisciplinarity primarily with the integration of knowledge and with twenty-first century skills for dealing with complex phenomena or wicked problems and, thus, expect to acquire more generic skills, which might be transferable to a volatile, uncertain, complex, and ambiguous (VUCA) world outside academia (e.g., see Bear & Skorton, 2019; Fadel & Groff, 2019; Rashid, 2019). They are not just interested in learning the basic concepts, theories and methods from different disciplinary approaches, but also in the theory and process of (collaborative) interdisciplinary research itself. Thus, they expect to learn *how to* actually engage in a (collaborative) interdisciplinary research process, *how to* practice interdisciplinary teamwork and *how to* integrate knowledge from multiple disciplinary perspectives to address complex cognitive phenomena in creative ways to arrive at novel insights. These students may find that these topics are insufficiently covered or even missing in the program over the course of their studies and eventually conclude that there are no researchers or course instructors, who can actually teach these topics. In the worst case, these students may get the impression that an interdisciplinary program is mostly a collection of tuned courses from different already existing programs under a common label but without providing any 'tools' or guidance to help them connect and integrate the acquired knowledge toward creating a more comprehensive understanding of a complex phenomenon or problem. This would be unfortunate because interdisciplinary integration is highlighted as a prominent design feature of the MEi:CogSci curriculum (Zimmermann et al., 2010).

The issue about what it means to become an interdisciplinary researcher in cognitive science is most evident in the MEi:CogSci when students start to work on their own master's thesis. Students are required to explicitly describe the relationship of their work to cognitive science and its interdisciplinary aspects in their master's thesis concept. With the exception of some students those supervisors are clearly working in a core domain of cognitive science (e.g., cognitive psychology or cognitive neuroscience), it is a very common experience for students to feel insecure about their work because they are not sure whether their research is actually cognitive science and whether it counts as interdisciplinary. The fact that these ques-

tions typically arise simultaneously at this point,[14] is probably the best indicator for entertaining doubt about the assumption that students (implicitly) develop a sufficient understanding of cognitive science as an interdisciplinary research enterprise and of interdisciplinary research processes in the course of their studies.

It is my conviction that some of the main problems students face about the meaning of cognitive science and interdisciplinarity in the context of the MEi:CogSci are rooted in *the absence of a clear (i.e., unambiguous), explicit, and shared concept of the professional identity of the interdisciplinary researcher in cognitive science*, which implies a clear understanding of interdisciplinary practice. It is this flaw that leads to poor communication about interdisciplinarity within the program. This is in a way ironic because conceptual clarity and awareness of communication issues are typically stressed as some of the most important conditions of successful interdisciplinary endeavors (S. Choi & Richards, 2017; O'rourke et al., 2013). However, I regard the situation as a result of a neglected developmental perspective on the study program due to the limited resources (staff, time, budget, etc.) available for supporting such efforts – and despite its negative impact on the duration of studies and drop-out rates of students.[15]

The current situation motivates a thorough analysis of the status quo in order to identify the underlying causes and open the potential space for future improvements.

1.4 Method

The present thesis is the result of the perspective of field philosophy on interdisciplinary practice in cognitive science in the context of the MEi:CogSci.

1.4.1 Field Philosophy

Field philosophy is promoted as an alternative model for practicing philosophy, which is particularly relevant within inter- and transdisciplinarity contexts (Frodeman, 2014).

One the one hand, field philosophy emerged as a situated and context-sensitive approach within the interdisciplinary field of environmental humanities to address the entanglement of meanings, actors and interests through field research (Buchanan et al., 2018). On the other hand, field philosophy has also been developed from within academic disciplinary philosophy as a complementary approach of practicing philosophy (Brister & Frodeman,

14 This is well known to the director of studies and his tutors or students assistants who teach the master's thesis seminar together.

15 It seems that there is only limited awareness from the university administration about the significant additional efforts interdisciplinary programs require beyond coordinating courses across departments and the usual administrative paperwork. For instance, see Holley (2017) and Wernli et al. (2017). In comparison, the curriculum of the bachelor's program "Cross-Disciplinary Strategies – Applied Studies in Art, Science, Philosophy, and Global Challenges" at the University of Applied Arts Vienna explicitly specifies that it is the job of the program coordinator to head/participate in courses on "Programme-related Reflection" and "Cross-Disciplinary Capabilities". See http://studien.homepage.uni-ak.ac.at/curricula/700_2019U_BA_e.pdf.

2020a; Frodeman, 2010, 2014; Frodeman et al., 2012; Frodeman & Briggle, 2016). This latter account of field philosophy is of particular relevance in the further course of the present thesis.

The label 'field philosophy' is intended to conceive of philosophical practice in analogy to fieldwork in sciences like anthropology, biology and ecology, and to contrast it with work in disciplinary philosophy in the same way field research is contrasted with laboratory research (Brister & Frodeman, 2020b). Engaging in fieldwork means to study the phenomenon of interest in its real-world context, i.e., embedded in the (natural) environment in which the phenomenon originally occurs, rather than creating controlled experimental settings in the laboratory to study the phenomenon in isolation (Brister & Frodeman, 2020b). Both approaches have their specific advantages and disadvantages, but can also be seen as complementary, especially when dealing with complex systems or wicked problems (Brister & Frodeman, 2020b). In like manner, field philosophy can be seen as a complement to disciplinary philosophy as it is practiced in philosophy departments of universities. Its 'field' can be broadly understood as "any complex setting where questions of knowledge and values arise" (Brister & Frodeman, 2020b, p. 3). More specifically, however, it is the inter- and transdisciplinary contexts addressing complex or wicked problems, which require the interaction and collaboration of multiple stakeholders and various kinds of specialists (Frodeman, 2014; Frodeman et al., 2012). In Frodeman's (2014) view, "field philosophy is kin to Mode 2 knowledge production" (p. 108). Nevertheless, this does not mean that it cannot also include laboratory research (Frodeman, 2010), or that it is not applicable to intra-academic contexts (see Brister & Frodeman, 2020a, pt. III).

Field philosophers work embedded in such inter- and transdisciplinary contexts as team-members on the project level, i.e., they work closely with non-philosophers on the co-production or interdisciplinary integration of knowledge in the context of its use (Brister & Frodeman, 2020b, pp. 9–11; Frodeman et al., 2012, p. 324). Their major goal is to support project stakeholders and their collaborators by "seeing 'the problem' from multiple perspectives and at multiple depths" (Frodeman et al., 2012, p. 325), and helping them "clarifying goals and values and expanding the decision space for complex problems" (Brister & Frodeman, 2020b, p. 4). Thus, they start their work bottom-up and focus their attention on the philosophical dimensions of issues as they emerge and unfold from actual situations in the context of the project (Brister & Frodeman, 2020b). They do not apply any particular set of philosophical methods, but rather need to be able to improvise and to strategically use whatever is prompted by the specific situation (Brister & Frodeman, 2020b). Yet, a crucial philosophical skill is to intervene in the given situation by posing questions to shift the perspective on a topic or problem with the intention to widen a discussion or provoke a constructive criti-

cal stance (Brister & Frodeman, 2020b). Thus, they can play an important role as facilitators (Brister & Frodeman, 2020b). In the words of Brister and Frodeman:

> Field philosophy gives priority to practicing philosophy at the moment it comes up in collaborative settings: raising questions, responding to queries, and expending the moral imagination of people as they are engaged in problem-solving. The goal is to influence events one the fly. Field philosophy is thinking put into action. The point is to help inform the ideas that are shaping events, rather than to critically evaluate them after the fact (Brister & Frodeman, 2020b, p. 8).

In general, their mode of inquiry is participatory and conversational (Brister & Frodeman, 2020b). They work with their collaborators on site and face-to-face over extended periods of time (months or years) (Brister & Frodeman, 2020b; Frodeman & Briggle, 2016, pp. 122–126). Most importantly, the products or results of their work are not primarily academic publications (Brister & Frodeman, 2020b). Although they may share their insights in the form of lessons learned or best practices with the broader academic community, their target audience are the project stakeholders and collaborators (Brister & Frodeman, 2020b). This has important consequences for the evaluation of their philosophical practice, because the contributions of field philosophers are in the first instance assessed by their collaborators, i.e., non-philosophers (Brister & Frodeman, 2020b). For field philosophers this means "adjusting standards of rigor to the limitation of partners' time, interest, and resources" (Brister & Frodeman, 2020b). Therefore, the artifacts they create may be reports, memos, or short briefings rather than full-blown philosophical publications (Brister & Frodeman, 2020b). Moreover, their main work product may even be "a technological product, a policy, or a reformed practice" (Brister & Frodeman, 2020b, p. 5).

This short characterization also clarifies how field philosophy can be distinguished from applied philosophy and experimental philosophy. Although applied philosophers aims to address real-world problems, and experimental philosophers try to enrich philosophical discussions by conducting empirical experiments, both start top-down from philosophical theorizing and end with academic publications assessed by philosophers (Brister & Frodeman, 2020b; Frodeman, 2010; Frodeman & Briggle, 2016, pt. II, chap. 3, "Applied Philosophy"). By contrast, field philosophers start bottom-up and their primary target audience are the project stakeholders with their standards of evaluation (Brister & Frodeman, 2020b; Frodeman, 2010). It means "beginning with the needs of stakeholders and drawing out philosophical insights after the work is completed" (Frodeman, 2010, para. 8).

1.4.2 Field Philosophy in the Context of the MEi:CogSci

The present thesis is the result of my field-philosophical perspective from the professional role of the international program coordinator of the MEi:CogSci, which I held between 2015 and 2019 at the University of Vienna.

The international program coordinator is responsible for the local and international coordination and management tasks in the MEi:CogSci and for supporting the international director of studies at the University of Vienna in administrative, communication, and operational matters. These tasks mainly concern the activities of the international network of the MEi:CogSci partner universities and the local interdisciplinary network of lecturers, course instructors, and project/thesis supervisors from various faculties of the University of Vienna, the Medical University of Vienna, and associated non-university research institutes. The scope of duties includes

- student support and consulting
- managing student and faculty mobility
- planning and organizing teaching and courses
- coordination and briefing of lecturers, course instructors, and tutors
- coordination and organization of lecture series, lab excursions, and student projects
- organizing and managing the application procedure with director of studies
- quality development
- planning and budgeting of MEi:CogSci course program with the director of studies
- decision support for the director of studies and the international steering committee
- preparing and chairing the meetings of the international steering committee

With this job profile, the position of the program coordinator offers special insight into the operations and, in particular, the various interdisciplinary aspects of the study program, the related research environments, and other interdisciplinary endeavors. It offers an excellent opportunity to gain deeper insights into interdisciplinary practice and interdisciplinary education in cognitive science from an organizational and operational perspective and to actively participate in its development as a field philosopher.

My experiences as a student, tutor and student assistant at the MEi:CogSci further contributes to the comparison of the operational and the student perspective on the program. It is this 'field experience' that provides the empirical foundation on which the present thesis is based.

1.5 Goal and Approach

The major goal of this work is to elucidate how interdisciplinary practice and the professional identity of the interdisciplinary researcher in cognitive science are best understood from a student perspective with regard to pursuing an academic career in cognitive science since these topics are insufficiently covered in the introductory literature on cognitive science and on interdisciplinary in cognitive science. In particular, the present thesis is intended to provide a viable answer to the question of what it means for interested students in general and first-year students of the MEi:CogSci in particular to become an interdisciplinary researcher in cognitive science.

To accomplish this goal I initially proceed in two steps:

1. Answer the question of what constitutes the profession identity of the interdisciplinary researcher in cognitive science in general. (Part I)
2. Answer the question of what it means to become an interdisciplinary researcher in cognitive science by studying the MEi:CogSci in particular. (Part II)

The question of the profession identity of the interdisciplinary researcher in cognitive science – which implies an understanding of interdisciplinary practice in cognitive science – is first answered in general. The question aims at a 'template' for an academic job profile and the basic skills and competences it requires. This understanding of the professional identity of the interdisciplinary researcher in cognitive science is then applied to the MEi:CogSci by asking how the development of this professional identity is supported by the program.

The case of the MEi:CogSci is of particular interest because although it is not noticeable on its surface, a critical analysis of its curriculum design and pedagogy will show that the program is based on a different conception of the professional identity of the interdisciplinary researcher in cognitive science. As a result, the understanding of interdisciplinarity – implicitly and explicitly communicated through the didactics of central courses of the program – is undermined by the actual interdisciplinary practice students experience in the context of the cognitive science research environments of the MEi:CogSci partner universities. This leads to confusions and poor communication about interdisciplinary practice in cognitive science as well as further unfortunate consequences for students. Thus, the case of the MEi:CogSci exemplifies how important it is that the design and pedagogy of cognitive science programs is based on a clear, explicit and shared concept of the professional identity of the interdisciplinary researcher in cognitive science, which is also compatible with the actual interdisciplinary practice in real-world cognitive science research environments at universities.

A further step follows based on this insight:

3. Answer the question of what would be a feasible alternative model of interdisciplinary education and the professional identity of the interdisciplinary researcher in cognitive science in the initial spirit of the MEi:CogSci. (Part III)

This question is answered by proposing a variant of the professional identity of the interdisciplinary researcher in cognitive science in the original spirit of the MEi:CogSci, drawing attention to the relevant body of knowledge for their education and situating them within the cognitive science research.

A final remark about the use of interdisciplinary terminology in the context of this thesis: Instead of reviewing common typologies of different modes and varieties of interdisciplinary practice identified in the respective literature (see Jungert, 2013; Klein, 2017), which are likely to cause even more confusion among first-year students due to the breadth and complexity of the topic, I will take a minimalist approach to interdisciplinary terminology. I will introduce and apply three major distinctions as conceptual tools for clarification:

1. *Union definition* vs. *intersection definition* of cognitive science (and the corresponding professional identities of cognitive scientists) from Chipman (2017)
2. *Multidisciplinarity* vs. *interdisciplinarity* from Klein (2017)
3. *Generalist* vs. *integrationist interdisciplinarians* from Repko (2007)

Part I: Interdisciplinary Practice and the Professional Identity of the Interdisciplinary Researcher in Cognitive Science

The purpose of this part is to characterize interdisciplinary practice in cognitive science and thus to derive the professional identity of the interdisciplinary researcher in cognitive science. Since descriptions of interdisciplinary practice in cognitive science are highly abstract in the literature and thus of limited use to define a job profile, the professional identity of the interdisciplinary researcher in cognitive science is derived from the concrete practice in real-world cognitive science research environments. A brief introduction to cognitive science identifies cognitive science as an interdisciplinary field in its own right as well as the potential 'research space' of the interdisciplinary researcher.

2 A Short Introduction to Cognitive Science As an Interdisciplinary Field

„Cognitive science is the interdisciplinary study of mind and intelligence, embracing philosophy, psychology, artificial intelligence, neuroscience, linguistics, and anthropology." (Thagard, 2019, para. 1) Some introductory texts highlight its focus on the human mind (in contrast to animal or artificial minds) (e.g., Bermúdez, 2020; Li & Sobel, 2013), or the primacy of natural sciences methodology (in contrast to the long history of philosophical speculation) (e.g., Friedenberg & Silverman, 2016; Kolak et al., 2006). The most dominant associations with cognitive science with respect to easily accessible online encyclopedias and cognitive science textbooks are its view of the mind as an information processor and its interdisciplinary character (e.g., Bermúdez, 2020; Friedenberg & Silverman, 2016; Thagard, 2019). The term cognition does not have a clear definition (Buckner & Fridland, 2017). However, lists of cognitive capacities (or faculties, functions, powers) studied by cognitive scientists typically include attention, perception, memory, reasoning, decision making, problem solving, language use, control of movement, and sometimes consciousness and self-awareness (e.g., Friedenberg & Silverman, 2016; Kolak et al., 2006).

In the following sections, I will provide a brief introduction of cognitive science with an emphasis on its interdisciplinary character. I will start by introducing two conceptions of cognitive science to initially structure the field with respect to disciplinary and interdisciplinary research and to identify the potential 'research space' for the interdisciplinary researcher in

cognitive science. I will then offer a very short high-level overview of the main theoretical approaches or research programs in cognitive science as they are discussed in the philosophy of cognitive science (e.g., see Clark, 2014) The main reason for introducing these different approaches is that they can be regarded as conceptual and theoretical frameworks for guiding and integrating empirical research from the different cognitive science disciplines. In this sense they belong to the potential interdisciplinary 'research space' of cognitive science. To put it differently, *these theoretical approaches are not an intrinsic part of any of the cognitive science core disciplines, but rather act as overarching frameworks for interdisciplinary integration and thus can provide an identity for cognitive science as an integrated interdisciplinary field in its own right, rather than just as the sum of its contributing disciplines* (Bermúdez, 2020). Moreover, these theoretical approaches may shape the expectations of first-year students about how to identify genuine interdisciplinary cognitive science research done at their universities.

I will summarize the different approaches under two main headlines: (1) the 'traditional computational-representational view of cognition' and (2) the 'situated/4E view of cognition'. Furthermore, I will sketch the idea of 'predictive processing' as a current research trend in cognitive science. Finally, I will outline the implications of these approaches for interdisciplinary research practice and the professional identity of the interdisciplinary researcher in cognitive science. These different approaches will be recurring points of reference for my further investigations.

2.1 Two Conceptions of Cognitive Science

Since the focus of this thesis is on interdisciplinary practice and the professional identity of the interdisciplinary researcher in cognitive science, the two ways of defining cognitive science proposed by Susan E. F. Chipman in her introduction to the *Oxford Handbook of Cognitive Science* are of particular relevance (Chipman, 2017). She makes a distinction between the *union definition* and the *intersection definition* of cognitive science (Chipman, 2017, p. 1).

Chipman's *union definition* is a broad conception of cognitive science which includes all research from the different contributing cognitive science disciplines. With regard to the professional identity of cognitive scientists, this implies that "everyone working in these fields might be deemed *cognitive scientists*" (Chipman, 2017, p. 1). In other words, she considers psychologists, neuroscientists, artificial intelligence researchers, linguists, etc. as cognitive scientists under the union definition of cognitive science. Based on this broad understanding, many traditional disciplinary researchers are cognitive scientists, at least – I would suggest – when their research focus is on (some aspects) of cognition.

By contrast, Chipman's *intersection definition* is a narrow conception of cognitive science which identifies and limits the field to research drawing on at least two of the contributing disciplines. Such work can be achieved, for instance, through the integration of the empirical results from the different cognitive science disciplines into computational cognitive architectures or computational models for certain aspects of cognition (Chipman, 2017). According to the intersection definition of cognitive science, only researchers who draw on knowledge from two or more cognitive science disciplines in their work count as genuine cognitive scientists. With respect to the professional identity of the interdisciplinary researcher in cognitive science, Chipman's intersection definition not only narrows down the broad field of cognitive science (as it is understood under the union definition), but also defines the potential 'research space' of the interdisciplinary researcher in cognitive science. Furthermore, her definitions provide an initial means to differentiate between disciplinary (union definition) and interdisciplinary researchers (intersection definition) in cognitive science.

Chipman's two conceptions of cognitive science can also be understood as overlapping and thus as endpoints of a spectrum between disciplinary and interdisciplinary research, once the number of disciplines and the degree of interdisciplinary integration are considered. Another way to characterize cognitive science more concretely as an integrated interdisciplinary field is through its main theoretical approaches, i.e., its research programs.

2.2 Cognitive Science Research Programs

2.2.1 Traditional Computational-Representational View of Cognition

Traditionally, cognition denotes the mediating processes between sensory perception and action (Walter & Stephan, 2013). In this "sandwich model", cognition is clearly demarcated from mechanisms for sensory perception on the one hand and execution of action on the other (Hurley, 1998). The guiding metaphor for the mind is the computer as an information processor: Mental processes are realized as computations over mental representations (e.g., thoughts, concepts, ideas, rules, images, etc.) in the mind (e.g., Bermúdez, 2020; Friedenberg & Silverman, 2016; Thagard, 2019). In other words, perceptual information about the world from our senses is represented in our mind, stored in memory, processed (computed) in thought and can thus affect our actions (e.g., Friedenberg & Silverman, 2016; Kolak et al., 2006). The relationship between mind and brain is conceived analogous to that between software and hardware of a computer, i.e., the mind is seen as the software which runs on the brain as its hardware (e.g., Clark, 2014; Kolak et al., 2006). The mechanistic nature of computation prompts the conception of the mind as a machine (e.g., Boden, 2006; Friedenberg &

Silverman, 2016). There are two classical approaches to this computational-representational understanding of the mind: *physical symbol systems* and *connectionism* (Clark, 2014).

According to the *physical symbol systems* (or *symbol manipulation, symbol crunching*) approach to the study of cognition, intelligent behavior is realized through sequentially executed rule-bound manipulations of discrete physical symbolic structures in a purely causal-mechanical fashion (Bermúdez, 2020; Clark, 2014). In other words, symbolic structures are manipulated through an algorithm, i.e., computations over representations. A physical symbol system's particular symbolic structures can designate real-world objects through causal or dependency relationships to that particular symbol system (A. Newell & Simon, 1976). According to the "physical symbol system hypothesis" proposed by the artificial intelligence pioneers Allen Newell and Herbert A. Simon, such a system "has the necessary and sufficient means for general intelligent action" (A. Newell & Simon, 1976, p. 116). Given this hypothesis, human intelligence can be analyzed and understood in terms of physical symbol systems. The fact that such systems can be described formally (e.g., in principle with pencil on paper) and functionally realized in different physical substrata (e.g., silicon based computers) enables the study of cognitive capacities abstracted from (knowledge about) the concrete neural structures realizing them in the brain (Clark, 2014). The physical symbol systems approach to cognition has been successfully applied to expert systems and machine learning techniques in artificial intelligence (Bermúdez, 2020).

An alternative computational-representational approach to the study of cognition is known as *connectionism*. It is based on the assumption that the physical architecture of the brain is not irrelevant for the study of human cognition (Bermúdez, 2020). Put differently, studying models of connected brain cells might lead to a more realistic picture of how cognitive capacities are actually realized. In artificial neural network models the centralized and sequential (step-by-step) processing characteristic for physical symbol systems is replaced by parallel distributed processing (Bermúdez, 2020; Clark, 2014). Furthermore, a unit (i.e., a model of a single brain cell) of an artificial neural network is not necessarily a representational unit (Bermúdez, 2020). With the exception of so-called localist networks, representational states are distributed all over a network (subsymbolic or distributed representation) through the activation functions of units (representations of the thresholds for neuron firing) and the weights between units (representations of the strength of inter-neuron connections) (Bermúdez, 2020). Finally, the operations of an artificial neural network are not explicitly 'coded' by its designers (Clark, 2014). Instead, such networks can learn to perform a task using learning algorithms which can change the thresholds of activation functions of units or the weights between units (Bermúdez, 2020). For instance, models have been developed that can account for aspects of language acquisition (e.g., tense learning) without the need to ex-

plicitly 'code' any linguistic rules into these models (Bermúdez, 2020). It is the whole structure of the artificial neural network that is responsible for the emergence of cognitive performance (Bermúdez, 2020). Today, a particular successful family of artificial neural network characterized by many layers of units is known as deep learning (Bermúdez, 2020).

In summary, both physical symbol systems and artificial neural networks can be considered computer models of the mind with different forms of information processing and ways of representing (Thagard, 2019). Despite their differences, the two approaches are not necessarily in conflict. For instance, computational cognitive hybrid architectures combine the strengths of each approach within the same overall model of the mind (Bermúdez, 2020). Furthermore, both approaches to the study of cognition abstract from its underlying biological substrate. Even though connectionist models are inspired by the neuroanatomy of connected brain cells, they are still extremely idealized models which ignore many details known about the nervous system (Bermúdez, 2020). In addition, some proposed learning algorithms are biologically implausible (Bermúdez, 2020). Nevertheless, the computational-representational view of the mind characterized cognitive science from its beginning (Sturm & Gundlach, 2013), and is still dominant in many cognitive science introduction texts (e.g., Bermúdez, 2014; Friedenberg & Silverman, 2016; Kolak et al., 2006; Li & Sobel, 2013; Thagard, 2005b) as well as in the latest *Oxford Handbook of Cognition Science* which "is intended to facilitate the progress of students who will determine the future of cognitive science" (Chipman, 2017, p. 10).

2.2.2 Situated/4E View of Cognition

To say that the traditional view of cognitive science just presented has been called into question by various alternative approaches may even be an understatement. As the author of an 2017 article on the development of the field summarized, "virtually every aspect of this initial sketch of the nature of cognition and cognitive explanation has now been challenged" (Buckner & Fridland, 2017, p. 4191). The relevant keywords are dynamicism, embodied cognition, embedded cognition, extended mind, distributed (or social) cognition and enactivism (e.g., Clark, 2014; Walter & Stephan, 2013).

Core themes of these approaches are often summarized under the labels "situated cognition" (Bechtel, 2009; Bermúdez, 2020; Lyre & Walter, 2013), "4E cognition" (for embodied, embedded, extended and enactive) (Newen et al., 2018), "embodied cognitive science" (understood in a very broad sense of including aspects highlighted under other keywords) (Dawson, 2013; Wilson & Foglia, 2017), or just "enactivism" (Gallagher, 2017). For the sake of simplicity, I will refer to these approaches collectively as *situated/4E cognition*. The increasing interest in these approaches, especially over the last two decades, has even led some

authors to claim a general move away from the traditional computational-representational view towards situated/4E cognition ("E-turn" or "pragmatic turn") (Engel et al., 2015; Kirchhoff, 2018). However, the unity suggested by these common labels is in contrast to a number of disagreements about theoretical and philosophical issues (Menary, 2010; Newen et al., 2018). On a weak interpretation, the different approaches are less about a competing well-defined research program, but rather each expresses a different perspective on important aspects of cognition (Lyre & Walter, 2013). On such an interpretation, core themes of these approaches are not necessarily in contradiction with computational-representational views of the mind, but rather extend them (Bechtel, 2009; Newen et al., 2018; Walter, 2014). However, in a stronger interpretation these approaches are grouped together because of their explicit opposition to the basic assumptions of the computer model of the mind (Newen et al., 2018). The most radical proponents even reject any conception of cognition in terms of computation or representation (Kiverstein, 2012; Newen et al., 2018).

A common assumption of all these approaches is the conviction that cognition is not just solely located in the brain, but rather involves the body and the world, i.e., our natural, social/cultural and technological world (Lyre & Walter, 2013; Newen et al., 2018). In other words, cognition is situated in the brain, the body, and the world. On this view cognition is always dependent on specific situations or contexts (Engel et al., 2015; Newen et al., 2018), and thus the human mind becomes enculturated (Menary, 2015). As a consequence, cognition cannot be abstracted from the (plastic) brain, the body, and the environment without distorting the resulting picture – as it is the case with the traditional view of cognition. Therefore, explanations of cognition have to take into account the dynamical relationships between the environment, the body, and the brain (Gallagher, 2017). In stark contrast to the computer model of the mind, cognition is seen as grounded in sensorimotor skills rather than mental representations, and primarily concerned with action, instead of representational thinking (cognition based on use of symbols) over a stored repository of world knowledge (Engel et al., 2015). The top-down reverse engineering mindset associated with the physical symbol systems approach, which asks how intelligent behavior can be realized by abstract rules manipulating symbols in the mind, is replaced by a bottom-up approach, which asks how a cognitive agent immersed in a concrete environmental context can perform a specific cognitive task through practically and directly exploiting the specific features of its body and the (natural, social/cultural, technological) environment (Dawson, 2013; Walter, 2014). The previously discussed classical sandwich model according to which cognition happens 'offline', i.e., between sensory perception and action, is replaced with a situated model of 'online' sensorimotor cognition realized through continious real-time perception-action couplings – "the kinds of dynamics and complex response loops that couple real brains, bodies, and environments"

(Clark, 1997, pp. 1–2). Thus, "cognition is understood as the capacity to generate structure by action." (Engel et al., 2015, p. 3) In other words, practical know-how embodied in sensorimotor skills is prior to theoretical knowledge and reasoning. It is the whole body embedded in its environment which provides the foundation for the emergence of all higher cognitive capacities such as reasoning, language use or planing (Clark, 1997; Gallagher, 2017; Wheeler, 2005).

2.2.3 Current Trend: Predictive Processing

One of the most recent and ambitious research trends attempts to provide a unified explanatory account of cognition within a single framework by integrating situated/4E cognition with neuroscientific models known as *predictive processing* (or predictive mind, Bayesian brain hypothesis, action-oriented predictive processing – all associated with free energy principle) (Kirchhoff, 2018). In a nutshell, the predictive processing account of perception claims that the brain continually anticipates current and future sensory perceptions and their sources based on hierarchically organized representations of the environment, which are updated according to predication errors minimized by principles of Bayesian inference (Wiese & Metzinger, 2017). In everyday language, this means that whatever we perceive with our senses is already constructed by our brains based on our prior experience and knowledge about the world. Although typical examples for this approach focus on perception, the theoretical framework of predictive processing has an impressive range of applications (Clark, 2013), and many of them cover all cognitive capacities from perception to action in a unified way (Wiese & Metzinger, 2017). Given that the predictive processing framework is actually a computational-representational account (Wiese & Metzinger, 2017), it may be initially surprising to see it discussed together with situated/4E approaches which typically downplay the role of such processes (Kirchhoff, 2018). Nevertheless, it is considered as "one of the most cutting-edge and fast-moving intersections of research in the contemporary sciences of mind and brain" (Kirchhoff, 2018, p. 2355).

2.3 Summary

Chipman's (2017) union and intersection definitions of cognitive science initially structure the field regarding disciplinary and interdisciplinary research. The definitions help to understand in which respect cognitive science can be considered as an integrated interdisciplinary field and to identify the potential 'research space' of the interdisciplinary researcher in cognitive science. The various theoretical approaches or research programs in cognitive science 'populate' different (and sometimes overlapping) areas of this research space.

The computational-representational (or information processing) view of the mind, which has characterized cognitive science from its very beginning, is still dominant in many currently available introductory textbooks on cognitive science. However, the situated/4E view with its pragmatic conception of cognition at its roots and its emphasis on brain-body-environment interactions has strongly gained momentum over the last two decades. Furthermore, the alleged unifying theoretical capacity of the predictive processing approach to cognition is considered a current research trend on cognition.

It is these major theoretical approaches (or research programs) which characterize contemporary cognitive science (see Clark, 2014), and thus shape the expectations of first-year students about how to identify genuine cognitive science research done at their universities and the associated interdisciplinary research practice. In the case of the MEi:CogSci, these approaches are the relevant theoretical frameworks students are required to know for engaging in interdisciplinary research in cognitive science.

With respect to interdisciplinarity practice it seems to be obvious how interdisciplinary research within the traditional computational-representational view of cognition can be characterized. Insights from different cognitive science disciplines are integrated into computational models in either the physical symbol systems or artificial neural networks approach to cognition (Chipman, 2017). Both approaches are even compatible and can coexist, for instance, inside computational cognitive hybrid architectures (Chipman, 2017). The integrative frame of reference for research is computational modeling. This also suggests a specific academic job profile for the interdisciplinary researcher in cognitive science. Solid skills in computational modeling as well as detailed theoretical knowledge about the computational-representational research programs are required for such work. Furthermore, these researchers certainly require knowledge in one or more cognitive science disciplines – at least to a level which enables smooth collaboration and communication with experts from these disciplines on common research projects. Such a professional profile would match with Chipman's intersection definition of the professional identity of cognitive scientists and would thus clearly distinguish interdisciplinary researchers from disciplinary researchers in cognitive science.

The situation, however, is rather different when the situated/4E view of cognition is considered. On this view of cognition, it does not seem obvious by which means interdisciplinary integration of insights from different disciplines is achieved and how the professional profile for an interdisciplinary researcher in this area of cognitive science would look like. For one thing, this may be due to the fact that my description of the situated/4E view of cognition in the context of this thesis is very abstract and subsumes approaches which differ in their specific characteristics. Engineering physical artifacts such as robots that interact with the real world can be regarded as one paradigmatic way of practicing interdisciplinary research

on the situated/4E view of cognition (e.g., Bermúdez, 2020; Prescott & Verschure, 2015). Nevertheless, the situated/4E view of cognition cannot be considered a coherent and theoretical well-defined research program (Lyre & Walter, 2013). In this sense, the situation is in stark contrast to the computational-representational view of cognition, which provides a clear conceptual framework for interdisciplinary integration. The tensions resulting from this incoherences are evident in the discussions of predictive processing in the context of situated/4E cognition (Kirchhoff, 2018). Therefore, the question of what it means to become an interdisciplinary researcher in the area of situated/4E cognition is of particular interest in the context of this thesis. What interdisciplinary skills, competences or virtues would be required for future cognitive scientists working in this area of research? What theoretical and practical knowledge about interdisciplinary research would be beneficial? How should students develop their professional profiles as interdisciplinary researchers in the area of situated/4E cognition? It is especially these questions that drive the next two chapters.

3 Interdisciplinary Practice in Cognitive Science: A Short Review of Introductory Texts

As discussed in the previous chapter, the different theoretical approaches or research programs in cognitive science are of central importance for interdisciplinary integration of insights from different contributing disciplines (see chapter 2). But how is interdisciplinarity actually practiced by cognitive scientists?

Interdisciplinarity is probably the most exciting thing and the main reason for many students to choose a study program in cognitive science rather than one in a contribution discipline. It is certainly reasonable to suppose that interdisciplinarity is the special and unique feature of cognitive science which clearly differentiates it from disciplinary approaches to the mind such as psychology. Indeed, the official dictionary of the American Psychological Association (APA) defines psychology as "the study of mind and behavior", whereas cognitive science is defined as "an interdisciplinary approach to understanding the mind and mental processes" (VandenBos, 2015). Apart from being focused on mental processes, interdisciplinarity is its main distinctive feature. In fact, it is typically stressed that cognitive science is an interdisciplinary endeavor (e.g., Bermúdez, 2020; Friedenberg & Silverman, 2016; Thagard, 2019). It is even introduced as the "hallmark of cognitive science" (Friedenberg & Silverman, 2016, p. 2).

In contrast, it is rather obscure how interdisciplinarity finds its concrete manifestation in the research practice of individual cognitive scientists from such declarations alone. What is the difference between the interdisciplinary researcher as compared to the disciplinary researcher (of one of the cognitive science disciplines) with respect to (research) skills and the research process? What theoretical and practical knowledge about interdisciplinary research processes is unique to the interdisciplinary researcher?

In the following sections I will provide a short overview of how interdisciplinary practice in cognitive science is covered in introductory cognitive science texts and in the cognitive science specific literature on interdisciplinarity. The guiding question is: How does the topic appear to first-year students, who would like to learn about interdisciplinary research practice, especially, at the level of research projects?

3.1 Interdisciplinary Practice in Cognitive Science Textbooks

Surprisingly, there is not much content on what interdisciplinarity means in actual research practice within the introductory cognitive science literature. Broadly speaking, it is clear that at least some core disciplines are involved and that disciplinary knowledge on the mind is

somehow integrated into cognitive science through "intercommunication and cooperation among practitioners of these disciplines" or the "interaction" of the disciplines (Friedenberg & Silverman, 2016, p. 2). Unfortunately, such abstract descriptions almost exhaust the topic in major English-language textbooks (see Bermúdez, 2020; Dawson, 2013; Friedenberg & Silverman, 2016; Kolak et al., 2006; Li & Sobel, 2013; Thagard, 2005b). There is rarely a chapter explicitly dedicated to interdisciplinarity and how it is actually practiced. Friedenberg and Silverman (2016) introduce the parable of the "Blind Men and the Elephant" in their textbook (pp. 13-14). In their version, each of five blind men touches an elephant on a different spot (the tusk, trunk, ear, leg, tail) which results in disagreements about what kind of object it is that they are investigating. Luckily, through collaborating and sharing their insights the men are finally able to reconcile their different and conflicting views by jointly creating an integrative picture of the elephant. The authors present this story as a metaphor for the interdisciplinary character of cognitive science. Although I regard this as a vivid picture illustrating how different disciplines may focus on different aspects of the same target phenomenon and the relativity of disciplinary perspectives with respect to complex phenomena, it is not very informative about how such interdisciplinary collaboration actually looks like in practice, i.e., what the specific features of an interdisciplinary research process are.

The way cognitive science textbooks approach its interdisciplinary character does not seem to be of much help either. Thagard (2005b) describes the three ways an author could introduce cognitive science to a multidisciplinary audience in the preface of his textbook *Mind: Introduction to Cognitive Science*. The fist approach would be to organize it by the contributing disciplines of cognitive science. Examples are *Cognitive Science: An Introduction to the Study of Mind* (Friedenberg & Silverman, 2016) and *The Cognitive Sciences: An Interdisciplinary Approach* (Li & Sobel, 2013). In these books the perspectives on the mind of different disciplines are presented in separate chapters after a general introduction. The second approach Thagard considers, is to organize it around different cognitive capacities, such as attention, learning, language comprehension, memory, etc. An example is *Cognitive Science: An Introduction to Mind and Brain (Kolak et al., 2006),* where the authors dedicate single chapters to perception, thought (including memory and knowledge), action and emotion, language and consciousness. Thagard himself chooses a third approach for his book, that of "systematically describing and evaluating the main theories of mental representation that have been advocated by cognitive scientists, including logic, rules, concepts, analogies, images, and connections (artificial neural networks)" (Thagard, 2005b, p. x).

However, there is a laudable exception: Bermúdez (2014) explicitly organizes his textbook around the interdisciplinary integration of insights and methods from different disciplines. The second edition of his *Cognitive Science: An Introduction to the Science of the*

Mind is organized around the "Integration Challenge", to which he dedicates a whole part of 55 pages of the book (Bermúdez, 2014). The part includes a model of a three-dimensional cognitive science research space, an introduction to inter-theoretical reduction, examples of local integration, and discussions of levels of explanation, the range of applications of David Marr's classical tri-level hypothesis and even some cognitive architectures. Unfortunately, this part is no longer present in the third and revised edition of the book, which has been just released this year. The reason for removing this content is noteworthy: The author "wanted to make the book more accessible for students in the first and second years of their studies." (Bermúdez, 2020, p. xxiv) Therefore,

> the third edition no longer uses the integration challenge as an organizing principle. The additional layer of complexity is useful for many purposes, but not, I now think, for pedagogical ones. (Bermúdez, 2020, p. xxiv)

This might be irritating or even disillusioning for students whose major motivation for studying an interdisciplinary program is to learn how knowledge from different disciplines is integrated towards solving a complex scientific problem or explaining a specific cognitive phenomenon. Is not exactly this at the heart of interdisciplinary practice? If it is actually the case that these topics are too demanding or advanced for students in the first two years of their studies, what does this mean for students of a two year master's program in cognitive science like the MEi:CogSci? However, the author may have undergraduate students in mind who start a bachelor's program in cognitive science. The situation may be quite different, when students already have a bachelor's degree in one of the core disciplines of cognitive science.

3.2 Paul Thagard on Interdisciplinary Practice in Cognitive Science

Although cognitive science textbooks are generally not helpful to get a better picture of interdisciplinary practice in cognitive science, some clarification is provided by the philosopher and cognitive scientist Paul Thagard. Thagard's (2005a, 2017) two book chapters on interdisciplinary practice in cognitive science as contributions to the literature on interdisciplinarity are of particular value, as this issue seems to be scarcely written about, at least with specific reference to cognitive science.

In his book chapter "Being Interdisciplinary: Trading Zones in Cognitive Science" Thagard (2005a) draws on the anthropological metaphor of "trading zones" between different cultures (which he adopts from Galison (1997)) to illustrate the interdisciplinary character of cognitive science as a global research enterprise. The underlying idea is quite simple: Similar to the way different cultural groups were able to establish common ground for the purpose of

exchanging goods despite their otherwise irreconcilable worldviews, interdisciplinary interaction between disciplines is also possible on some common topics despite their different disciplinary perspectives. In other words, they can agree on local details although their global views may be in conflict. According to Thagard (2005a), these trading zones develop at the intersections of the core disciplines and are constituted by people, places, organizations, ideas, and methods:

- People, both at the inception and in the maturity of the field, who are willing and eager to cross disciplinary boundaries.
- Places where interdisciplinary communication and communication is encouraged.
- Organizations such as societies and journals that foster interdisciplinary communication.
- Ideas that provide bridges between disciplines and show that problems cross disciplines.
- Methods that require participation of people trained in more than one discipline. (Thagard, 2005a, p. 337)

Thagard even provides a more detailed description of the interdisciplinary practice of researchers in his "Cognitive Science" chapter in the *The Oxford Handbook of Interdisciplinarity*, where he distinguishes three distinct "styles" of interdisciplinarity within cognitive science (Thagard, 2017, p. 191).

The *first style* is about the individual researcher who tries to combine ideas and methods at the intersection of at least two disciplines (Thagard, 2017). However, as Thagard already remarks at the beginning of his chapter, this is almost impossible to manage in practice. He points out that it is already hard to become an expert in one discipline and that it seems questionable to acquire a similar level of expertise in two or even more disciplines and to follow the state of research. In a similar vein, Friedenberg and Silverman (2016) modestly state in their cognitive science textbook that "the most that can be expected is some degree of familiarity with the literature and techniques of disciplines outside one's own specific area" (p. 455).

The *second style* of interdisciplinarity research is about the direct collaboration of experts from different fields on common projects (Thagard, 2017). In other words, it is about teamwork. Thagard notes that this has often been the most common and successful form of interdisciplinarity in cognitive science and that it only requires a basic level of mutual understanding between the collaborators, rather than detailed or specialized knowledge and skills in multiple domains and methods.

Finally, the *third style* is basically about relying on one's disciplinary expertise, but to apply it to topics or problems, which are of high relevance for experts from other fields of the

cognitive science research community or even inspired by their work (Thagard, 2017). Although this approach does not appear to be a genuine case of interdisciplinary research in the sense of combining theories or methods from different disciplines or direct collaboration with peers from other fields, Thagard emphasizes, that much fruitful work in cognitive science has been done in this way. To provide an example, he points to the multidisciplinary academic journal *Cognitive Science*. Many published articles in this journal are contributions from single fields, but they are still relevant for researchers from other fields (Thagard, 2017). According to Thagard, this approach typically requires basic knowledge of other cognitive science disciplines as well as familiarity with its literature, but he regards it as far less demanding than the previous two styles of interdisciplinary engagement. However, I suppose that a specific challenge in this case lies in communicating the (potential) relevance and impact of one's own work for the work of other researchers of the multidisciplinary target audience.

3.3 Summary

Overall, the description of interdisciplinary practice in cognitive science is rather abstract in introductions to the field. The references to collaboration and communication in cognitive science textbooks are only marginally helpful for first-year students because there are typically no further details on how collaborative interdisciplinary research is actually practiced on the project level, i.e., how interdisciplinary research processes actually look like. Nor are there any elaborations on specific challenges of interdisciplinary communication, such as particular strategies or best practices to address them. In this sense, it is disappointing that the parable of the 'blind man and the elephant', which is intended to illustrate how interdisciplinary collaboration solves complex problems, at the same time obscures the fact that the actual challenge may often lie in conflict resolution and questions of how to integrate different disciplinary perspectives into a coherent picture.[16]

Although Thagard gives a more detailed account of how interdisciplinarity can be understood in cognitive science by utilizing the metaphor of trading zones, it appears to have most value for describing cognitive science as a global research enterprise or larger-scale research endeavor (e.g., the whole cognitive science research initiative at a university), but is of rather limited use for illuminating interdisciplinary practice at the project level. His distinction between the three styles of interdisciplinary work in cognitive science can certainly provide some initial orientation for students. Nevertheless, details on or references to the theory and practice of interdisciplinary research processes or best practices are not addressed.

16 It could be argued that this is not the aim of introductory textbooks in cognitive science, which are supposed to provide a theoretical introduction to the field rather than to address practical concerns. However, I think that the emphasis on interdisciplinarity justifies demanding at least references to further reading on interdisciplinary research practice.

4 Interdisciplinary Practice in Academic Cognitive Science Environments and the Professional Identity of the Interdisciplinary Researcher in Cognitive Science

Theoretical and practical aspects of how to conduct interdisciplinary research are typically not addressed in the introductory cognitive science literature (see chapter 3).[17] Therefore, it appears to be reasonable for students to expect that they will learn all about them in the context of an interdisciplinary program in cognitive science such as the MEi:CogSci. What else – one could ask – would be at the heart of an interdisciplinary program in cognitive science, if not learning how to anticipate the potential interdisciplinary interactions between different disciplinary fields of research and how to practice (collaborative) interdisciplinary research by connecting and integrating knowledge from different disciplines to address complex phenomena or problems? Is this not the major characteristic for interdisciplinary researchers in cognitive science?

I think that such reasonable expectations as well as the image of cognitive science as an interdisciplinary field I sketched out previously (see chapter 2) – including the much more substantial and elaborate versions which can be found in introductory textbooks or handbooks – are both misguiding with respect to what students actually find in many interdisciplinary study programs in cognitive science (such as the MEi:CogSci) at their universities. They are misguiding (1) in terms of how cognitive science research is actually conducted at a particular university and (2) in terms of how interdisciplinary practice is understood. These two aspects are interconnected and have further consequences with respect to what it means to be an interdisciplinary researcher in cognitive science. The resulting image, however, can be in stark contrast to the initial motivations and expectations of students for starting an interdisciplinary program.

In my view the major confusions and misunderstandings are ultimately about what it means to become an interdisciplinary researcher in cognitive science from a student perspective. Based on the introduction to cognitive science and interdisciplinary practice in cognitive science provided above (chapter 2 and 3), the sources of these confusions will become clear as soon as one gets a better understanding of how real-world academic cognitive science environments looks like at universities. I will use the label 'academic cognitive science environment' to refer to to the sum of practices related to research and education in cognitive science

17 However, dedicated specialized literature from within the cognitive science seems to be nonexistent too.

together with the utilized infrastructure and administration/service activities at a particular university.[18] In the following sections, I will provide a brief overview of the organizational structure of real-world academic cognitive science environments at universities, the interdisciplinary practices such environments enable, and the resulting consequences for the professional identity of cognitive scientists as interdisciplinary researchers.

4.1 Organizational Structure of Academic Cognitive Science Environments

4.1.1 Distributed Academic Cognitive Science Environments and Their Multidisciplinary Character

In the specific case of the MEi:CogSci joint partner universities the local academic cognitive science environments are spread across multiple departments. The program is also administrated at different faculties or departments at each partner university.[19] Furthermore, the number and selection of participating departments from different disciplines also vary among the partner universities.

Although universities often foster collaboration and communication among researchers from different disciplines by creating dedicated research centers – or clusters, platforms, hubs, etc. – (Friedenberg & Silverman, 2016),[20] such a distributed structure of academic cognitive science environments, where research and education is spread across faculties or departments of universities (and sometimes even across universities) may appear 'half-baked' for first-year students. One could certainly expect to find more integrated and disciplinary well-balanced cognitive science departments at universities with faculty from all the core cognitive science disciplines, which also operate and administrate cognitive science degree programs, given that the institutionalization of cognitive science as a research enterprise already started in the mid-1970s (Thagard, 2019).

However, as Graff (2015) in his historic case study on the interdisciplinary character of cognitive science points out, it never really developed into an interdiscipline with clearly articulated relationships between a stable set of core disciplines and a well-defined research focus via a common set of questions. Although cognitive science is regarded as interdisciplinary almost by definition, based on Graff's study, it looks like that the more or less loosely connected collaborative efforts between some departments and researchers at (or across some)

18 In other words, a characterization of a university department or faculty, without its actual physical presence.

19 At the Department of Applied Informatics at the Comenius University in Bratislava, the Faculty of Education and Psychology at Eötvös Loránd University Budapest, the Faculty of Education at the University of Ljubljana and the Department of Philosophy at the University of Vienna.

20 In the case of the MEi:CogSci partner universities there is the Centre for Cognitive Science at the Comenius University in Bratislava, the Center for Cognitive Science at the University of Ljubljana Faculty of Education and the Vienna Cognitive Science Hub at the University of Vienna.

particular universities have always been the norm and in this sense decisive about the local understanding of what cognitive science research is mainly about – e.g., how the relationships between its disciplines are conceived and which topics and methods are most relevant. Moreover, according to Mandler (1996) the constituting (and sometimes varying number of) disciplines may be regarded as independent "cognitive sciences" on their own (i.e., sciences concerned with studying some cognitive phenomena) with no need for an overarching "cognitive science" label (as cited in Graff, 2015, pp. 158–159). Overall, Graff concludes that cognitive science is "at most, multidisciplinary, a congeries of discipline-based efforts to address a set of questions whose center is strangely undefined" (p. 133).

It is worth noticing that Graff (2015) characterizes cognitive science as *multidisciplinary* rather than interdisciplinary. The distinction between multidisciplinarity and interdisciplinarity is used in the theoretical discourse on interdisciplinarity to highlight that the majority of scholars in this field consider the integration of disciplines or of knowledge from different disciplines as the benchmark for genuine interdisciplinary endeavors (Klein, 2017). Multidisciplinarity refers to the juxtaposition of disciplines or disciplinary research on a shared topic or problem (Klein, 2017). In other words, a topic or problem is tackled from different disciplinary perspectives, but neither are the disciplines integrated into a coherent new field (i.e., an *interdiscipline*) on the topic, nor are the different disciplinary insights integrated toward a more comprehensive understanding of the problem at stake (Klein, 2017). In both cases they are rather juxtaposed. Multidisciplinary research draws on knowledge from different disciplines, but keeps the respective disciplinary identities intact (B. C. K. Choi & Pak, 2006; Klein, 2017). By contrast, genuine interdisciplinarity – also referred to as *theoretical*, *integrated* or *conceptual interdisciplinarity* (Klein, 2017) – would require integration of knowledge toward something new. Therefore, describing cognitive science as interdisciplinary often just abstractly refers to the collaboration between disciplines and more-than-disciplinary approaches to research. Yet, when cognitive science (as an empirical scientific enterprise) is understood under Chipman's (2017) union definition, which I regard as the standard case, it would for the most part be more adequately characterized as multidisciplinary.

Graff's historical account with its characterization of cognitive science as multidisciplinary is in line with the results of a recent empirical study by Núñez et al. (2019) in which the authors attempt to show that cognitive science failed to mature into a coherent interdisciplinary academic field based on bibliometric and socio-institutional data. With respect to undergraduate study programs, Núñez et al. found that cognitive science curricula are incoherent and inconsistent regarding the representation of core disciplines, i.e., which disciplines are included in the curricula and the amount of training students receive in each discipline, as well as genuine cognitive science contents among different universities in North America.

For instance, they report that there are not even explicitly labeled cognitive sciences courses as part of cognitive science study programs at some universities. Furthermore, they found that dedicated cognitive science departments with academic staff and research groups from multiple disciplines, which also grant PhDs in cognitive science are barely existent. Since, "a curriculum is a constitutive part of the definition of a field", would it not be a sign of maturity to train future generations of cognitive scientists based on a common body of knowledge independent of the university where they begin their studies (Núñez et al., 2019, p. 17)?[21]

Núñez's et al. (2019) article provoked a number of critical commentaries in the academic journal *Topics in Cognitive Science* (see Gray, 2019 for an introduction to the commentaries), which predominantly defend cognitive science as a very fruitful scientific enterprise. Although the situation is not straightforward, Núñez's et al. multidisciplinary characterization of cognitive science as well as its distributed 'institutionalization' over different (disciplinary) departments is more or less acknowledged in the commentaries (e.g., see Broude et al., 2019; Cooper, 2019; R. M. French, 2019; Gentner, 2019).[22] Moreover, as Richard P. Cooper, the current editor of the journal *Cognitive Science* points out in his commentary, their observations regarding study programs should come as no surprise given the high number of core cognitive science disciplines (Cooper, 2019). According to Cooper, demanding equal training in all of the six disciplines would be highly unrealistic and only result in superficial knowledge in comparison to students, who are explicitly trained in a single discipline.

4.1.2 The Spectrum Between More Integrated and More Dispersed Academic Cognitive Science Environments

There are also a number of different practical considerations from the perspective of managing interdisciplinary study programs across departments or universities. The contents and the extent of such programs in terms of variety of courses and research opportunities for students depend on the available research environment (faculties, departments, centers, laboratories, etc.) of the particular university, the investment (time, commitment, budget, etc.) of interested parties (individual researchers/lecturers, research groups, administration) from different departments, and, overall, coordination and administration by means of pragmatic decisions within local organizational and legal constraints. Therefore, the particular disciplinary emphasis and the degree of organizational integration of an academic cognitive science environment may vary widely when these parameters are compared between different universities.

21 Graff (2015) draws the same conclusion (see pp. 138-139).
22 See Oey et al. (2020) for a very recent empirical attempt which suggests that cognitive science is moving from multidisciplinarity toward interdisciplinarity.

To get an idea of the range of this spectrum, at one end of the extreme (the 'integrated' end), the efforts at a university may be largely concentrated on one or two already dominant cognitive science core disciplines, which may also shape the overall picture of cognitive science research for students. This might especially be the case at universities with strong psychology or neuroscience departments with a dedicated research focus on cognition. For instance, some see cognitive psychology already dominating the cognitive science discourse and research agenda (e.g., Goel, 2019; Rosenbloom & Forbus, 2019; Schunn, 2019). Indeed, the trend toward the domination of psychology was even predicted ten years ago based on the proportion of papers submitted to the journal *Cognitive Science* (Gentner, 2010). According to the author's speculative calculation, cognitive science might be completely absorbed by cognitive psychology by 2038![23] Such a view of cognitive science was already expressed in the 90s by the philosopher Jerry Fodor (1935-2017), one of the most influential contributors to the field. In an interview he remarked:

> My own view is that cognitive science is basically just cognitive psychology, only done with more methodological and theoretical sophistication than cognitive psychologists have been traditionally trained to do. If you are a cognitive psychologist and know a little bit about philosophy of mind, linguistics, and computer theory, that makes you a cognitive scientist. (Baumgartner & Payr, 1995, p. 85).

In contrast to the different research programs mentioned at the beginning, cognitive science is here mainly understood as information processing psychology. Just compare Fodor's view with the following description from the latest edition of Robert J. and Karin Sternberg's popular introductory textbook *Cognitive Psychology* published 2017:

> Cognitive psychologists study how people perceive, learn, remember, and think. Although cognitive psychology is a unified field, it draws on many other fields, most notably neuroscience, computer science, linguistics, anthropology, and philosophy. (Sternberg & Sternberg, 2017, p. xxiv)

Notice that the fields cognitive psychologists draw on (according to the above description) are the ones which are typically listed as the core disciplines of cognitive science. If a cognitive science curriculum is designed and implemented at a dominant psychology department, I suppose it will be hard for students who become enculturated in such an academic environment not to see cognitive psychology as the genuine integrative center of cognitive science. In such a picture, other core disciplines are then mainly acting as 'external suppliers' for data,

23 However, it seems that some other core disciplines could reclaim some territory again (Cooper, 2019).

concepts, theories, and methods. Similar considerations can be made for neuroscience, computer science, etc.

At the other end of the extreme (the 'dispersed' end), however, where there are no departments with a strong focus on cognitive research or dedicated top-down initiatives like research centers (or clusters, platforms, hubs, etc.), which define the overall orientation or focus areas of cognitive science research at the particular university, students may find it much more difficult to even recognize the probably scattered local efforts collectively as cognitive science. In such environments bottom-up ('grassroot' like) initiatives by individual researchers and research groups doing more or less cognitive science related research at different departments will characterize the local image of cognitive science research at the level of the university. For instance, there might be an artificial neural network modeling group at the computer science department, some cognitive psychology research groups at the psychology department, some research in cognitive biology at the life science faculty, some philosophers of mind at the philosophy department, etc. There may even be relevant research from disciplinary perspectives which are not even mentioned in the mainstream cognitive science literature (e.g., from theatre studies, education, economics or sociology). At best, there will also be (temporary funded) interdisciplinary research projects on cognition or with cognitive aspects (e.g., through research fellowships). In such an academic environment many of the current research trends in cognitive science may not be represented at all. Instead, cognitive science related applied research, topics currently at the periphery of cognitive science, or topics which are traditionally more rooted in the respective disciplines may be more prominent. From the perspective of a study program implemented across departments in such an academic environment, it will be a special challenge to provide even a loose integrative picture of cognitive science for students. Suppose that only a couple of genuine interdisciplinary research projects are conducted and a significant part of research on cognition only fits remotely into prominent cognitive science research programs? In such a case it may be easy for students to side with the philosopher John R. Searle, who concluded already 25 years ago: "I am not sure whether there is such a thing as cognitive science." (Baumgartner & Payr, 1995, p. 203)

4.2 Interdisciplinary Practice in Academic Cognitive Science Environments

With regard to the organizational structure of academic cognitive science environments, students will typically find themselves somewhere in a spectrum between more integrated or more dispersed local cognitive science research environments with different disciplinary or

theoretical perspectives emphasized at their universities.[24] It is in such academic cognitive science environments in which interdisciplinary practice and interdisciplinary study programs are embedded. Therefore, knowledge of the particular organizational structure of such an academic environment is required to shed light on the details of the specific manifestation of interdisciplinary practice (Lerch, 2017, pp. 98–99), i.e., the extend, intensity and kinds of interdisciplinary collaboration and communication between the interested parties, which the specific organizational structure together with the existing cognitive science related research actually enables. For the sake of clarity, I propose to consider interdisciplinary practice at academic cognitive science environments at two different levels: Firstly, on an organizational level of research centers (or clusters, platforms, hubs, etc.) and/or across departments (or even universities). Secondly, on the level of ongoing (basic) research endeavors and (temporary) projects.

4.2.1 The Organizational Level of Interdisciplinary Practice

Above all, many interdisciplinary activities can exist at an organizational level between the different stakeholders of cognitive science research centers (or clusters, platforms, hubs, etc.) and/or from different departments. However, students may not identify such work as instances of genuine interdisciplinary cooperation, but rather as administrative activities alongside with it, since they are not immediately related to a research topic. Nevertheless, organizing joint events such as multidisciplinary conferences, symposia, lectures and lecture series, workshops, summer schools, etc. is a vital part of creating a flourishing socio-cultural academic cognitive science environment.[25] These events can be regarded as interdisciplinary trading zones in Thagard's sense (Thagard, 2005a). These joint events strengthen coherence and foster communication among interested parties across departments and universities. They are opportunities for researchers to present their work and research interests to a multidisciplinary audience of colleagues and interested students. This might in turn inspire the research of others or lead to (new) collaborations between researchers from different disciplines: Some may decide to contribute to work of colleagues from a different department, or to work together on a new topic based on shared interests, or even apply for research grants together as an interdisciplinary team. Nevertheless, researchers engaging in interdisciplinary collaboration and communication on the organizational level do not necessarily also collaborate with colleagues from different disciplines in their own research projects and their own labs, i.e., when they do research on some aspects of cognition from their own disciplinary background. Therefore, research in cognitive science at universities is for the most part best

24 This is a very rough generalization. Even within a local cognitive science research environment, there may be clusters of related research which are more tightly integrated and others more loosely.

25 One should keep in mind that designing, implementing, and administering interdisciplinary study programs can also be considered a part of this organizational level too.

understood as *multidisciplinary,* i.e., as the juxtaposition of cognitive science relevant disciplines and research ares, which are, however, not integrated toward a common theme, question, method, problem, phenomenon, etc. (Klein, 2017).

4.2.2 The Research Level of Interdisciplinary Practice

The form of interdisciplinary practice which probably lives most up to students' expectations is manifest when different researchers collaborate directly at the level of a joint research project in a small team (of 2-8 team members). Thagard (2017) described this style of interdisciplinary interconnection as the most successful one in cognitive science (see chapter 3.2). For instance, when clinical neuroscientists and psychologists work together to set up brain imaging studies, or linguists and artificial intelligence researchers join forces to create a computational model for a specific kind of language processing. At this level, methods (*methodological interdisciplinarity*) or even concepts and theories (*theoretical interdisciplinarity*) from different disciplines are aligned toward a more comprehensive understanding of the target phenomenon or problem (Klein, 2017, pp. 24–26). However, such projects often only account for a minor part compared to the more general work on the organizational level which acts as an enabler or catalyst for such collaborative interdisciplinary research.

Finally, according to Thagard's three styles of interdisciplinary interconnections in cognitive science (see chapter 3.2), researchers may work interdisciplinary even without directly collaborating or engaging with colleagues from different disciplines (Thagard, 2017). Local researchers might practice cognitive science relevant interdisciplinary research as individuals on their own, or rather as individuals or in teams from a narrow disciplinary perspective on a topic which is also tackled by researchers from other disciplines (Thagard, 2017).

4.3 Consequences for the Professional Identity of Cognitive Scientists as Interdisciplinary Researchers

In a nutshell, the organizational structure of real-world academic cognitive science environments prompts two major ways of understanding interdisciplinary practice: On the one hand, it can refer to communication and collaboration between academic researchers from different disciplines on an organizational level for the purpose of developing or maintaining an academic cognitive science environment. On the other hand, it can refer to the actual interdisciplinary research practice in such academic cognitive science environments which is, however, often best characterized as multidisciplinary (rather than interdisciplinary).

4.3.1 Interdisciplinarity as Extension of Disciplinary Specialization

If this dual understanding of interdisciplinary practice in academic cognitive science environments is the guiding model for educating future cognitive scientists, then a cognitive science

study program is basically about specialized professional training for students in advancing, applying and representing disciplinary knowledge of one core discipline in the context of an academic cognitive science research environment and (sometimes) in interdisciplinary research teams. In other words, it is about training a disciplinary specialized researcher, who, in addition, is familiar with the current state of research in the philosophy of cognitive science and has basic knowledge of (at least one) other core discipline(s) of cognitive science. By means of this additional knowledge – including an unrealistic array of soft skills or "boundary crossing competencies" (Bierema, 2019, p. 69) typically expected by any graduate –, the disciplinary expert is thus able to collaborate and communicate more effectively with other disciplinary experts on cognitive science topics and related activities.

It is important to stress that, contrary to what the term 'interdisciplinary' suggests – i.e., working in an area between the disciplines and focusing on integration and implementation (e.g., Bammer, 2017; Repko et al., 2017) –, interdisciplinary practice *in this conception of interdisciplinarity* is not understood in opposition to disciplinary specialization. This is clearly expressed in the report of The British Academy's investigation on interdisciplinary research and higher education which focuses on the challenges and opportunities for interdisciplinary research careers (The British Academy, 2016). The researchers of inter-and transdisciplinarity Antonietta Di Giulio and Rico Defila argue for the same conlusion (Defila & Di Giulio, 1998). Contrary to the common assumption according to which interdisciplinary endeavors are about universalization, they explain that they are in general more directed toward new forms of specialization – new disciplines and sub-disciplines (Defila & Di Giulio, 1998). Thus, disciplinary specialization is also the educational goal of interdisciplinary study programs (Defila & Di Giulio, 1998). In other words, the main focus of an interdisciplinary researcher remains on building expertise in a specific field (or subfield) and problem domain. Nevertheless, specialization should be complemented with additional skills or competences, which enable effective collaboration across disciplinary boundaries.

I think it is crucial to be clear and explicit about this conception of interdisciplinary practice and competences, because otherwise it may lead to confusions for first-year students. According to the scholar of interdisciplinary studies Allan Repko, interdisciplinary researchers can be broadly divided into two categories based on their understanding of interdisciplinary practice: "generalists" and "integrationists" (Repko, 2007, p. 2; see also Repko & Szostak, 2017, pp. 221–230). Whereas *generalist interdisciplinarians* treat any form of interaction between researchers form different fields as interdisciplinary, use it in the broadest sense, and often synonymous with teamwork, *integrationist interdisciplinarians* regard integration of insights from different disciplines as *the* key characteristic of genuine interdiscipli-

nary research (Repko, 2007; Repko & Szostak, 2017). They thus have different conceptions of what it means to practice interdisciplinary research and to be an interdisciplinary researcher.

4.3.2 The Interdisciplinary Researcher in Cognitive Science as T-Shaped Researcher

The generalist conception of interdisciplinary practice and competences as basically an extension to disciplinary specialization outlined here is often dominant in the German literature on interdisciplinarity (e.g., Defila & Di Giulio, 1998; Di Giulio et al., 2008; Dressel et al., 2014; Lerch, 2017; Winfried, 2013), and probably most common among academics. In this sense it is primarily 'situated' within the boundaries of academia and thus defines the job profile for interdisciplinary academic researchers. However, as Dezure (2017) notices, such skills are highly in demand by different interest groups outside academia too:[26]

> There have been calls from higher education, industry, government, foundations, and professional associations for college graduates who will be *T-shaped professionals* who have deep disciplinary knowledge in at least one area, an understanding of systems, and an ability to function and collaborate across a variety of different disciplines and social, cultural, and economic boundaries. (Dezure, 2017, p. 560)

The 'T-shaped professional' personifies depth and breath (symbolized by the 'T') of knowledge and skills (Bierema, 2019; Hansen & Oetinger, 2001). In other words, they are domain experts with deep knowledge in a specific field but at the same time they are supposed to have broad general knowledge and skills across many other areas. This profile enables them to communicate and collaborate more easily with domain experts from different fields and to jointly solve complex problems. With respect to aspirations for a career as an interdisciplinary academic researcher, it means to focus on and excel in one research discipline according to its specific scientific standards, and as far as possible to actively engage with research done in related disciplines at the same time (Brown et al., 2015; The British Academy, 2016).

The professional identity of an interdisciplinary researcher in cognitive science can thus be understood as that of a T-shaped professional – or to follow Brown et al. (2015) as *T-shaped researcher*. An interdisciplinary researcher in cognitive science is (1) a disciplinary expert with deep knowledge in one cognitive science discipline and corresponding research area, who has also (2) broad knowledge about the basics of some other core disciplines and is (3) familiar with the theoretical discourses in the philosophy of cognitive science – the area of genuine conceptual and theoretical interdisciplinary integration.

26 See Bierema (2019) for an in-depth discussion on developing T-shaped professionals in the context of higher education as a strategy to enhance employability.

4.4 Summary

Other than the emphasis on the interdisciplinary character of cognitive science might initially suggest, actual (collaborative) interdisciplinary research between researchers of different disciplines in small teams or individual interdisciplinary research may only play a minor role in real-world academic cognitive science environments. With reference to Chipman's (2017) union and intersection definitions of cognitive science, cognitive scientists under the intersection definition are likely to be the minority in comparison to their disciplinary colleagues. Interdisciplinary collaboration and communication between researchers often manifests on an organizational level by creating interdisciplinary trading zones which can foster professional knowledge exchange across disciplines and inspire future (collaborative) interdisciplinary research. Essentially, it is the common cognitive science knowledge base, which enables engagement in (collaborative) interdisciplinary research projects on cognition, rather than any theoretical knowledge on (collaborative) interdisciplinary research processes or best practices.[27] Overall, the collective (especially empirical) research efforts in cognitive science at universities are often best understood as multidisciplinary, i.e., as the juxtaposition of research efforts on aspects of cognition from different disciplines.[28] Therefore, to be an academic interdisciplinary researcher in cognitive science typically means to be (1) a disciplinary expert in one of the cognitive sciences (i.e., one cognitive science core discipline or any other discipline or subdiscipline studying some aspects of cognition) with a dedicated research focus on some cognitive phenomenon, who also has (2) basic knowledge in some other core cognitive science disciplines and is (3) familiar with the theoretical discourses in the philosophy of cognitive science. This understanding of the cognitive scientist's professional identity as a T-shaped researcher can be derived from the way real-world academic cognitive science environments look like at universities and the resulting job profile for an academic career in this field.

27 This is probably also the main reason why neither knowledge about interdisciplinary research processes, nor guidelines or best practices for engaging in (collaborative) interdisciplinary research can be found in the cognitive science literature.

28 Therefore, intricate epistemological or methodological questions concerning the practice of interdisciplinary research projects integrating insights from multiple disciplines toward solving complex problems may only rarely pose pressing problems.

Part II: Becoming an Interdisciplinary Researcher in Cognitive Science: The Case of the MEi:CogSci

The purpose of this part is to address the question of what it means to become an interdisciplinary researcher in cognitive science by studying the MEi:CogSci. A critical analysis of the MEi:CogSci curriculum design and pedagogy shows that the MEi:CogSci can successfully train cognitive scientists as T-shaped researchers, but fails to train cognitive scientists as integrationist interdisciplinarians, which is the actual educational goal of the program.

5 MEi:CogSci Curriculum Design and Pedagogy

Given the overall multidisciplinary character of academic cognitive science environments at universities and the resulting professional identity of interdisciplinary researchers in cognitive science as T-shaped researchers specialized in one core cognitive science discipline and research area, the design and the pedagogy of cognitive science study programs can be assessed based on how well they support the training of such future cognitive scientists.

In the following sections I will derive general requirements for cognitive science curricula design and pedagogy for training T-shaped researchers based on my exposition of academic cognitive science environments (see chapter 4). Then I introduce the MEi:CogSci curriculum and apply these requirements to assess its design and pedagogy. Finally, I infer implications in terms of what it means for studying the MEi:CogSci to become an interdisciplinary researcher in cognitive science from the perspective of first-year students.

5.1 General Requirements for Cognitive Science Curricula Design and Pedagogy

Based on the organizational structure and the multidisciplinary character of academic cognitive science research environments at universities and on the specification of the job profile for interdisciplinary researchers, the design of cognitive science curricula can be considered in this light. From the perspective of a curriculum, embedded in such an academic environment with the goal of training future cognitive scientists as T-shaped professionals, it follows that there are at least four required focus areas:

1. *It must be possible for students to (further) specialize in (a) specific cognitive science relevant topic area(s) of a core discipline.* For instance, through courses and project

work in fields like cognitive psychology, computational linguistics, artificial intelligence, etc.

2. *Students need to acquire basic knowledge in other core disciplines.* Introductory courses from the different departments are a salient option here.
3. *Students are required to do at least introductory courses in the philosophy of cognitive science to get an overview of the different cognitive science research programs and learn about current trends and open questions on a conceptual and theoretical level.* Genuine interdisciplinary integration (in the sense that concepts and theories from different disciplines are synthesized to understand cognitive phenomena) is mainly achieved in the philosophy of cognitive science (e.g., Cain, 2016; Frankish & Ramsey, 2012a; Klein, 2017).
4. *Coursework needs to be complemented with practical research activities as members of interdisciplinary research teams or with supervisors working at the intersection of disciplines so that students can learn to apply their knowledge in an interdisciplinary research context.* In the best case, teaching methods from interdisciplinary pedagogy such as collaborative and cooperative learning, problem-based learning, integrative learning, etc. are an essential part of the curriculum (Dezure, 2017). According to some educational scholars, central interdisciplinary competences such as the ability to work in a team, to communicate effectively across disciplines and being reflective about one's own approaches cannot be taught directly, but are acquired *en passant* and over long periods of time through experience, e.g., in the practice of research as members of interdisciplinary research teams and through joint learning activities (Lerch, 2017, pp. 56, 94–95, 109). Therefore, such activities are crucial to prepare for the development of interdisciplinary competences in the long run.

5.2 The MEi:CogSci Curriculum Architecture

As described in the introduction (see chapter 1.3), the Bologna-conform 120 ECTS MEi:CogSci is designed as a research-based master's program, which offers a broad range of areas for specialization through project work and thesis supervision in the cognitive science research environments of the partner universities. Furthermore, team work and the interdisciplinary character realized through its curriculum architecture and pedagogical principles are particularly emphasized.[29] I will briefly provide a high-level overview of the curriculum architecture and its modular structure as a basis for further discussion.[30]

29 See https://www.meicogsci.eu/mei-cogsci.html and https://senat.univie.ac.at/fileadmin/user_upload/s_senat/konsolidierte_Masterstudien/MA_CogSci.pdf.
30 See also https://ssc-phil.univie.ac.at/studien/master-cognitive-science/curriculum/.

5.2.1 High-level Overview of the Curriculum Architecture

The MEi:CogSci curriculum implements a two-dimensional architecture conceptualized as two phases and three columns (see Figure 1). The two phases indicate the temporal dimension of the architecture: (1) the 'introductory phase' over the first and second semester and (2) the 'thematic/phenomenon and research oriented phase' over the third and fourth semester. The three columns indicate the functional organization of the architecture. Each column represents courses or student activities (e.g., project work, internships, etc.) that are (a) 'discipline oriented', (b) 'tools' (i.e., research tools such as specific methods), or belong to the (c) 'integrative kernel' as the central element for core cognitive science topics and interdisciplinary discourse. However, such courses or activities can also span over more that one column. All three columns span over the 'introductory phase' and 'thematic/phenomenon and research oriented phase'. In other words, disciplinary, methodological and theoretical cognitive science/interdisciplinary elements are longitudinally implemented over the whole course of studies.

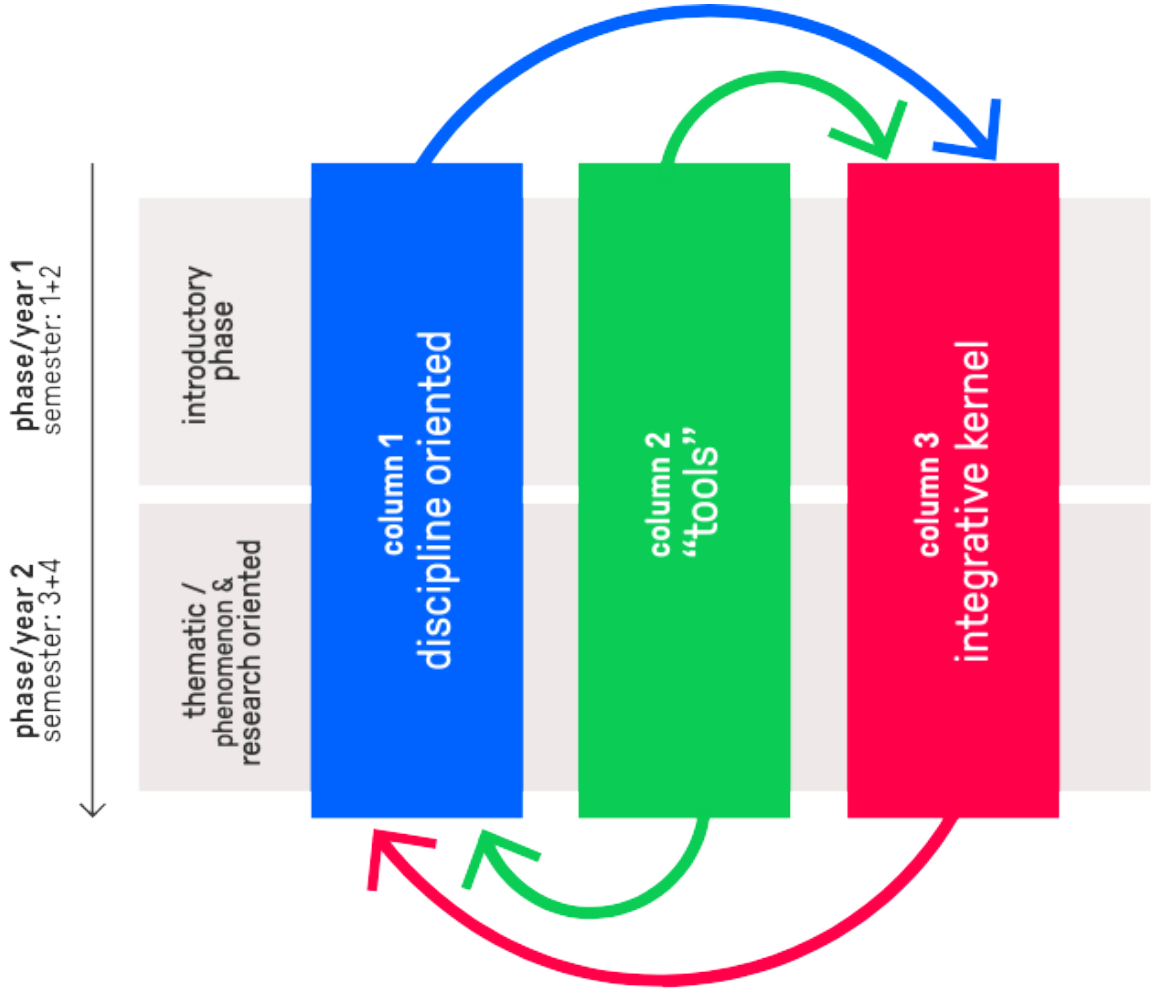

Figure 1: High-level view of the MEi:CogSci curriculum architecture

University of Vienna, https://www.meicogsci.eu/mei-cogsci.html

5.2.2 Modular Structure of the Curriculum

Courses and other student activities (such as project work) are organized into thematic modules within the two-dimensional high-level architecture of the curriculum (see Figure 2, and table 1 for the module descriptions). A certain number of credits is assigned to each module. Some modules are compulsory for all students (e.g., the modules of the integrative kernel) while other modules are compulsory only for some students as they depend on the disciplinary background of the students (i.e., basic modules in the disciplinary oriented and the tools column have to complement students' disciplinary background). The modules in the disciplinary oriented and tools column in second phase/year of the program are research-based and can be configured according to students' individual interests.[31]

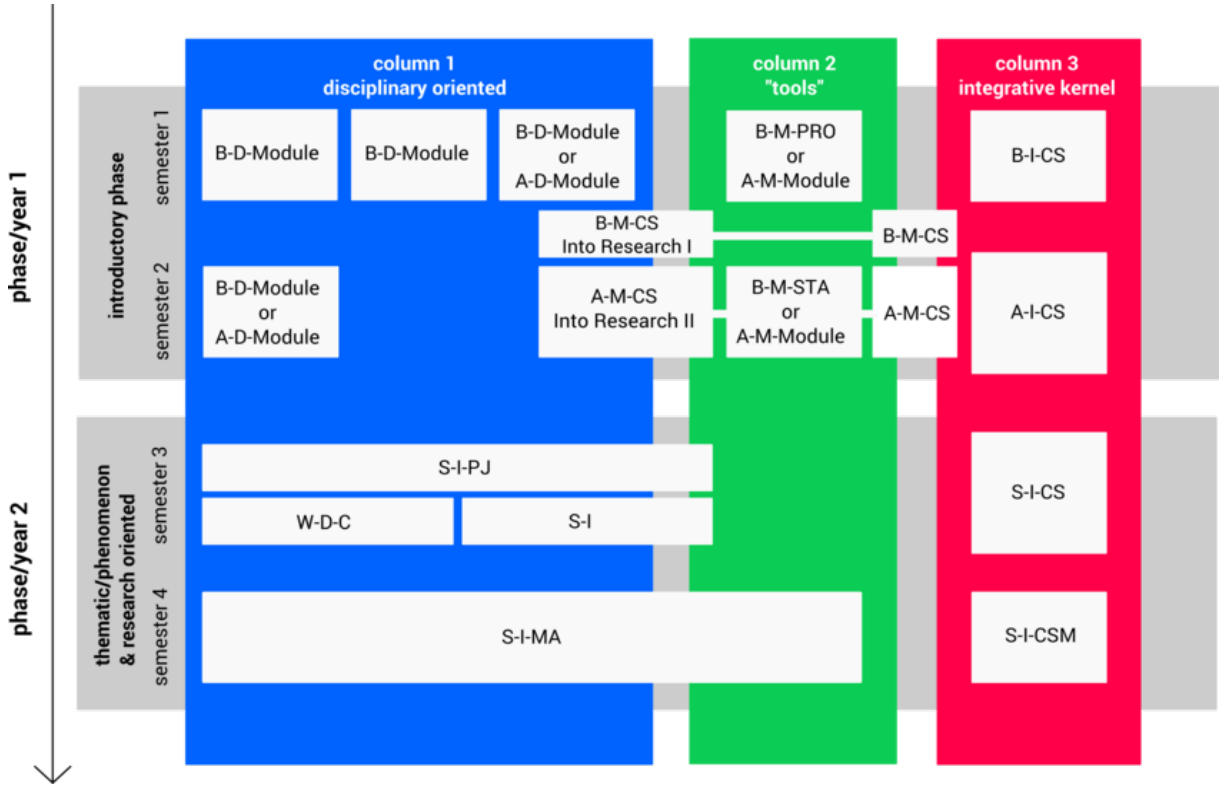

Figure 2: Modular structure of the MEi:CogSci curriculum

University of Vienna, https://ssc-phil.univie.ac.at/studien/master-cognitive-science/curriculum/

31 For more details see https://ssc-phil.univie.ac.at/fileadmin/user_upload/s_philosophie/Studien/MA_MeiCogSci/MeiCogSci_Vienna_Curriculum_Information.pdf.

The following table provides a short description of all MEi:CogSci modules:

Module Abbreviation	Module Name	Description	ECTS
B-D-Module	Basic Disciplinary Module	Contains one or more introductory courses of a particular discipline (e.g., linguistics, psychology, etc.)	5
A-D-Module	Advanced Disciplinary Module	Contains one or more advanced courses of a particular discipline (e.g., linguistics, psychology, etc.)	5
B-M-Module	Basic Methods Module	Contains one or more introductory courses on a particular method (e.g., the 'B-M-STA' basic statistics module, the 'B-M-PRO' for basic programming, or other methods such as computational modeling, EEG, etc.)	5
A-M-Module	Advanced Methods Module	Contains one or more advanced courses on a particular method (e.g., computational modeling, EEG, etc.)	5
B-I-CS	Introduction to Cognitive Science I	Contains introductory courses to core concepts of cognitive science and cognitive science research programs.	5
B-M-CS	Into Research I – Basic Methods in Cognitive Science	Contain and interdisciplinary lecture series and lab excursions to various research facilities	5
A-I-CS	Introduction to Cognitive Science II	Contains advanced theoretical courses on cognitive and topic-oriented interdisciplinary courses.	10
A-M-CS	Into Research II – Advanced Methods in Cognitive Science	First research project on a cognitive science topic (specified via a learning contract between student and project supervisor)	10
S-I-PJ	Special Topic of Interest (Project) Module	Phenomenon-oriented interdisciplinary module, which contains projects, courses, and/or literary research from at least two different disciplinary perspectives (specified via a learning contract between student and project supervisor)	10/ 15/ 20
S-I	Special Topic of Interest Module	Phenomenon-oriented interdisciplinary module, which contains projects, courses, and/or literary research from at least two different disciplinary perspectives (specified via a learning contract between student and project supervisor)	5/10
W-D-C	Elective Module	Elective courses (do not need to be cognitive science related)	5
S-I-CS	New Trends in Cognitive Science	Contains courses on current topics in cognitive science	10
S-I-MA	Master Thesis	Work on master's thesis	25
S-I-CSM	Master Thesis Seminar (and Defensio)	Seminar to support work on the master's thesis	5

Table 1: List of MEi:CogSci module abbreviations and description

5.3 Initial Assessment of the MEi:CogSci Curriculum Design and Pedagogy

Given the requirements described previously (chapter 5.1), the curriculum design and pedagogy of the MEi:CogSci is strikingly comprehensive and sophisticated (see Zimmermann et al., 2010).

One the one hand, all the required aspects are present in the curriculum and its local implementation at the University of Vienna:[32] The MEi:CogSci is designed as a master's program. Admitted students already have (at least) a bachelor's degree in one of the core disciplines (or another relevant discipline) and are thus already on a path to further disciplinary specialization. Advanced courses in a specific discipline can be done in the context of the program. This might be especially interesting for students, who already have a bachelor's degree in cognitive science. Furthermore, students have to do introductory modules in at least two other core disciplines from the natural sciences, formal sciences, social sciences, or the humanities to complement their previous studies. In addition, two methodological modules in programming and statistics or other complimentary methods have to be completed. Students also need to do introductory and advanced courses in cognitive science. And, finally, work on research projects is a required and substantial part of the curriculum and handled with maximum flexibility via learning contracts, which are individually negotiated between students and their supervisors and specify the project work in detail.

On the other hand, there are many additional features beyond these core requirements which further add to a rich interdisciplinary learning environment (see Zimmermann et al., 2010). For instance, students get an overview of (at least a representative part of) the local cognitive science research environment via a lecture series, where researchers from different departments and related non-university research institutes present their work. In this context, lab excursions to some of the different research facilities are offered for students. There are also activities (talks, workshops, etc.) organized by the Vienna Cognitive Science Hub – the interdisciplinary research network of cognitive science at the University of Vienna –,[33] which students may attend in addition. Together, these activities enable students to dive deeper into the different research topics and to better orient themselves within the local cognitive science research landscape. In some cognitive science courses students work on theoretical problems or cognitive phenomena in interdisciplinary teams with their colleagues and present their insights to their peers. Moreover, there are some phenomenon-centered interdisciplinary courses, where cognitive phenomena are tackled from different disciplinary per-

32 See https://senat.univie.ac.at/fileadmin/user_upload/s_senat/konsolidierte_Masterstudien/MA_CogSci.pdf.

33 See https://cognitivescience.univie.ac.at/.

spectives. Since the MEi:CogSci is a joint study program implemented across five universities, students spend a semester abroad at one of the MEi:CogSci partner universities to do advanced courses and project work. In this way, they also get familiar with different cognitive science research environments and cultures at other universities and have the opportunity to exchange views and experiences with MEi:CogSci students across the partner universities. Finally, there is the annual MEi:CogSci student conference. After students from all the partner universities engage in a structured peer-review process to get feedback on their conference abstracts for their research projects from their colleagues, they meet at one partner university for the two and a half days conference to present their own work to the multidisciplinary audience of their international MEi:CogSci colleagues via posters and talks.

Furthermore, the limited number of students admitted to the program each year adds to the exclusive character of the program. Only about 25 students start the program each year at each partner university. The admission procedure is designed to promote disciplinary diversity, i.e., to admit an equal number of students from the natural sciences, formal sciences, social sciences, the humanities or a preceding cognitive science program. Given that the program is fully taught and assessed in English and that there are no or just small tuition fees as compared to international standards, the program is particularly attractive for students from all over the world. This, in turn, contributes to cultural diversity within such an annual cohort of students. The fact that these students have to spend much of their time together in courses – some of which include cooperative or collaborative learning activities within the first year of their studies – fosters the creation of a disciplinary and culturally diverse integrative learning community of cognitive science students whereby students also implicitly learn from one another. All these pedagogical measures are designed and implemented to prepare the long-term development of interdisciplinary competences.

5.4 Implications for First-Year MEi:CogSci Students

So far, the implications for beginning MEi:CogSci students, who aim for an academic career in cognitive science, should be evident from my elaborations in the previous section. It is important for students to develop a clear focus on one cognitive science discipline and a related research area for specialization in the course of their studies – typically, by focusing on a cognitive science research area actively pursued by researchers or research groups at the MEi:CogSci partner universities. It is certainly beneficial to specialize in a cognitive science research area which is already related to the discipline of one's own previous studies. Moreover, the research area for specialization can also guide choices on additional disciplinary and methodological courses. Thus, it is also clear what 'finding your voice' means in the context of the MEi:CogSci: It is about learning to situate one's own research area of specialization

within the overall landscape of cognitive science research programs as well as its specific connections to (research from) other cognitive science disciplines.

5.5 Summary

In sum, the MEi:CogSci offers excellent opportunities for students to become interdisciplinary researchers in cognitive science by developing their own profiles as T-shaped researchers. In other words, the joint program is well-suited to produce disciplinary experts with deep knowledge in one cognitive science discipline and research domain, who at the same time acquire broad knowledge about the basics of other cognitive science disciplines as well as the philosophy of cognitive science – the area of genuine interdisciplinary integration on the conceptual and theoretical level. Furthermore, the pedagogy of the joint program helps to prepare the long-term development of interdisciplinary competences (i.e., the capacity for teamwork, communication skills and reflective/metacognitive skills) by engaging students from different disciplines and cultural backgrounds in collaborative and cooperative learning activities and interdisciplinary project work at both their home universities and the partner universities in the mobility semester. The aims and results of the different pedagogical measures within the program become visible at the annual international MEi:CogSci student conference. In the best case all these activities culminate in the development of self-organized learning communities of cognitive science students.

6 The Problem with the MEi:CogSci Curriculum Design and Pedagogy

According to the initial assessment of the MEi:CogSci curriculum design and pedagogy the study program turned out to meet – and even surpass – all the requirements for training future cognitive scientists as T-shaped researchers (see chapter 5). There would not be something substantial to add in this respect *if the MEi:CogSci curriculum and pedagogy would have been primarily designed and thus consistently and clearly operated and communicated with the goal of training such T-shaped researchers in mind*.

This statement may appear puzzling at first, since I praised the MEi:CogSci curriculum for its comprehensive and sophisticated design with respect to training future cognitive scientists as T-shaped researchers including all its pedagogical measures to prepare the long-term development of interdisciplinary competences. My appraisal is due to the fact that the MEi:CogSci *can* be studied in this manner, i.e., by focusing on a cognitive science research area through disciplinary specialization to become a T-shaped researcher and this is exactly what some students are looking for and are happy with. The problem, however, is that the program was explicitly designed with an emphasis on interdisciplinary integration, rather than disciplinary specialization,[34] and thus with a different educational goal in mind. Not only is the program likely to fall short of the expectations of those students, who were especially attracted by this emphasis. The resulting inconsistencies – in addition to the unclear or missing articulation of the meaning of 'interdisciplinarity', 'integration' and the professional identity of the interdisciplinary researcher in cognitive science – are a further source of confusion about interdisciplinary practice for MEi:CogSci students, whether they are interested in disciplinary specialization or interdisciplinary integration.

The following in-depth analysis of the initial aim of the MEi:CogSci curriculum design and pedagogy will reveal the different senses in which 'interdisciplinarity' and 'integration' are understood in the context of the program and spell out the resulting and unfortunate consequences for students.

6.1 The Initial Aim of the MEI:CogSci Curriculum Design and Pedagogy

The emphasis of the MEi:CogSci on interdisciplinary integration is clearly articulated in the 2010 research article "Constructivist Curriculum Design for the Interdisciplinary Study Programme MEi:CogSci – A Case Study", in which the founders of the program of the University

34 The design of the MEi:CogSci curriculum is described in detail in Zimmermann et al. (2010). Notice, that the authors also explicitly acknowledge that some students take the path of disciplinary specialization (see Zimmermann et al., 2010, p. 154).

of Vienna describe the pedagogical design of the curriculum in detail (Zimmermann et al., 2010). It is also expressed (or at least suggested) by the use of the labels "integrative kernel" for the central modules/courses of the program required for all students and "thematic/phenomenon and research oriented" for the focus of studies in the second year of the program (Zimmermann et al., 2010, p. 150).[35] In fact, one of the goals of the design and pedagogy of the MEi:CogSci curriculum was to focus on interdisciplinary and integrative aspects because these were found to be missing in many other cognitive science curricula in Europe and the USA at that time (Zimmermann et al., 2010, p. 145). More specifically, "courses or modules that explicitly target interdisciplinary integration, are barely found [in other curricula], while teaching and learning concepts that could act as transversal through all courses, are missing" (Zimmermann et al., 2010, p. 145). As a response to this, interdisciplinary and integrative aspects were built into the design and pedagogy of the MEi:CogSci curriculum using a constructivist epistemological framework as a foundation for its development and implementation. In a nutshell, constructivist epistemology understands knowledge as a process, through which knowledge is actively constructed and socially negotiated between different points of view rather than being something objective discovered by means of a research method. As a consequence of the constructivist framework its pedagogy engages students in group work and social activities to experience the construction and negotiation of knowledge first hand using learner-centered approaches such as collaborative or cooperative learning, problem-based learning or similar approaches. This also changes the role of course instructors to that of facilitators and co-learners, who configure the learning environment and support students in their knowledge creation processes (Zimmermann et al., 2010, pp. 154–155). Constructivist principles and didactics are guiding the courses of the "integrative kernel", which focus mainly on the philosophy of cognitive science. More precisely, the "integrative kernel"

> aims to provide a *space for interdisciplinary dialogue* and discussion, furthering the *reflection* and *integration* of disciplinary approaches by explicitly analysing their epistemological attitudes and hidden assumptions (Zimmermann et al., 2010, p. 151).

However, the impact of the constructivist framework for the design and implementation of the curriculum is much wider than its direct implications for the didactics of the "integrative kernel". It also manifests in all the program features which I already highlighted previously such as the student conference and peer-review process, the multidisciplinary and intercultural student audience, the mobility semester, etc. (see chapter 5.3). All these features together can be broadly understood as the implementation of a "learning space" comprising the

35 See also https://www.meicogsci.eu/mei-cogsci.html.

interdisciplinary and integrative aspects of the program (Zimmermann et al., 2010, p. 149),[36] "where students can actively learn and experience interdisciplinary research" (Zimmermann et al., 2010, p. 144).

In addition to this rather broad understanding of the interdisciplinary and integrative aspects of the curriculum, there is also a narrower sense of how interdisciplinary integration is understood and which is more directly concerned with the practice of interdisciplinary research. Overall, the MEi:CogSci curriculum is designed as a two years research-centered master's program enabling students to pursue an academic career. This is evident in the temporal design of the curriculum, which is divided into the "introductory phase" for the first year (first and second semester) and the "thematic/phenomenon and research oriented phase" for the second year (third and fourth semester) of studies. In more detail, this means:

> While in the first semester students get acquainted with research in cognitive science in various departments of their home university and local partner institutions, mainly throughout a lecture series and lab excursions, they already have to do a *small scale research project* in the second semester. The results of this project are presented to an international audience during the yearly MEi:CogSci Conference. The third and fourth semester [i.e., the "thematic/phenomenon and research oriented phase"] are especially devoted to research, doing *interdisciplinary research project(s)* on a phenomenon of cognitive science and maybe continuing this work in their masters theses. The focus on a phenomenon from the viewpoint of at least two disciplines should deepen the level of cross-disciplinary integration as well as further reflection on disciplinary methods' epistemological assumptions (Zimmermann et al., 2010, p. 153).

The "thematic/phenomenon and research oriented phase" in the second year of the program is specifically dedicated to practicing interdisciplinary research. Notice that 'cross-disciplinary' is used here merely as an antonym to 'disciplinary', i.e., in the sense of Eigenbrode et al. (2007) to denote "research that crosses traditional disciplinary boundaries" (p. 55), without any further qualification (Zimmermann et al., 2010, pp. 145–146). It is important to highlight how the intended "cross-disciplinary integration" is understood in the context of the MEi:CogSci:

> Cognitive science has varying layers and levels of integration, depending on the problem addressed as well as on the number of disciplines involved in a particular question and their way of collaboration. . . . *We are trying to implement a rather high level of cross-disciplinary integration by following a mainly phenomenon-driven approach to cognition* [emphasis added] (Zimmermann et al., 2010, p. 146).

36 Notice that I completely ignore the "virtual dimension" of the learning space here, since this aspect of the program is outdated and also irrelevant for my argument (see Zimmermann et al., 2010, p. 153).

I regard this clarification essential to understand the intended educational goal of the program with respect to interdisciplinary research practice and what it means to become an interdisciplinary researcher. At its heart, it indicates the crucial difference between the conception of the interdisciplinary researcher as T-shaped professional and thus as basically a disciplinary specialist versus an alternative conception of the interdisciplinary researcher as a specialist for integrating insights from different disciplines towards a new or more comprehensive understanding of the target phenomenon.

As pointed out in chapter 4.3, the difference between these two conceptions of the interdisciplinary researcher has been highlighted by the scholar of interdisciplinary studies Allan Repko. Repko distinguishes between "generalist" and "integrationist" interdisciplinarians in the academic discourse on interdisciplinarity (Repko, 2007, p. 2; see also Repko & Szostak, 2017, pp. 221–230). For *generalists*, any form of interaction between researchers form different fields already counts as interdisciplinary and thus it is often synonymous with teamwork (Repko, 2007). In other words, generalists understand interdisciplinarity in the widest sense of Frodeman's (2017) "all more-than-disciplinary approaches to knowledge" (p. 4). In contrast, *integrationists* regard interdisciplinary integration of insights from different disciplines as essential for interdisciplinary research and are particularly concerned with the specific features of a distinctive interdisciplinary research process (Repko, 2007). In a nutshell, "integrationists regard integration as *the key distinguishing characteristic* of interdisciplinarity and *the goal* of fully interdisciplinary work" (Repko & Szostak, 2017, p. 224).

This critical difference becomes apparent in the design of the MEi:CogSCi as soon as one focuses on how students are supposed to study the program. The six-step "phase-model" developed by the designers of the curriculum makes the intended progression of students over the course of the two years program explicit (Zimmermann et al., 2010, p. 149). Here is the description of all the six phases of the model in full detail:

1. Reflection: this phase is triggered and nourished by the interdisciplinary context in which the student is involved from the very first moment in this programme;
2. *Posing one's own question(s)* on the basis of having a more reflected view on one's own disciplinary background. This phase has a strong emphasis on self-refection (i.e., reflecting on one's own assumptions, intentions, goals, and epistemological as well as ethical attitudes, etc.). This is also the first step towards "finding one's own voice;"
3. *Discovering a (cognitive) phenomenon in a new light*: the questions lead to a new perspective on a seemingly well-known phenomenon. The very phenomenon is supposed to come to the fore (rather than the methods or already existing theories or models of this phenomenon). The phenomenon is expected to be explored, described, and understood in a qualitative – or almost philosophical – manner;

4. Only in a [*sic*] this rather late step does one start to search for or *develop adequate methods* and already existing approaches or models; they enable this phenomenon to be studied in a more systematic manner. It is important to keep in mind that these methods and models have to comply with the need to work in an interdisciplinary manner;
5. *Exploration* and studying the (cognitive) phenomenon in a systematic and interdisciplinary manner;
6. *(Co-)Construction* of a (new or alternative) model of or approach to the specified phenomenon (Zimmermann et al., 2010, p. 149).

The first two phases can be characterized by increasing reflection of the students. The *first phase* describes the overall impact of the interdisciplinary and integrative learning space including team building and group activities of the courses of the "integrative kernel" at the beginning of the program on students. The *second phase* highlights the intention of the didactics of the courses of the "integrative kernel". Students' implicit disciplinary background assumptions as well as their motivations and goals for studying are made explicit, juxtaposed, contextualized and relativized. Through intensified self-reflection students are supposed to get to the bottom of who they want to become as researchers, i.e., initializing the development of individual professional identities to position themselves within the scientific community ("finding one's own voice"). The fist two phases prepare the next four phases, which are directed toward the "thematic/phenomenon and research oriented" second year of the program. Students apply for the program with a guiding research question, which should lead them through the program (Zimmermann et al., 2010, p. 151). This guiding question and the phenomenon it addresses can act as a point of reference for filtering and relating knowledge from different disciplines as well as suggesting possible paths through the program. As a result of the increased awareness of different disciplinary perspectives and cognitive science research programs, students may see their guiding question and their cognitive phenomenon of interest in a new light or may get interested in a cognitive phenomenon they did not even consider relevant for their interests. In the *third phase* students are supposed to 'get in touch' – metaphorically speaking – with the cognitive phenomenon of interest again by tying to see it in all ts complexity in its real-world contexts, rather than already through the lens of some academic discipline. Only after students have a better grasp of the specific ways the phenomenon manifests in the relevant real world contexts, they enter the *fourth phase* by looking for tools provided from different disciplines applicable for the scientific study of the phenomenon. In the *fifth phase* these tools are then applied to the phenomenon in a "systematic and interdisciplinary manner" with the aim of acquiring scientific knowledge from multiple, i.e., at least two, disciplinary points of view. In the final *sixth phase* the acquired knowledge is

then integrated into a new model of the target phenomenon or a new approach to it. Notice that the emphasis for the whole process is on novelty:

> Students are explicitly requested to engage in self-reflection and – on the basis of that – in exploring, developing, and (co-)creating new approaches, models, etc. that might not yet be scientifically established (Zimmermann et al., 2010, p. 149).

Within the whole process, teams of two to three students can engage in interdisciplinary project work together , although students can work on their own too. As a team they can distribute the work, which is especially helpful for studying aspects of the target phenomenon form different disciplinary points of view. Each team member can focus on one disciplinary perspective. Moreover, team members can finally engage in the process of co-creation of a new understanding of the phenomenon in the final phase of interdisciplinary integration.

The phase-model reveals how radically the phenomenon-oriented way of studying the MEi:CogSci (especially in the second year of the program) deviates from the more conventional way of developing an individual profile as T-shaped researcher by specializing in one cognitive science discipline and research area.[37] It also brings to light how the difference between interdisciplinary integration and disciplinary specialization – i.e., between Repko's (2007) integrationist and generalist interdisciplinarians – can be understood by students in the course of their studies and how it relates to their interests and expectations. In the former (integrationist) case one's studies are primarily directed toward the practice of interdisciplinary research and the creation of new knowledge by integrating insights from whatever disciplines are relevant for the cognitive phenomenon of interest (Repko et al., 2017; Repko & Szostak, 2017). Disciplinary specialization is secondary. Therefore, it is important that the phenomenon is first qualitatively explored in its real-world contexts, i.e., detached and independent from any disciplinary and methodological perspectives, before any rash decisions on disciplinary approaches for the scientific study of its aspects are made (Repko & Szostak, 2017). The interdisciplinary research process is driven by the phenomenon (or problem) of study (Repko & Szostak, 2017). By contrast, in the latter (generalist) case one's studies are primarily directed toward developing or deepening one's expertise in an already existing disciplinary research area at (one of) the MEi:CogSci partner universities. Interdisciplinary integration is secondary. Therefore, the respective (inter)disciplinary approach (especially the methodological approach) to a specific cognitive phenomenon of interest is commonly already determined through the disciplinary background(s) or affiliation(s) of the respective researchers or research groups in this research area.

37 It could be argued that both can be done if students specialize in different disciplines but do their interdisciplinary project work on a common phenomenon together as a team. However, as I will point out later in more detail this is rather a theoretical than a practical option.

In conclusion, the intended phenomenon-oriented path through the program can be literally understood as *inter-disciplinary*, i.e., moving through the program *between the disciplines* instead of committing to one of them eventually, yet drawing on disciplinary insights and methods and finally integrating them toward new knowledge about a complex cognitive phenomenon. *In this conception of interdisciplinarity*, an interdisciplinary researcher in cognitive science is a specialist for integrating insights from multiple disciplines toward the creation of new knowledge about complex cognitive phenomena. In Repko's (2007) terminology, they are *integrationist interdisciplinarians,* i.e., "scholars familiar with strategies for integrating insights from diverse disciplines" (Repko et al., 2017, p. 17). In this sense, the MEi:CogSci curriculum also lives up to the promise of implementing interdisciplinary and integrative aspects into its design by scaffolding a path through the program with a clear focus on interdisciplinary integration realized by practicing phenomenon-oriented (collaborative) interdisciplinary research.

6.2 Why It Does Not Work

The overall design and implementation of the MEi:CogSci curriculum as an interdisciplinary joint study program over five universities in four different countries including international student mobility and an annual joint student conference is undoubtedly an amazing achievement.[38] I am also impressed by its pedagogical sophistication and the brave decision to implement the phase-model toward interdisciplinary integration as its centerpiece, i.e., to educate *integrationist interdisciplinarians* in cognitive science. Nevertheless, I think that the conception of the phenomenon-oriented path through the program as outlined in the phase-model, i.e., as the central and general path through the program for all students, is flawed.

Although the learning space implemented through the MEi:CogSci curriculum is an excellent environment for bootstrapping the long-term development of interdisciplinary competences, its pedagogical measures are quite independent of the primary interest and focus of studies of students, i.e., whether they are more interested in interdisciplinary integration or disciplinary specialization. The ability to work in a team, good communication skills and reflective/metacognitive skills are important social and personal competences for any kind of collaborative (interdisciplinary) practice. Although these pedagogical measures may prepare the development of a new "thought style" (in the sense of the Ludwik Fleck), which specifically subserves interdisciplinary collaboration (Darbellay, 2015; Lerch, 2017), they do not provide any guidance on how to actually practice interdisciplinary research. However, when the focus of studies is on interdisciplinary integration and the practical realization of (collaborative) interdisciplinary project work or master's theses, explicit training in the theory and

38 Initially it was even seven universities in five different countries.

process of interdisciplinary research is essential to get students started (Repko et al., 2017; Wernli et al., 2017).[39] Here, it is important to notice that the "integrative kernel" of the program does not promise to equip students with any knowledge on how to actually practice (collaborative) interdisciplinary research in their studies, i.e., for their project work or master's theses. The didactical goal of the courses of the "integrative kernel" with respect to interdisciplinary integration is to engage students in (self-)reflection and discussions to make the epistemological assumptions, attitudes and values of the different disciplinary perspectives explicit. Reflective practice certainly furthers an awareness of the limits of one's own disciplinary perspective and in this sense contributes to improved interdisciplinary collaboration and communication, but it cannot provide any guidance on the interdisciplinary research process itself. Similarly, introducing the different cognitive science concepts and approaches/ research programs[40] in their historical context will make the interaction of some disciplines apparent (Zimmermann et al., 2010, p. 151), but such knowledge is only of very limited use when students engage in their own interdisciplinary research projects. Apart from the master's thesis seminar in the last semester, the courses of the "integrative kernel" are not connected to students' own interdisciplinary research in the "thematic/phenomenon and research oriented" phase of the program. Rather "students consolidate their knowledge of cognitive science, keep track of current developments in the field and continue the interdisciplinary dialogue with students from the partner universities" (Zimmermann et al., 2010, p. 150). Nor are there any other courses or activities (neither obligatory nor optional) which specifically address the practice of (collaborative) interdisciplinary research.[41]

One might suppose that (other than through coursework) students are instructed and guided on how to practice (collaborative) interdisciplinary research by their project supervisors as soon as they engage in interdisciplinary project work in the first year of their studies and in the "thematic/phenomenon and research oriented" phase in the second year of their studies. However, researchers of the multidisciplinary cognitive science research environments at the MEi:CogSci partner universities are (at best) themselves T-shaped (disciplinary) specialists – or in Repko's (2007) terminology *generalist interdisciplinarians*. They may be excellent supervisors for research in their own domains of expertise, where they may even draw on insights from other disciplines. Yet, for the main part their research typically still stays within the boundaries of their own discipline. Moreover, they commonly do not have any formal training in the theory and process of integrationist interdisciplinary research.

39 See chapter 7.2, in particular 7.2.4.

40 The different research programs in cognitive science are referred to as "paradigms" in Zimmermann et al. (2010).

41 Although students already engage in their first research project in the context of the "integrative kernel" in the second semester of their studies ('Into Research II Module', see https://senat.univie.ac.at/fileadmin/user_upload/s_senat/konsolidierte_Masterstudien/MA_CogSci.pdf), taking an interdisciplinary approach is not required.

Therefore, it is hard for potential supervisors to provide the level of guidance students would expect and need to meet the demanding requirements for their own phenomenon-oriented interdisciplinary research modules, namely:

> It is a requirement [for students' interdisciplinary research modules] that this phenomenon has to be studied in an *interdisciplinary* manner, i.e., research has to be done on the chosen phenomenon from at *least two* different disciplinary perspectives in order to bring out the necessity of reflecting on paradigms, methods used, hidden assumptions and values (Zimmermann et al., 2010, p. 150).

As pointed out in the previous section (chapter 6.1), the phenomenon-oriented approach is targeted toward a "high level of cross-disciplinary integration" where students are supposed to start with a qualitative exploration of a cognitive phenomenon which serves as the basis for identifying the relevant disciplines and methods for its study (Zimmermann et al., 2010, p. 146). It is hardly possible to do such phenomenon-oriented interdisciplinary project work "from at least two disciplinary perspectives" by engaging in some already predefined projects, which are offered from researchers or research groups from the multidisciplinary cognitive science research environments of the MEi:CogSci partner universities.[42] In these cases, the only way to meet the requirements for the phenomenon-oriented interdisciplinary research modules is to find a supervisor who is willing to support such a (collaborative) interdisciplinary project although they may not feel competent in all the relevant disciplines involved.[43] However, supervisors and students can collaborate by joining their different disciplinary expertise for the interdisciplinary study of the cognitive target phenomenon. Still, the challenge of integrating disciplinary insights toward new knowledge remains in place for students as well as supervisors in such cases. Therefore, the result is probably at best multidisciplinary, i.e., juxtaposing the insights from the different disciplinary perspectives on the target phenomenon, without any further steps toward interdisciplinary integration. Nevertheless, even multidisciplinary juxtapostion from two disciplinary perspectives is rarely achieved in the practice of students' project work.[44]

In sum, systematic theoretical and practical training on how to conduct phenomenon-oriented (collaborative) interdisciplinary research focusing on the integration of insights and methods from multiple disciplines is insufficient in the implementation of the curriculum

42 The only exception are probably researchers engaging in interdisciplinary projects whose field of disciplinary specialization is philosophical phenomenology (e.g., doing research within the neurophenomenological research program (see Olivares et al., 2015)). See https://www.meicogsci.eu/downloads/MEiCogSci_Projects_All_Partner_Universities.pdf for a list of research projects offered for MEi:CogSci students in the second year of their studies.

43 It is also conceivable to work with two supervisors from different fields. However, in practice this is hardly manageable. It is already a challenge to find one supervisor for a phenomenon-oriented interdisciplinary research project from two disciplinary perspectives.

44 This is evident from reviewing student's third-semester learning contracts.

and its pedagogy. In general, a systematic introduction to the theory and practice of interdisciplinary research processes is neither provided in the context of the courses of the "integrative kernel", nor in any other courses of the program. The constructivist didactics of the "integrative kernel" with its focus on explicating and reflecting disciplinary assumptions certainly contributes to improved interdisciplinary communication and collaboration, but does not provide any concrete guidance on how to practice interdisciplinary research. Furthermore, (potential) project or master's thesis supervisors from the cognitive science research environments of the MEi:CogSci partner universities are typically disciplinary specialists without any formal training in the theory and practice of interdisciplinarity. In other words, neither the study program nor the cognitive science research environments of the MEi:CogSci partner universities can sufficiently facilitate the intended phenomenon-oriented path toward interdisciplinary integration outlined by the phase-model.

6.3 Unfortunate Consequences

The phenomenon-oriented design of the MEi:CogSci curriculum toward interdisciplinary integration has some unfortunate consequences for all students of the program independent of their specific interests. One the one hand, students with a primary focus of studies on interdisciplinary integration, who follow the phenomenon-oriented path through the program as intended, often miss more specific theoretical and practical training on interdisciplinarity. Most likely, they will not feel that they have been prepared to engage in their own (collaborative) interdisciplinary research. In many cases they will not find sufficient support, guidance or leadership and no role models over the course of their studies. This can be frustrating and disappointing for students, who understand the emphasis on interdisciplinarity and integration in the context of the program mainly in the sense of learning how to anticipate the potential interdisciplinary interactions between different disciplinary fields of research and how to practice interdisciplinary research in a team or on their own by connecting and integrating knowledge and methods from multiple disciplines to address complex phenomena or problems. On the other hand, the curriculum design also affects students with different interests because the requirements for interdisciplinary work in the "thematic/phenomenon and research oriented phase" of the program apply to all students. Therefore, even if students do project work or their master's thesis in an active research area of cognitive science – e.g., as a team member of a local research group –, this research may still not meet the requirements for phenomenon-oriented interdisciplinary research as defined in the curriculum. In fact, offering cognitive science related research projects from researchers and research groups of the MEi:CogSci partner universities for students in the "thematic/phenomenon and research oriented phase" *undermines* the phenomenon-oriented approach toward interdisciplinary inte-

gration, because such project work often redirects students toward disciplinary specialization. It is important to emphasize that this happens exactly at the point where the educational study program interfaces with the professional cognitive science research environment. It demonstrates that the integrationist conception of interdisciplinary practice envisioned by the phase-model of the MEi:CogSci is in many cases at odds with the actual interdisciplinary practice in the cognitive science research environments of the MEi:CogSci partner universities. Thus, a confusing ambiguity about interdisciplinary practice is unintentionally 'built into' the program.

The tension between the ideal of the phenomenon-oriented path through the program and the actual conditions for practicing cognitive science research at the MEi:CogSci partner universities leads to a weakening of the whole concept of phenomenon-oriented interdisciplinary integration.[45] In fact, it is often hardly possible for students to practice phenomenon-oriented interdisciplinary research as defined in the curriculum. As a pragmatic consequence, interdisciplinarity is tacitly understood in its broadest possible way: Almost any kind of research, which is not a textbook case of a disciplinary approach, is regarded interdisciplinary. Only on this very broad understanding of interdisciplinarity, all MEi:CogSci students can actually *practice* interdisciplinary research.

It may be easier to see now, why interdisciplinary integration is frequently mentioned in student feedback as the major flaw of the program implementation. Further unfortunate consequence of the flawed implementation of the phase-model are its implicit messages about interdisciplinary practice for the students:

- There is no distinct body of knowledge on the theory and practice of interdisciplinarity. (In other words, the topic is theoretically exhausted by means of references to 'communication', 'collaboration" and 'combining methods from different disciplines'.)
- There are no experts, researchers or course instructors, who could teach how to practice interdisciplinary research by introducing students to theories, research processes, best practices, walk-throughs, etc.
- The whole idea of the interdisciplinary researcher as a specialist for integrating insights from multiple disciplines toward the creation of new knowledge about complex phenomena or problems (as it is promoted by Repko et al. (2017) and others)[46] is either poorly implemented or illusory.

45 On close reading, this tension is already *implicitly* present in Zimmermann's et al. (2010) article on the design and pedagogy of the MEi:CogSci.
46 See chapter 7.

6.4 Possible Objection and Response

It could easily be argued that this criticism is overly exaggerated and thus far less serious than it appears at first glance. A plausible line of reasoning could be stated as follows: The difference in kind between disciplinary specialization and interdisciplinary integration is a false dichotomy. Instead, it is merely a difference in degree rather than of kind. Disciplinary research also starts with a phenomenon of investigation and even disciplinary approaches often draw on insights from different disciplines – especially in the research areas of cognitive science with its overall multidisciplinary character regarding empirical research. The high level of interdisciplinary integration I am highlighting is only accomplished in the philosophy of cognitive science and actually very rarely in empirical research. Therefore, doing mainly disciplinary based research, which draws on insights from other disciplines within a cognitive science research area, is perfectly fine. The different research programs in cognitive science already provide conceptual frameworks to integrate empirical research in larger contexts. Furthermore, the phase-model is not explicitly promoted, i.e., students are neither instructed nor required to follow it. Indeed, the model is not even explicitly presented to students. It is an ideal model for studying the program, but no one is forced to follow it. If students develop an awareness of the epistemic issues involved when researcher from different disciplines work together and learn to reflect on the epistemic assumptions of different disciplinary perspectives a major learning goal of the program is accomplished. Moreover, the motivations and interests of students are much more diverse than disciplinary specialization versus interdisciplinary integration. It may be the case that some students have unrealistic expectations about interdisciplinary practice, but these will be corrected in the course of the program. Finally, the constructivist design of the curriculum requires students to actively engage in their studies. Students need to take responsibility for their own path though the program and their own professional development. The university provides an academic environment for studying cognition. In the end, it is on the students to link and integrate knowledge form different domains and disciplines.

Although I think that these points are all valid to some extent, they miss the point of my main criticism: Even if the phase-model toward phenomenon-oriented interdisciplinary research is not explicitly presented to students, *the phase-model is implemented through the constructivist principles guiding the didactics of the program* (Zimmermann et al., 2010, p. 149)– or, more precisely, guiding the didactics of the courses and activities of the "integrative kernel" of the program. Implicitly and explicitly, this affects how the concept of interdisciplinarity is presented and communicated to students. Therefore, the implementation of the phase-model guides students toward a conception of phenomenon-oriented interdisciplinary

research – an integrationist conception of interdisciplinary practice – which is insufficiently supported by the study program as well as the cognitive science research environments of the MEi:CogSci partner universities. In other words, the implementation of the phase-model first and foremost *creates* the discrepancy between theory and practice and thus leads to confusion about interdisciplinary practice and the educational goal of the program. It all culminates in the question: What does it means to become an interdisciplinary researcher in cognitive science?

The aim of my analysis is not to articulate a general critique of the MEi:CogSci curriculum based on Zimmermann's et al. 10 year old case study. Even the designers of the curriculum may see some things different from today's point of view.[47] As I already pointed out, the program is still excellent when it is studied with a clear focus on developing a profile as T-shaped researcher in cognitive science. The high number of successful MEi:CogSci alumnis, who took this path, speaks for itself. However, – *and that is the crux of the matter and irony of it* – these former students were successful not because of the educational path implemented by the phase-model, but in spite of it.

The whole purpose of making the initial design of the MEi:CogSci curriculum and, especially, the phenomenon-oriented path implemented by the phase-model explicit, is to disclose it as the major source of confusion about the way interdisciplinary practice is understood in the context of the program. This source of confusion, which initially creates the ambiguity about interdisciplinary practice, is at the core of the design of the program and still find its expression in different aspects of its implementation and communication. Therefore, making the design explicit helps to explain some of the recurring issues students face about finding their way through the program and identifying and characterizing cognitive science research and interdisciplinary research in general. The present analysis can help to specifically address the root cause of these problems. Moreover, it reveals the importance of a clear (i.e., unambiguous), explicit, and shared concept of the professional identity of the interdisciplinary researcher in cognitive science as a foundation for successful communication about interdisciplinarity. A clear introduction to interdisciplinary practice in cognitive science and what it means to become an interdisciplinary researcher in cognitive science could prevent confusions and manage expectations in the first place.

47 Some of the 'surrounding conditions' of the program also changed. For instance, the number of MEi:CogSci partner universities is less than it was at the launch of the program. In addition, there were no top down cognitive science initiatives at the University of Vienna at the time the MEi:CogSci program was launched in 2007. The first major cognitive science initiative ("Cognitive Science Platform") at the University of Vienna was established in 2011, which was later replaced by Vienna Cognitive Science Hub in 2019. As I already pointed out in the introduction (chapter 1.3), a developmental perspective on the program would have noticed discrepancies early and could have initiated countermeasures.

6.5 Summary

While I highly appreciate the intention and courage of designing an interdisciplinary curriculum with an explicit vision and focus on high-level interdisciplinary integration (*integrationist interdisciplinarity*), the MEi:CogSci curriculum implementation suffers from a lack of theoretical and practical training as well as guidance on how to conduct phenomenon-oriented (collaborative) integrationist interdisciplinary research. Yet, without sufficient training in the theory and practice of (collaborative) interdisciplinary research, it is hardly possible for students to actually follow the phenomenon-oriented path through the program because cognitive science research environments often undermine it through their overall multidisciplinary character. As a result, students, who are particularly interested in integrationist interdisciplinary research, may leave the program disappointed and with the impression that such an approach to research and knowledge is didactically and practically underdeveloped or non-existent.

Part III: An Alternative Model for Integrationist Interdisciplinary Education in Cognitive Science

The purpose of this part is to outline a feasible educational model for training integrationist interdisciplinary researchers in cognitive science. According to my proposal, the integrationist interdisciplinary researcher in cognitive science is a T-shaped researcher, whose area of specialization is the theory and process of interdisciplinary research itself. Such a specialist could act as facilitator in complex collaborative inter- and transdisciplinary research projects and work in academic management. A 'complexity mindset' is the foundation for an integrationist interdisciplinary approach and of particular relevance for interdisciplinary research on situated/4E cognition. The requisite body of knowledge to train integrationist interdisciplinarians is already available from the academic field of interdisciplinary studies.

7 Integrationist Interdisciplinarity and Interdisciplinary Studies

The analysis of the particular case of the MEi:CogSci in part II demonstrated that its educational goal implemented as the phenomenon-oriented path toward interdisciplinary integration through the phase-model is generally not feasible (see chapter 6). Neither the courses of the "integrative kernel" nor the cognitive science research environments of the MEi:CogSci partner universities can sufficiently support the model. However, the model of the cognitive scientist as the T-Shaped researcher is already supported by the program and the cognitive science research environments of the MEi:CogSci partner universities and thus implicitly guides students. The resulting mixed messages students receive with respect to what it means to become an interdisciplinary researcher in cognitive science can be easily avoided through (1) minor revisions of the curricular requirements, and (2) by explicitly and consistently communicating and promoting the professional identity of the interdisciplinary researcher in cognitive science as that of the T-shaped researcher as the primary educational goal of the program (see chapter 10 for details).

Does the particular case of the MEi:CogSci suggest that an educational path toward integrationist interdisciplinarity is generally not a feasible model for educating interdisciplinary researchers in cognitive science? Regarding the MEi:CogSci, I do not think that the integrative path implemented by the phase-model *as a general path for all students* could be

fixed – or at least not without major revisions of the design of the program. Even if the program design would be revised (by providing new courses and/or restructuring the integrative kernel, etc.) the local research environments could still only poorly support it. However, suppose that the integrative path as it was initially conceived would be successfully implemented as a general path for all students through a revision of the MEi:CogSci design. I do not believe that it would be a smart decision to put it into practice. The program already implements a viable and highly successful path towards becoming a cognitive scientists as T-shaped researcher. Not only does this model integrate very well with the existing cognitive science research environments of the MEi:CogSci partner universities, it also excellently prepares students for an (international) academic career in cognitive science. The same line of reasoning might be applied to other interdisciplinary study programs in cognitive science.

Nevertheless, I see a possible and feasible alternative way to enable integrationist interdisciplinarity education and practice for cognitive science students: by viewing it as a distinct research area of specialization. That is to say, while cognitive science programs are generally directed toward training T-shaped researchers, who specialize in a discipline and research area relevant for cognitive science, it would also be possible for some students to specialize in the theory and process of integrationist interdisciplinary research instead. These students would learn how to apply integrationist interdisciplinary research to topics in cognitive science.

I will outline the general motivation for such an area of specialization and introduce interdisciplinary studies as the relevant academic field that already provides a body of knowledge for formal training in integrationist interdisciplinarity.

7.1 Motivation for Educating Integrationist Interdisciplinary Researchers

The basic idea motivating integrationist interdisciplinary education and practice for students of interdisciplinary cognitive science programs is simple: One of the possible specific profiles of an interdisciplinary researcher in cognitive science as T-shaped researcher could be that of a specialist in the theory and process of interdisciplinary research itself. Such specialists could act as facilitators in complex collaborative inter- and transdisciplinary[48] research projects and work in academic management as *T-shaped managers* (see Hansen & Oetinger, 2001).[49]

48 I use the term *transdisciplinary* in today's common use of "a type of interdisciplinarity with extra defining characteristics: nonacademic participation, teams, and case studies" (Repko et al., 2017, p. 74). It is associated with Mode 2 knowledge production (Klein, 2017).

49 For instance, the Berlin School of Mind and Brain at the Humboldt-Universität zu Berlin offers "academic management" as a distinct area of specialization within its interdisciplinary master's program "Mind and Brain". See http://www.mind-and-brain.de/master/tracks-areas-of-specialization/.

Indeed, such an idea would resonate with researchers like Gabriele Bammer, who has argued for the establishment of a distinct field of specialization, which compiles methodological know-how from different disciplines for practicing collaborative research on complex real-world problems for some years now (Bammer, 2013, 2017). Bammer develops *implementation and integration sciences (I2S)* as a new scientific discipline, which acts as a repository for methods for synthesizing disciplinary and stakeholder knowledge, understanding and managing critical unknowns and providing integrated research support for policy and practice change to address complex societal and environmental problems (Bammer, 2017, p. 2). This new discipline compiles and links existing knowledge on inter- and transdisciplinary research, systemic intervention, system dynamics, community operational research, complex systems science, sustainability science, action research and change management (Bammer, 2017, p. 3). I2S can also be seen as a one-stop knowledge base for T-shaped researchers, which provides tools for practicing collaborative trans- and interdisciplinary research on complex problems (Bammer, 2017).

However, there already exists a well established academic field, which is also particularly attuned to an educational setting: *interdisciplinary studies*. Leading researchers in the field of interdisciplinary studies like Tanja Augsburg, Julie Thompson Klein, William H. Newell, Allen F. Repko and Rick Szostak explicitly promote the education of interdisciplinary researchers as specialists for integrating insights from multiple disciplines to address complex real-world problems (Augsburg, 2016; Klein, 2010; W. H. Newell, 2001; W. H. Newell et al., 2012; Repko et al., 2017; Repko & Szostak, 2017; Szostak, 2013b, 2013a). These researchers made important contributions to the development of a comprehensive body of knowledge on the theory and practice of interdisciplinary research including overarching interdisciplinary research processes (see Repko et al., 2017; Repko & Szostak, 2017). Today a few up-to-date textbooks like *Introduction to Interdisciplinary Studies (Repko et al., 2017)*, *Interdisciplinary Research: Process and Theory* (Repko & Szostak, 2017), *Case Studies in Interdisciplinary Research* (W. H. Newell et al., 2012)*, Becoming Interdisciplinary (Augsburg, 2016)* and the introductory book series Perspectives on Interdisciplinarity from Amsterdam University Press (e.g., Greef et al., 2017; Menken & Keestra, 2016; Post et al., 2017, 2018; Tromp, 2018) are already available.

A particularly important characteristic of interdisciplinary studies is the conviction that (1) the practice of interdisciplinary research can be taught and that (2) interdisciplinary research can also be conducted by individuals (Szostak, 2013a). Even interdisciplinary teamwork can be taught (Szostak, 2013a). This is in stark contrast to the common view that interdisciplinary competences cannot be taught and that interdisciplinary research can only be conducted in teams of disciplinary experts (e.g., Defila & Di Giulio, 1998; Lerch, 2017). It is

therefore worth mentioning that educating students in interdisciplinary research processes and the theory and practice of interdisciplinary research via dedicated textbooks is explicitly recommended in the position paper "Interdisciplinarity and the 21st century research-intensive university" (Wernli et al., 2017) by the League of European Research Universities (LERU), which formulates recommendations for universities on how to incorporate interdisciplinarity in their policies and programs.

From the perspective of interdisciplinary study programs in cognitive science the possibility to specialize in the process and theory of interdisciplinary research could be particularly interesting for those students, who are initially more attracted by the 'interdisciplinary part' of studying cognitive science than to delve deeper into one of its (disciplinary) research areas. Some students choose an interdisciplinary study program because they associate interdisciplinarity with twenty-first century skills for handling complex and wicked problems in a volatile, uncertain, complex and ambiguous (VUCA) world and expect to acquire generic skills which are transferable to the world outside academia. These students could also develop profiles as T-shaped researchers, but would position themselves more as interdisciplinary integration specialists with detailed knowledge of (collaborative) interdisciplinary research processes, best practices, and strategies for integrating insights from different disciplines. They would ideally exemplify "interdisciplinary virtues" characteristic for interdisciplinary practitioners (Frodeman, 2014).

7.2 A Brief Overview of Interdisciplinary Studies[50]

7.2.1 Definition

The interdisciplinary scholar Tanja Augsburg defines interdisciplinary studies in her textbook *Becoming Interdisciplinary: An Introduction to Interdisciplinary Studies* in the following way (Augsburg, 2016):

> *Interdisciplinary studies is the application of interdisciplinarity in educational contexts.* Interdisciplinary studies is where interdisciplinary teaching, learning, understanding, and research takes place. (Augsburg, 2016, p. 18)

On the one hand interdisciplinary studies refers to degree programs at universities which cross disciplinary boundaries. Such degree programs may be thematic (e.g., environmental studies, sustainability studies, etc.) or generic (degree in interdisciplinary studies), which means that students have to find their own individual focus area. On the other hand, interdis-

50 I will almost exclusively draw on the textbooks by Repko et al. (2017) and Repko and Szostak (2017), because I consider their works to be the most comprehensive introductions that are currently available. For a critique of interdisciplinary studies see Hvidtfeldt (2018).

ciplinary studies also refers to the field of research that is concerned with questions on how to practice and teach interdisciplinary research on complex real-world problems. Thus, the interdisciplinary researchers Alan F. Repko, Rick Szostak and Michelle Phillips Buchberger present an "integrated definition" of interdisciplinary studies in their introductory textbook *Introduction to Interdisciplinary Studies*, which synthesizes commonalities of widely recognized definitions from other scholars (Repko et al., 2017, p. 65):

> Interdisciplinary studies is a cognitive process by which individuals or groups draw on disciplinary perspectives and integrate their insights and modes of thinking to advance their understanding of a complex problem with the goal of applying the understanding to a real-world problem. (Repko et al., 2017, p. 65)

The authors explicitly highlight the "five ideas", which are contained in their definition (Repko et al., 2017, p. 66):

1. They define interdisciplinary studies as a *cognitive process*. It is a process by which individuals or teams create or acquire knowledge by drawing on multiple disciplinary perspectives. This view also implies that academic disciplines are a necessary foundation for interdisciplinary studies. Indeed, interdisciplinary and disciplinary research can be conceived as having a symbiotic relationship (Repko & Szostak, 2017, p. 8).
2. They regard *integrating insights* from different disciplines as an essential part of this cognitive process. That is to say, integrating insights is not a nice-to-have feature of interdisciplinary research, but at the very heart of it (Repko et al., 2017, p. 170). Therefore, they define interdisciplinarians as "scholars familiar with strategies for integrating insights from diverse disciplines" (Repko et al., 2017, p. 17).
3. The whole process is directed toward *advancing the understanding* of complex problems.
4. The relevant problem is a *complex problem*. The underlying idea is that only problems of a certain complexity require an investigation from two or more disciplinary perspectives. Therefore, it is important to learn to "see" (perceive) complexity in the familiar as well as to "see" complex problems in context (Repko et al., 2017, p. 175). One of the first steps in the interdisciplinary research process is to justify using an interdisciplinary approach by showing that the problem of investigation is complex (Repko et al., 2017, p. 269). One's understanding of a complex problem is advanced by following an overarching interdisciplinary research process (Repko et al., 2017, p. 64).

5. Finally, *applying this advanced understanding* to a real-world problem is the designated goal of the process. A more comprehensive understanding of a complex problem should also enable new ways of taking action (Repko et al., 2017, p. 64).

It is this understanding of interdisciplinary studies as a cognitive process in the sense of Repko et al. (2017), which is relevant for practicing integrationist interdisciplinary research.

7.2.2 History

Today, motivations for interdisciplinary research are typically associated with (abstract) notions of complexity and innovation (Lerch, 2017, p. 50). Given that the first thematic interdisciplinary studies programs were established in the early 1980s in the USA (Repko et al., 2017, p. 32), it is worth to take a glimpse at the historical development of the field and to learn in which societal and political contexts initiatives for interdisciplinary education emerged in the USA in the twentieth century.

Repko et al. (2017) trace the rise of interdisciplinary studies back to the general educational reforms in the USA after World War I & II, which were targeted towards a more integrative education and oriented towards the European humanist tradition (pp. 32-34). The motivations for these educational reforms is quite interesting from today's perspective. After World War I, the massive influx of immigrants was perceived as a threat to cultural unity or national identity, and disciplinary specialization at universities as a threat to a well-balanced education (Repko et al., 2017, pp. 32–33). An integrated educational experience was intended to solve these two problems at the same time (Repko et al., 2017, p. 32). Similarly, after World War II an educational reform in the spirit of the European humanist tradition (liberal arts education) was intended to strengthen democracy in light of communist ideology (Repko et al., 2017, pp. 33–34). In the 60s and 70s political and societal tensions (Vietnam War, issues of race and marginalized groups) as well as criticism of disciplines as power and control structures (by the French philosopher Michel Foucault) and their impact on marginalizing holistic thinking paved the way for interdisciplinarity as an alternative to traditional (disciplinary) education (Repko et al., 2017, pp. 33–36). Calls for educational initiatives, which were more directed toward solving pressing real-world social issues finally led to the development of the first thematic interdisciplinary studies programs such as African American studies, women's studies, ethnic studies, but also environmental studies, developmental studies and urban studies (Repko et al., 2017, p. 35). Despite these efforts there was no common body of knowledge informing interdisciplinary teaching and research processes, which motivated interdisciplinarians to found their first professional associations (Repko et al., 2017, p. 37). Notice that research on interdisciplinary theory and practice in higher education gained its momentum especially due to the focus on teaching in different studies programs (Repko et

al., 2017, p. 37). However, as calls for interdisciplinary research at universities got louder (e.g., through dedicated funding of interdisciplinary research), traditional disciplinary based faculties adopted the label 'interdisciplinary' without any clear implementation strategies and unaware of the already existing body of knowledge on the theory and practice of interdisciplinary research from interdisciplinary studies (Repko et al., 2017, p. 38). Today, consensus on many areas of interdisciplinary theory and practice especially in the context of higher education is emerging and a growing body of literature from interdisciplinary studies is available (see also Dezure, 2017; Repko et al., 2017, p. 38).

7.2.3 Motivation

Repko et al. (2017) highlight six "drivers" of interdisciplinary studies from today's perspective, which they also interpret as evidence that interdisciplinarity will become an integral part of higher education (p. 4):

1. *The complexity of nature, society, and ourselves.* All of these are highly complex systems that require study from multiple disciplinary perspectives (Repko et al., 2017, pp. 4–5).
2. *The complexity of the globalized work place*. The IT revolution together with the process of globalization have radically transformed the world economy within the last decades (Repko et al., 2017, p. 5). According to Repko et al. (2017), the complexity – and I would add uncertainty as a corollary – of the globalized workplace with its high dynamic fueled by new information and communication technologies demands new kinds of workers:

   > This is a person who can understand, use, and integrate knowledge, technology, and methods, as well as collaborate with persons from diverse cultural backgrounds with diverse disciplinary training. This person must be able to work with intangible information to produce a tangible product. (Repko et al., 2017, p. 6)

3. *The need for system's thinking and contextual thinking*. Making sense of interrelated aspects of complex problems studied from different disciplinary perspectives requires skills in system's thinking and contextual thinking (Repko et al., 2017, pp. 6–9).
4. *The changing nature of university research.* The authors point to the general trend towards interdisciplinary research to advance scientific knowledge production at universities (Repko et al., 2017, pp. 9–11).
5. *The public world and its pressing needs*. Such pressing societal issues include global issues like climate change, world hunger, sustainable resources, but also local issues like

homelessness, affordable housing, green spaces for recreation and public transportation (Repko et al., 2017, pp. 11–16).

6. *A knowledge society needs both disciplinarity and interdisciplinarity*. As the authors see it, shifts toward interdisciplinarity are not about overcoming or devaluing disciplinary knowledge production and structures. Instead, they point out that disciplinary and interdisciplinary practices are both required and interdependent in a knowledge society (Repko et al., 2017, pp. 16–17).

The authors are convinced that interdisciplinary studies helps students to develop the required skills "for the realities of life in the twenty-first century with its growing complexities and new challenges" (Repko et al., 2017, p. 3).

7.2.4 On The Need for Formal Training in Interdisciplinary Studies

The preface from Repko's et al. textbook *Introduction to Interdisciplinary Studies* is especially illuminating with regard to the need for formal training – i.e., systematic and structured training – in interdisciplinary studies (Repko et al., 2017). It is particularly worth to present some passages from it in the authors' own words. They start their preface with the following paragraph:

> The purpose of this book is to provide instructors and students in entry-level interdisciplinary courses and thematic programs with a comprehensive introduction to interdisciplinary studies. This book introduces students to the cognitive process that interdisciplinarians use to approach complex problems and eventually arrive at more comprehensive understandings of them. Put another way, *students in these courses will learn to think like interdisciplinarians* [emphasis added]. By the end of an interdisciplinary course in which this book is used, students should be able to differentiate between disciplinary and interdisciplinary approaches to learning and research, follow and critique interdisciplinary arguments, understand interdisciplinary process, and assess the quality of their own work. (Repko et al., 2017, p. xvii)

Notice that the authors identify the target audience of their book as the students and course instructors for general (non-thematic) courses on interdisciplinary studies as well as thematic programs (e.g., cognitive science programs). Moreover, they immediately point out that becoming an "interdisciplinarian" requires its own specific training, which is different from disciplinary training. Articulating this difference is an important study goal for students.

Later in their preface, the authors elaborate on their motivation for writing a textbook on interdisciplinary studies. In this respect, they remark that,

> until recently, it was common practice for entry-level courses, whether in interdisciplinary studies or thematic interdisciplinary programs, to be taught by teams of disciplinarians who had no formal training in interdisciplinarity. Shrinking budgets have made this practice a luxury that few institutions can afford. Today, the responsibility for teaching an introductory course is more commonly the responsibility of a single instructor who is often more familiar with the disciplinary literature pertaining the course or program theme than with the extensive literature on interdisciplinarity and the principles and best practices of the field. (Repko et al., 2017, pp. xviii–xix)

I suppose that this diagnosis fits for many thematic interdisciplinary programs (including the MEi:CogSci). Moreover, the authors point out later that students "often bring into the course misperceptions about interdisciplinary learned from other students or from disciplinary instructors" as one of the obstacles to developing interdisciplinary competences (Repko et al., 2017, p. xxiii). In other words, the authors indicate that confusions about interdisciplinarity are quite common and in need to be addressed, which is also the overall theme of the present thesis.

In regard to thematic interdisciplinary programs (such as cognitive science programs), the authors also explicitly mention that their book may be useful as a "supplemental text for entry-level courses in thematic multidisciplinary 'studies' programs that focus on a single issue or theme" (Repko et al., 2017, p. xx). Their list of such programs also includes cognitive science. In this context they note:

> Many of these programs claim interdisciplinary status, which means that they probably subscribe to the core principles of interdisciplinarity discussed in this book. The majority of the readings used in introductory courses to these programs focus primarily on the topic of the course and only secondarily on interdisciplinarity, which is referenced in class discussion during the semester. However, these courses need to introduce students to the basics of interdisciplinarity as well as to the substantive content of the theme. After all, thematic programs typically build on disciplinary courses from several disciplines (Repko et al., 2017, p. xxi).

The authors' description here is considerable in line with regular feedback from MEi:CogSci students about interdisciplinarity in the courses of the "integrative kernel" (see chapter 6). Given that this is stated in the preface of an introductory textbook to interdisciplinary practice, I assume that this experience is quite common for students of other thematic interdisciplinary programs too.

7.2.5 Core Contents and Learning Goals

To get a initial impression of the core contents and learning goals – "the basics elements of this diverse and maturing field" (Repko et al., 2017, p. xix)– for students of interdisciplinary studies, here is the short outline as presented by the authors in their introductory textbook:

> This book (1) identifies the 'drivers' of interdisciplinary learning and research and relates these to students' preparation for the rapidly changing job market of the new millennium; (2) situates interdisciplinary studies as part of the history of knowledge formations and the differentiation of knowledge into disciplines; (3) offers an integrated definition of interdisciplinary studies that helps students articulate the nature, value, and characteristics of interdisciplinary studies to friends, parents, and prospective employers; (4) helps students understand what it means to be interdisciplinary in terms of the cognitive abilities, values, and traits and skills that exposure to interdisciplinary studies fosters; (5) explains the role of the disciplines in the university and how interdisciplinary studies differs from, yet builds upon, the disciplines; (6) examines the diverse forms of interdisciplinary studies in terms of their assumptions, theories, commitment to epistemological pluralism, and perspectives on reality; (7) facilitates students' ability to think critically about real-world problems and intellectual questions that span a range of disciplines and interdisciplinary fields in the undergraduate curriculum; (8) presents models commonly used by practitioners for addressing issues that are complex; (9) introduces a rubric that enables students to assess the quality of interdisciplinary work by others as well as their own; (10) integrates discussions concerning intellectual autobiographies, student portfolios, and service learning; (11) presents material that is consistent with a constructivist and pragmatic approach to learning; and (12) prepares students for advanced interdisciplinary studies. (Repko et al., 2017, p. xix)

I think that this short summary already outlines the range of the topics covered. However, for a thematic program in cognitive science the specific details of an overarching interdisciplinary research process would be of particular interest.

Repko and Szostak (2017) address the interdisciplinary research process in their other dedicated textbook *Interdisciplinary Research: Process and Theory*, which aims "to provide a comprehensive and systematic presentation of the interdisciplinary research process and the theory that informs it, not only for students, but also for professionals and interdisciplinary teams" (p. xvii). It is intended as "a corrective to those who argue that interdisciplinarity is too hard to do" as well as "to those who argue that interdisciplinarity is easy in the sense that it can be done without reflection" (Repko & Szostak, 2017, p. xviii). Probably the most important contents are summarized by the authors in the following way:

> (1) It [the book] describes how to *actually do* interdisciplinary research using processes and techniques of demonstrated utility whether one is working in the natural sciences, the social sciences, the humanities, or applied fields. (2) It integrates and applies the body of theory that informs the field into the discussion of the interdisciplinary research process. (3) It presents an easy-to-follow, but not formulaic, decision-making process that makes integration and the goal of producing a more comprehensive understanding achievable. (Repko & Szostak, 2017, p. xx)

The emphasis on the practice of interdisciplinary research is an outstanding feature of their work.

7.3 Summary

In addition to the T-shaped researcher, who specializes in a discipline and corresponding research area relevant for cognitive science, a different kind of specialization for cognitive science students can be motivated by the complexity and challenges of (collaborative) inter- and transdisciplinary research itself. Experts in inter- and transdisciplinary research highlight the demand of specific skills and know-how for engaging in real-world research projects on complex or wicked problems. Cognitive scientists, who develop their T-shaped profile by specializing in the theory and process of interdisciplinary research, could act as facilitators in complex collaborative inter- and transdisciplinary research projects and work in academic management. The relevant body of knowledge for formal training in the theory and practice of integrationist interdisciplinary research is already available from the academic field of interdisciplinary studies.

8 Complexity As a Mindset for Integrationist Interdisciplinarians

Although complexity is often highlighted as one of the main motivations for an interdisciplinary approach, it is surprisingly uncommon to find a substantial explication or introduction to what it means and implies in the respective context. Yet, a basic understanding of complexity is required in the context of interdisciplinary studies (Repko et al., 2017), and the interdisciplinary research process (Repko & Szostak, 2017) since the theory of complex systems was proposed as the very foundation for interdisciplinary studies by William H. Newell (one of the pioneers of interdisciplinary studies) in 2001 (W. H. Newell, 2001) It has since shaped the development of the field (Welch, 2018). Although the role of complex systems as *the* foundation for an interdisciplinary approach has been questioned and is now seen more pragmatic (Welch, 2018), complexity is an important criterion to motivate an interdisciplinary approach (Repko & Szostak, 2017). In addition, systems thinking and contextual thinking are highlighted as crucial skills for interdisciplinary researchers (Repko et al., 2017).

In the following sections, I will briefly introduce the relevant concept of complexity, which provides the foundation for interdisciplinary studies and its integrationist interdisciplinary approach, connect it to systems thinking and, moreover, to a 'complexity worldview' and 'complexity mindset' characteristic for researchers working on complex phenomena or wicked real-world problems.

8.1 Complex Systems As the Foundation for Integrationist Interdisciplinarity

It may sometimes be assumed that a basic understanding of complexity and its related concepts is already common knowledge and, therefore, there is no need to elaborate on it. This might be even true for phrases like 'the whole is more that the sum of its parts' to refer to emerging properties characteristic for complex systems or keywords like 'nonlinearity' to characterize the interactions of such a system's elements in mathematical terms (Holland, 2014). Typical textbook examples like insect colonies, the brain, the immune system, economies and the world wide web may also come to mind (e.g., Mitchell, 2009). These examples point to the hierarchical organization characteristic for complex systems such as the interactions of individual H_2O molecules on a lower level of organization giving rise to the 'wetness' of water and its fluid dynamics on a higher level of organization (Holland, 2014), or myriads of interacting neurons in the brain giving rise the emergent property of consciousness of the whole brain (or animal) (Mitchell, 2009). Examples like the dynamics of stock

markets can even create a vivid picture of inter-level effects like when the changes of stock prices influence the behavior of buyers and sellers (top down effects) which in turn effects the stock prices (bottom up effects) (Holland, 2014, p. 5). These characteristics and examples already point into the direction relevant for motivating an interdisciplinary approach (see W. H. Newell, 2001). However, without explicitly explaining in which specific sense complexity is of particular relevance in the context of interdisciplinary there is the danger of understanding the word in its everyday meaning as something which consists of many (interconnected) parts or just as complicated. A jigsaw puzzle with hundreds of pieces would also meet such an everyday definition, but it is certainly not complex in the sense of the previous examples. Furthermore, on such a vague meaning probably all scientific research endeavors are somehow complex and thus reference to complexity is quite uninformative with respect to specifically motivating an interdisciplinary approach.

The concept of complexity that is relevant from the perspective of interdisciplinary studies is drawn from the field of complex systems research (W. H. Newell, 2001). Complex systems researchers use mathematical and computational methods to model different kinds of complex systems, and to explore, describe and predict their properties and behaviors (Thurner et al., 2018). Due to the methodological progress in the field it might even be regarded as an independent natural science discipline (Thurner et al., 2018). As a rule of thumb, when people are talking about complexity from the point of view of complex systems science, their explications will be centered around mathematical equations and computational analysis/models using some of the following terms: adaptation, agent/agent-based modeling, attractor, bottom-up/top-down effect, complex adaptive system, boundary, chaos, diversity, dynamical system, dynamics, emergence, environment, (co-)evolution, (positive/negative) feedback loop, fragility, hierarchy, interaction, interconnectedness, interdependence, interrelatedness, learning, network/network analysis, non-linearity, non-reducibility, path-dependance, phase transition, resilience, robustness, self-organization, self-regulation, simulation, state space, open/closed system, trajectory, etc. (e.g., see Boulton et al., 2015; Meadows, 2008). In contrast to the quantitative approach of complex systems research, however, there is also a qualitative approach to complex systems – to 'see' complexity in everyday life.

8.2 Systems Thinking As a Qualitative Approach to Complex Systems

Complex systems research is typically not what is intended when researchers motivate their interdisciplinary approach – at least not at the level of mathematical analysis. Rather than studying complex systems with mathematical and computational tools, complexity can also be approached from our everyday experiential point of view on a conceptual level. For in-

stance, Donella Meadows introduces complexity and complex systems in *Thinking in Systems: A Primer* in such a spirit (Meadows, 2008):

> Long before we were educated in rational analysis, we all dealt with complex systems. We are complex systems—our own bodies are magnificent examples of integrated, interconnected, self-maintaining complexity. Every person we encounter, every organization, every animal, garden, tree, and forest is a complex system. We have built up intuitively, without analysis, often without words, a practical understanding of how these systems work, and how to work with them. Modern systems theory, bound up with computers and equations, hides the fact that it traffics in truths known at some level by everyone. It is often possible, therefore, to make a direct translation from systems jargon to traditional wisdom. (Meadows, 2008, p. 3)

Meadows (2008) wants to raise awareness of the fact that we are already embedded in a world where complex phenomena are ubiquitous in our everyday lives and in this sense already have at least some a preconceptual or practical understanding (know-how) of some features of complex systems. One of her examples is the phenomenon of drug addiction (Meadows, 2008, p. 2). It might be much easier to understand why it may be hard for some people to break the circle of substance abuse, when it is not just seen as weakness of will of individual people but as systemic effect of multiple interrelated and interacting factors such as physiological dispositions, family circumstances, work issues, societal factors, etc. Therefore, she proposes that systems thinking can also be applied to everyday phenomena to a large extend even without the application of mathematical of computational tools. For Meadows it is primarily a "different way of seeing and thinking" (Meadows, 2008, p. 4). In other words, systems thinking is in the first instance about training our perception, i.e., about when, where and what to pay attention to, and a way to organize and think about the complex phenomena of our everyday life by applying a refined conceptual framework developed for this purpose. This way of seeing and thinking can be learned and practiced without first mastering advanced mathematical tools required for the detailed scientific study of complex systems for its own sake.

According to Repko et al. (2017) interdisciplinary studies "sees" complexity in the familiar, complex problems in context, commonality amid difference and conflict, and contingency in certainty (p. 175-176). Perceiving phenomena as complex systems, i.e., identifying their interacting components, and the ways in which they constitute the phenomena, provides the basis for engaging in interdisciplinary studies (Repko et al., 2017). Thus, from the perspective of an interdisciplinary practitioner,

> a subject or problem is complex when its multiple parts require study by different disciplines. *These parts interact in important ways, but the disciplines by their nature fail to study the interactions* [emphasis added]. (Repko et al., 2017, p. 4)

The emphasis on the interaction between those parts that constitute the subject or problem to be studied is essential here:

> What distinguishes phenomena and problems that are merely complicated from those that are complex is the nature of the relationships among the parts. Complexity refers to the parts of a phenomenon or problem that *interact* in surprising/unexpected ways. Interdisciplinary complexity theory states that interdisciplinary study is necessitated when the problem or question is multifaceted and functions as a 'system'. (Repko & Szostak, 2017, p. 14)

In other words, perceiving the world as complex and learning to think in systems are required for further engagement in interdisciplinary studies.

8.3 Complexity As a Worldview and Mindset[51]

8.3.1 Complexity Thinking

Whereas Meadows (2008) focuses on systems thinking in the tradition of systems theory to tackle complexity, the authors Jean G. Boulton, Peter M. Allen, and Cliff Bowman of *Embracing Complexity: Strategic Perspectives for an Age of Turbulence* go one step further to the theory on complex adaptive systems and propose "complexity thinking" as an extension or advancement (Boulton et al., 2015, p. 1):

> Systems thinking deals with stable patterns, and history deals with the particularity of events, conditions and individuals – but complexity thinking marries the two and provides us with a sophisticated and unique theory of change. (Boulton et al., 2015, p. 29)

In other words, while systems thinking seeks to understand how the interactions keep phenomena stable, complexity thinking focuses on how phenomena develop over time, their becoming and change (Boulton et al., 2015). The impact of particular events or minor variations in patterns (or regularities) which otherwise constitute stable phenomena can have surprising and unexpected effects and are key to understanding the nature of change (Boulton et al., 2015). In the words of the authors, "it is detail and variation coupled with interconnection that provide the fuel for innovation, evolution, change and learning" (Boulton et al., 2015, p.

51 See also Tromp's (2018) textbook *Wicked Philosophy: Philosophy of Science and Vision Development for Complex Problems* for an introduction.

29). Despite this difference in focus, the authors share Meadow's basic intention. In the same spirit they suggest to understand complexity as a "worldview" (Boulton et al., 2015, p. 27), which means accepting and embracing the idea that "the world is really complex, uncertain, and changing" (Boulton et al., 2015, p. 28). "The complexity worldview," the authors explain, "is sandwiched between a view that the world works like a machine and a view that the world is chaotic, unpredictable, and without structure" (Boulton et al., 2015, p. 29).

8.3.2 Approaching the Complex World With a Corresponding Mindset

It is important to notice that when Boulton et al. (2015) refer to the world as a machine they do not just intend to point to this specific conceptualization of the world as empirically inadequate. They rather want to draw our attention to an underlying attitude, stance or mindset, which above all motivates and sometimes even mindlessly forces such a mechanistic conceptualization onto phenomena. According to the authors, at the heart of this attitude is the idea of controlling things. A mechanistic worldview, alongside with analytic approaches towards phenomena (dividing wholes into parts and understanding them in isolation) and an inclination for determinism, exactness, predictability, reproducibility, traceability, etc. are seen as an expression of this attitude (Boulton et al., 2015). In other words, the motivation for a mechanistic conceptualization of phenomena – and as a corollary the presumption or postulation of simple causalities – might sometimes be rooted in the implicit human desire for control over things. The complexity worldview which the authors promote can be seen as a means to develop a different attitude toward how we initially approach phenomena. Indeed, the crucial point is that complexity thinking is first and foremost about a "mindset" (Boulton et al., 2015, p. 230), about the beliefs, intentions, interpretations and actions when approaching real-world problems (Boulton et al., 2015, p. 13). It takes into account that which is "beyond what can be tackled analytically, with precise equations and mathematics" (Boulton et al., 2015, p. 13) – and can therefore be seen in tension with the quantitative approach of complex systems research. It embraces the assumption that there are inherent limits to our knowledge and thus situates knowledge always in context (Boulton et al., 2015). It is open in the sense that it is prepared for surprises, i.e., the appearance of new and unexpected aspects or behaviors of phenomena over time (Boulton et al., 2015). It also points toward flexible and pragmatic approach to research (Boulton et al., 2015).

Adopting a complexity mindset has consequences for the way research is done. Which methods are relevant or adequate is not the only issue here. Although established methods may be used, they have to be applied with a complexity mindset, which is based on guiding principles and frameworks instead of the algorithmic steps and rules of an overall research

methodology (Boulton et al., 2015, p. 5). Here is how the authors describe "a complexity-informed research process" (Boulton et al., 2015, p. 112):

> What would a research process able to deal with the complexities of the world have to do? It would have to try to give room for, and not to constrain, the emergence of something new *during* the investigation, and it would need to make more allowance for the unexpected. It would need to follow the *process* of the emergence of new factors and outcomes. It would need to pay attention to the systemic nature of the situation and not require too narrow a path of inquiry, but allow the taking of detours and the consequent widening of the factors of interest. It would facilitate the noticing of emergent contextual features or of new entrants into the situation. It would recognize the importance of the detail – the particularity, the granularity of the conditions and events, and the particularity of the order in which things occurred, the *sequence* of events. (Boulton et al., 2015, p. 112)

With respect to the epistemology of interdisciplinary research, Boon and Van Baalen (2019) point out that

> in order to actually use and generate 'knowledge' for solving complex real-world problems, researchers need higher-order cognitive skills, because rules or algorithms for how to use a theory, model, concept or data in this respect usually are not given by the epistemic resources. (Baalen & Boon, 2019, p. 9)

The philosopher Robert Frodeman would certainly agree with all these authors when he argues in his book *Sustainable Knowledge: A Theory of Interdisciplinarity* that "skill at interdisciplinary work thus becomes a matter of character rather than methodology" (Frodeman, 2014, p. 48). I think that this spirit of how to engage in research on complex phenomena is what Repko and Szostak (2017) have in mind when they conceive of engagement in their overarching interdisciplinary research process:

> The term *process* is used rather than *method* [for practicing interdisciplinary research] because, definitionally, *process* allows for greater flexibility and reflexivity, particularly when working in the humanities, and distinguishes interdisciplinary research from disciplinary methods. (Repko & Szostak, 2017, p. xx)

According to Repko and Szostak (2017) "interdisciplinary research is a decision-making process that is heuristic, iterative and reflexive" (p. 79). Moreover, Szostak (2017) characterizes the interdisciplinary research process as a creative design process.

8.4 Summary

Complexity as it is understood in complex systems research is at the foundation of interdisciplinary studies. Learning to 'see' (perceive) phenomena or problems as complex and in complex contexts is an essential skill for researchers engaging in integrationist interdisciplinary research. The primary interest of integrationist interdisciplinary researchers are the interactions between parts of complex systems, because the parts are (or can be) studied from disciplinary perspectives, but studying their interactions requires interdisciplinary integration. Engaging in an interdisciplinary research process can be contrasted with applying a method. Developing a 'complexity worldview' and a 'complexity mindset' can be seen as relevant virtues for engaging in an interdisciplinary research process, which is best understood as a decision-making and creative design process.

9 Integrationist Interdisciplinarity for Cognitive Science

In *The Mind's New Science: A History of the Cognitive Revolution* – the first book on the history of cognitive science published in 1985 – the psychologist Howard Gardner highlighted the "belief in interdisciplinary studies" as integral part of the cognitive science research enterprise (Gardner, 1987, p. 42). In his own words: "Cognitive scientists harbor the faith that much is to be gained from interdisciplinary studies." (Gardner, 1987, p. 6)

In the previous chapter (chapter 8), I highlighted the importance of complexity as a foundation for interdisciplinary studies. In the following sections, I will elaborate on how a complexity worldview and mindset can be understood in the context of cognitive science research. I will first discuss complexity in the context of the traditional computational-representational view of cognition, then continue with the situated/4E view of cognition and, finally, suggest that from an educational point of view interdisciplinary studies can be seen as specifically relevant for future researchers engaging in research on situated/4E cognition.

9.1 Complexity and the Traditional Computational-Representational View of Cognition

My previous elaborations on complexity, the complexity worldview and mindset may appear to be in plain contradiction with the mode in which basic research is conduced in the traditional computational-representational view on cognition since it is a purely a mechanistic conception of the mind (e.g., Bermúdez, 2020; Clark, 2014). Yet, Boulton et al. (2015) introduced complexity in contrast to the mechanistic conception of phenomena (see chapter 8.3). Is the computational-representational view of cognition not open for an integrationist interdisciplinary approach?

Indeed, reference to mechanisms and mechanistic explanations can be considered a cornerstone of cognitive science (C. Wright & Bechtel, 2007). Explaining cognitive phenomena with reference to models of mechanisms is the "common explanatory practice in [information processing] psychology" (C. Wright & Bechtel, 2007, p. 72), and in neuroscience (C. F. Craver, 2007). The reference to mechanisms is also explicit in many book titles (e.g., *The Computer and the Mind* (Johnson-Laird, 1989), *Mindware* (Clark, 2014), *The Mechanical Mind* (Crane, 2015), or *Mind as Machine* (Boden, 2006)) and sometimes illustrated with gears as symbols for cognition. Therefore, it is plausible to conclude that it may not be open to interdisciplinary research in the sense of interdisciplinary studies conceived by Repko et al. (2017).

One the one hand, adopting a complexity worldview does not mean that it may not be perfectly viable to conceptualize a natural phenomenon at some scales, some levels of abstraction and for certain purposes, i.e., from specific points of view, in a purely mechanical fashion. Indeed, the physical symbol systems approach in cognitive science is a prime example of this explanatory strategy. Moreover, strongly contrasting mechanisms with complexity can be misleading too. For one thing, it may suggest that mechanisms are much simpler things or easier to understand. Yet, mechanistic conceptions of phenomena can be highly sophisticated. Psychology based computational cognitive architectures, i.e., large-scale software models, which attempt to cover the whole range of human cognitive capacities, are prime examples of sophisticated mechanistic conceptions of the mind (e.g., Chipman, 2017, pt. I; Kotseruba & Tsotsos, 2020). To make things worse, according to the analysis of philosophers mechanism and mechanistic explanations are not necessarily deterministic, reductionistic or linear/sequential (C. Craver & Tabery, 2019). Mechanisms may have stochastic components, may depend on the activities of other system levels, or may have feedback loops or cycles (C. Craver & Tabery, 2019). On broad conceptions of mechanisms, complex systems might even be regarded as mechanistic (C. Craver & Tabery, 2019). Conversely, complex (surprising or unexpected) behavior may already emerge from very simple mechanical systems (e.g., Braitenberg, 1986). Therefore, mechanistic conceptions for some kinds of complex behaviors or at some level of complex phenomena are not necessarily contradictory. By providing both a reductionist an emergentist perspective, mechanistic explanations can even be understood as bridging different levels of analysis (Bechtel & Wright, 2009). This can make mechanistic explanations especially attractive for integrating knowledge from different (disciplinary) perspectives if the underlying phenomenon can be modeled as a mechanism.

On the other hand, even if some complex phenomena can be modeled in terms of mechanisms, the salient point of the complexity worldview and interdisciplinary studies is to learn to see them embedded within a complex context. The philosopher Shaun Gallagher vividly expresses this idea with reference to building a robot for real-world applications:

> Just as one can design a robot by assigning teams to construct different modules, which turn out to work well as individual modules, it may happen that when the modules are brought together, they don't play well together. No one has considered the relational aspects of how one module will dynamically connect with another in a complex system, and the result is a clunky machine-like behavior. (Gallagher, 2017, p. 22)

He also points to similar issues, which arise when researchers try to integrate insights from different scientific disciplines or research approaches/programs:

> Scientific experiments, designed within the framework of their own particular paradigm, often study the pieces of a system but don't always consider how the dynamical relations among those pieces work, and *don't always have the vocabulary to address those relations* [emphasis added]. Even working in an interdisciplinary way we often find ourselves building a clunky theory where insights from different disciplines don't integrate well. (Gallagher, 2017, p. 22)

This is exactly what Repko et al. (2017) are referring to when they motivate interdisciplinary studies by pointing out that "the disciplines by their nature fail to study the interactions" of different parts of a complex system, when multiple disciplinary perspectives are involved (p. 4). In both of Gallagher's cases, systems thinking/complexity thinking provide a vocabulary to conceptualize these relationships and interdisciplinary studies would find its starting point there.

9.2 Complexity and Situated/4E Cognition

It appears that interdisciplinary studies is a particularly suitable approach in the context of situated/4E views of cognition, i.e., when research on cognition involves the body and the environment (e.g., Bermúdez, 2020; Gallagher, 2017; Lyre & Walter, 2013; Newen et al., 2018; Wilson & Foglia, 2017). Moreover, the complexity worldview or, more precisely, an explicit ontology as a foundation for complex systems may actually be required to make sense of the emergence and development of some of the most fundamental properties of the mind from a scientific point of view.

9.2.1 Process Metaphysics As Ontology for Complex Systems

The philosopher and theoretical psychologist Mark H. Bickhard consistently argues that models of human cognition need to be grounded in a process metaphysics – in other words, an ontology for complex systems – to be able to account for the emergence of normativity and in further consequence (mental) representations (Bickhard, 2009). According to Bickhard,

> process, in fact, is now the dominant language of science. Every science has progressed beyond an initial conception of its phenomena in substance terms to understanding that they are in fact process phenomena. Fire is no longer modeled in terms of the substance phlogiston, but instead in terms of the process of combustion; heat no longer in terms of caloric, but in terms of random kinetic processes; life no longer in terms of vital fluids, but in terms of special kinds of far from thermodynamic equilibrium processes. And so on. Every science, that is, *with the exception of the sciences and philosophies of mind and persons* [emphasis added]. (Bickhard, 2009, p. 553)

On his analysis, major theoretical approaches in cognitive science (physical symbol systems, connectionism, dynamicism, enactivism, action-oriented predictive processing) fail to provide an adequate account of representation, i.e., for the emergence of representations about the world which can be true or false for a cognitive agent – rather than being only true or false from the point of view of an outside observer (Bickhard, 2015). Yet, such representations may be at least required for higher forms of cognition (e.g., reasoning, planing, language use, etc.) and are, therefore, a criterion for human cognition. Bickhard argues that a proper understanding of the ontological emergence of normativity and representation, i.e., how they come into existence, is impeded by an (implicit) substance metaphysics guiding cognitive science research and theorizing (Bickhard, 2009). A substance metaphysics expresses the philosophical assumption that a set of discrete, countable, non-changing entities are the basic building blocks of the world (Seibt, 2018). As a result, nothing entirely new can emerge, i.e., can come into existence, which cannot be finally analyzed as a composite of those basic entities. By contrast, in a process metaphysics, where change is fundamental, the emergence of something entirely new is a direct consequence of the organization of processes:

> A process metaphysics yields ontological emergence as a "natural" kind of phenomenon in the world – including, in particular, normative emergences. Mentality and personhood are saturated with, and constituted in, such multifarious normativities. These include function, representing, rationality, action, social ontologies, personhood, language, and ethics. Multiple other phenomena emerge as specializations of, elaborations of, and aspects of these basic kinds of phenomena, e.g., perceiving, memory, motivation, and so on. We cannot understand psychological phenomena, and the development of psychological processes, without understanding the nature and origin of these emergent normative processes, and we cannot understand emergent normative processes without a process metaphysical framework that can account for emergence and normative emergence. (Bickhard, 2019, p. 242)

Adopting a process metaphysics has implications for the creation and interpretation of scientific models of cognition. When change is default, it is stability that needs to be explained in terms of processes (Bickhard, 2009).

9.2.2 Grounding Situated/4E Cognition in Process Metaphysics

Bickhard develops his own "interactionist model" of representation and cognition: a pragmatic action and interaction based dynamic systems approach (Bickhard, 2009, see also 2015, pp. 17, 20–23). His model can be considered a family member of situated/4E views of cognition, because on these views cognition is broadly understood as enacted through the

complex dynamic interactions between environment, body and brain. With respect to Bickhards arguments, situated/4E views of cognition can be generally conceived as grounded in an ontology for complex systems although this is rarely explicitly considered or articulated. From a historical perspective, systems thinking and the early study of complex systems are actually scientific antecedents of situated/4E views (Clancey, 2009; Varela et al., 2016). The philosopher John Protevi argued in several articles that providing an ontological foundation for dynamic systems theory within situated/4E cognition would be the required next step (Protevi, 2010a, 2010b, 2012). According to Protevi, without a proper ontological foundation, 'the subject' (i.e., the human being) of current situated/4E cognitive science is still abstracted from political categories like race or gender through which we become enculturated subjects and that culture is too narrowly conceived just as a scaffold for developing individual problem-solving skills instead of taking into account the much broader impact of social power structures and their effects on the development of cognitive and affective traits. Therefore, he suggests to adopt the metaphysical framework developed by the French philosopher Gilles Deleuze (1925-1995) to make sense of the process of subjectification, i.e., of becoming a (human) subject. In a similar spirit, David Weinbaum adapted Deleuze's "philosophy of becoming" based on its exposition in the context of contemporary (analytic) philosophy of science by DeLanda (2013) as a conceptual foundation for the study of complex systems (Weinbaum, 2015), and develops an approach to understand (artificial) general intelligence by shifting the question from "what does it mean *to be* intelligent?" to "what does it mean *to become* intelligent?" (Weinbaum (Weaver) & Veitas, 2017, p. 376).

All these researchers have already taken the step of conducting their research explicitly on the basis of a process metaphysics: an ontology of complex systems – or, in Boulton's et al. (2015) terminology, a complexity worldview. As pointed out in chapter 8, adopting a complextity worldview has implications for the way research is conducted. The body of knowledge from interdisciplinary studies can be helpful to introduce cognitive science students to this different kind of approach.

9.3 Mode 2 Research and Situated/4E Cognition

Explicitly approaching the study of cognition with a complexity mindset gives priority to situated/4E views of cognition, and this may have broader implications for the way cognitive science research takes shape (Dominey et al., 2015; Prescott & Verschure, 2015). For instance, Gallagher (2017) argues that enactivism is better conceived as a philosophy of nature instead of a scientific research program. On his view enactivism is more about interpreting research results from different research programs and guiding further research within a holistic con-

ceptual framework for understanding cognition from a critical distance. In this sense, enactivism also presents "a challenge for science" (Gallagher, 2017, p. 21):

> Enactivists, by focusing on not just the brain, not just the environment, not just behavior, but on the rich dynamics of brain–body–environment, offer a holistic conception of cognition. To put it succinctly, however, it is difficult to operationalize holism. Neither experimental control nor the division of labor in science allows for all factors to be taken into consideration at once. (Gallagher, 2017, p. 21)

As a consequence of complexity, a situated/4E view of cognition points more toward a mode of (scientific) knowledge production, which has been conceptualized as "Mode 2" (Gibbons et al., 1994; Nowotny et al., 2003; Prescott & Verschure, 2015).

9.3.1 Mode 1 vs. Mode 2 Research

Using only a few keywords, Mode 2 knowledge production is associated with complexity, non-linearity, heterogeneity and transdisciplinarity (Klein, 2017, p. 30). It is contrasted with "Mode 1" which is "characterized by the hegemony of theoretical or, at any rate, experimental science; by an internally-driven taxonomy of disciplines; and by the autonomy of scientists and their host institutions, the universities" (Nowotny et al., 2003, p. 179). In other words, Mode 1 represents how disciplinary basic research at universities is traditionally conceived. A key characteristics of Mode 2 is that knowledge is produced in the context of its application, which leads to a dissolution of the distinction between basic and applied research (Nowotny et al., 2003, p. 186). Moreover, it is problem-centered and transdisciplinary, "by which is meant the mobilization of a range of theoretical perspectives and practical methodologies to solve problems", but "unlike inter- or multi-disciplinarity, it is not necessarily derived from pre-existing disciplines" (Nowotny et al., 2003, p. 186). Other characteristics are the diversity of sites and types of knowledge produced (e.g., by think-tanks, management consultants, activist groups), the high reflexivity and conversational nature of the research process, and the context sensitivity of quality control (Nowotny et al., 2003, p. 187).

Although the specific conception of Mode 2 knowledge production has been criticized from empirical, conceptual and political perspectives (Hessels & van Lente, 2008), it is still often used in discussions about inter- and transdisciplinarity (e.g., Dressel et al., 2014; Frodeman et al., 2017). Therefore, I think it is at least useful as a heuristic notion to get an initial idea of the general direction in which situated/4E cognitive science research is pointing to. In contrast to the multidisciplinary character of much basic research in academic cognitive science environments, an inter- or transdisciplinary approach in the spirit of Mode 2 knowledge production seems to be more attuned for research projects based on a situated/4E

view of cognition with real-world applications (Prescott & Verschure, 2015). For researchers participating in such an inter- or transdisciplinary endeavor it means that

> the creative act lies just as much in the capacity to mobilize and manage these [theoretical] perspectives and methodologies, their 'external' orchestration, as in the development of new theories or conceptualisations, or the refinement of research methods, the 'internal' dynamics of scientific creativity. In other words, *'Mode 2' knowledge is embodied in the expertise of individual researchers and research teams* [emphasis added] as much as, or possibly more than, it is encoded in conventional research products such as journal articles or patents (Nowotny et al., 2003, p. 186).

9.3.2 Implications For Interdisciplinary Education in Cognitive Science

From an educational point of view, training in overarching interdisciplinary research processes may be especially valuable as a preparation for future collaborative Mode 2 research. Moreover, since interdisciplinary competences are person-centered (Lerch, 2017), an introduction to interdisciplinary studies and its "cognitive toolkit" (Repko et al., 2017, p. 91), as well as practice in (collaborative) integrationist interdisciplinary research are conducive to bootstrap the process of developing these competences. Indeed, in his book *Sustainable Knowledge: A Theory of Interdisciplinarity* the philosopher Robert Frodeman raises awareness of the importance of developing "interdisciplinary virtues" for successful interdisciplinary work (Frodeman, 2014, p. 7):

> Skill at interdisciplinary work thus becomes a matter of character rather than methodology. Interdisciplinary work requires the development of a peculiar set of virtues – or perhaps better said, the development of a set of virtues to a particularly heightened degree. These include the openness to new perspectives, a willingness to admit the inadequacies of one's own point of view, to be wrong and to play the fool, and generosity in interpreting the position and motives of others. Rhetorical skill thus plays as much of a role as logic, as we adjust our diction as well as our standards to the exigencies of the moment. This isn't relativism or a situational ethics. These are adjustments that issue in a successful outcome – or not. (Frodeman, 2014, p. 48)

Formal training in interdisciplinary studies can provide a solid foundation for bootstrapping the development of interdisciplinary competences and virtues in actual interdisciplinary practice in the long run (see Szostak, 2013a).

9.4 Summary

The mechanistic approach of the traditional computational-representational view of cognition appears to be in contradiction with a complexity worldview and mindset, which are the foundation for an integrationist interdisciplinary approach in the spirit of interdisciplinary studies. However, as soon as the broader application contexts of such information processing models are considered, the relevant interconnections come into play. Systems thinking and complexity thinking provide the vocabulary to conceptualize such interrelationships and interdisciplinary studies provides process models and tools to guide interdisciplinary research. The situated/4E view of cognition with its focus on brain-body-environment interconnections is a prime candidate for the integrationist interdisciplinary approach of interdisciplinary studies. This is even more obvious when research on situated/4E cognition is explicitly grounded in a process metaphysics – an ontology for complex systems. Inter- and transdisciplinary research in the spirit of Mode 2 knowledge production has already been identified as relevant research approach for this area. Educating cognitive science students in interdisciplinary studies may help to prepare students for these exciting research areas.

10 Conclusion

The intended goal of the present thesis was to clarify how interdisciplinary practice and the professional identity of the interdisciplinary researcher in cognitive science – in the sense of a specific academic job profile and the skills and competences it requires – are best understood from the perspective of students in the pursuit of an academic career in cognitive science. In particular, the present thesis was intended to provide a viable answer to the question of what it means for interested students in general and first-year students of the MEi:CogSci in particular to become an interdisciplinary researcher in cognitive science.

Clarifying these issues was motivated by the observation that the topic of interdisciplinarity repeatedly causes confusion among students of the MEi:CogSci and thus affects their studies and their judgment of the quality of the study program in term of its interdisciplinary aspects. Questions about interdisciplinary practice in cognitive science and the professional identity of the interdisciplinary researcher in cognitive science have not been explicitly addressed in the study program, nor are they sufficiently covered in the introductory literature on cognitive science or in the literature on interdisciplinarity in cognitive science.

The question of how to understand interdisciplinary practice in cognitive science, the professional identity of the interdisciplinary researcher in cognitive science, and what it means to become an interdisciplinary researcher in cognitive science were approached in three steps corresponding to the three parts of the present thesis. Part I was concerned with interdisciplinary practice and the professional identity of the interdisciplinary researcher in cognitive science in general. It concluded that the professional identity of the interdisciplinary researcher in cognitive science based on interdisciplinary practice in real-word academic cognitive science environments is a cognitive science specific version of the T-shaped researcher. Part II was particularly concerned with the question of what it means to become an interdisciplinary researcher in cognitive science by studying the MEi:CogSci. A critical analysis of the MEi:CogSci curriculum design and pedagogy demonstrated that the MEi:CogSci can successfully train cognitive scientists as T-shaped researchers, but fails to train cognitive scientists as integrationist interdisciplinarians, which is the program's actual educational goal. Thus, a confusing ambiguity about interdisciplinary practice is unintentionally 'built into' the program. The analysis revealed how important it is that the design and pedagogy of cognitive science programs is based on a clear, explicit, and shared concept of the professional identity of the interdisciplinary researcher in cognitive science. Furthermore, this professional identity also has to be compatible with the actual interdisciplinary practice in real-world cognitive science research environments at universities. Part III is a construc-

tive response to part II and proposes an alternative educational model for training T-shaped researchers as integrationist interdisciplinarians in the original spirit of the MEi:CogSci.

The major insights gained in the course of the present thesis are summarized in the following sections.

10.1 Confusions About Interdisciplinary Practice and the Professional Identity of the Interdisciplinary Researcher in Cognitive Science

Other than introductions to cognitive science and its different approaches or research programs might suggest, real-world cognitive science (related) research at universities may not fit neatly into one or another of these research programs. What counts as genuine cognitive science research may be conceived broader or narrower in the sense of which research programs, disciplines, or research areas are included or excluded. Furthermore, cognitive science research may be more or less coordinated (toward some dedicated focus area(s) or fragmented without clear focus areas) at different universities. Thus, the integrative picture of cognitive science suggested in many textbooks is likely to be misleading for first-year students with respect to the specific manifestations of real-world cognitive science research at a particular university.

Moreover, (collaborative) interdisciplinary research on complex phenomena from multiple disciplinary perspectives in small teams may only play a minor role in real-world academic cognitive science environments compared to the more disciplinary based basic research on cognition done at different (disciplinary) university departments. This is due to the fact that academic cognitive science environments at universities are often distributed across departments and are thus best understood under the union definition of cognitive science, which regards cognitive science as the sum of the research done on cognition from all its contributing disciplines. As a result, interdisciplinary cooperation and communication between local researchers on cognition often manifests on an organizational level, i.e., through organizing joint events such as multidisciplinary conferences and symposia, lectures and lecture series, workshops and summer schools, etc. In this sense, interdisciplinary collaboration is a vital part of creating and maintaining a flourishing socio-cultural academic cognitive science environment as an enabler for the development of (collaborative) interdisciplinary research projects. Genuine conceptual and theoretical interdisciplinary integration is typically achieved only in the field of philosophy of cognitive science and rarely on the level of empirical research projects. In general, empirical research in cognitive science is technically often better characterized as multidisciplinary rather than interdisciplinary.

As a consequence, the professional identity of the interdisciplinary researcher in cognitive science can be characterized as a T-shaped researcher, who is specialized in a specific

(disciplinary) research area, rather than a specialist for practicing interdisciplinary research at the intersection of or across various disciplines. The T-shaped researcher in cognitive science is a disciplinary or domain expert with profound knowledge in one cognitive science relevant research area, who at the same time possesses broad knowledge about the basics of other cognitive science disciplines as well as the philosophy of cognitive science. To become an interdisciplinary researcher in cognitive science means to become a T-shaped researcher.

It is this profile as T-shaped researcher, rather than specific knowledge of the theory and process of interdisciplinary research, which enables cognitive scientists to communicate and collaborate more easily with one another on common projects. This is often in contrast to what students expect from an interdisciplinary education.

10.2 Confusions About Becoming an Interdisciplinary Researcher in Cognitive Science Exemplified by the Case of the MEi:CogSci

The MEi:CogSci curriculum design with its emphasis on interdisciplinary integration further contributes to confusions about interdisciplinary practice in cognitive science and what it means to become an interdisciplinary researcher in cognitive science. Labels such as 'integrative kernel' and 'thematic/phenomenon and research oriented' as well as the requirements of interdisciplinary modules point toward an integrationist interdisciplinary conception of studying between the disciplines (or at their intersections), which focuses on integrating disciplinary insights to create new knowledge about complex cognitive phenomena. Moreover, the implemented didactical model even aims at integrationist interdisciplinary practice as the educational goal of the program. However, neither the courses of the 'integrative kernel' nor the cognitive science research environments of the MEi:CogSci partner universities can sufficiently support this educational goal. As a result, a discrepancy between theory and practice is created which leads to even more confusions about interdisciplinary practice and the educational goal of the program.

In general, the use of the keywords 'interdisciplinarity' and 'integration' in the context of the MEi:CogSci without providing any further specifications or qualifications can raise expectations, which are either unrealistic or cannot be met in the program. In addition, these keywords can attract students, who are more interested in interdisciplinary learning and generic skills for practicing integrationist interdisciplinary research rather than starting an academic career as cognitive scientists. Student feedback repeatedly showed that these keywords evoke connotations of practices, which students find to be insufficiently realized or missing in the program. Recurrent themes in this respect include

- interconnections between the contents of different (disciplinary/methodical) courses,

- integration of contents from disciplinary courses into the courses of the 'integrative kernel',
- interdisciplinary collaborative research by researchers from different disciplines,
- training in (collaborative) interdisciplinary research processes, and
- leadership or role models for interdisciplinary practice with respect to interdisciplinary integration.

10.3 Two Key Insights

10.3.1 The Ambiguity of Interdisciplinarity

I think that one of the most important insights – and the central theme driving the current thesis – with regard to what it means to practice interdisciplinary research is the ambiguity at the core of the term 'interdisciplinarity'. This is particularly well expressed in Arnold's (2013) definition of interdisciplinarity or interdisciplinary research:

> The term interdisciplinarity or interdisciplinary research (ID) can be defined in two distinct but intersecting ways: interdisciplinarity means either the collaboration of researchers trained in different fields of knowledge or the integration of different concepts, methods, and data from two or more different disciplines, no matter if this interdisciplinary integration is achieved by an interdisciplinary research group or by a single researcher. (Arnold, 2013, p. 1105)

The essential point is whether integration is considered a necessary part of genuine interdisciplinary work. According to Klein (2017), the majority of scholars of interdisciplinarity consider the integration of disciplines or of knowledge from different disciplines as the benchmark for genuine interdisciplinary endeavors. However, as Frodeman (2017) points out, "interdisciplinarity is most commonly used as a portmanteau word for all more-than-disciplinary approaches to knowledge" (p. 4). Repko's (2007) distinction between generalist and integrationist interdisciplinarians gets to the heart of the matter by drawing the line between whether or not integration is a necessary part of interdisciplinary work. This distinction can lead to radically different conceptions of what it meas to practice interdisciplinary research. Therefore, it can be a major source of confusion. The case of the MEi:CogSci demonstrates this very well.

10.3.2 Awareness of Interdisciplinary Studies and Its Body of Knowledge

It is surprising that there does not seem to be much awareness of the academic field of interdisciplinary studies and the body of knowledge it produced on interdisciplinary practice and teaching. The latter point is particularly interesting for stakeholders of interdisciplinary study programs. In contrast to common assumptions that practicing interdisciplinary research cannot be taught and that interdisciplinary research can only be conducted in teams of disciplinary experts (e.g., Defila & Di Giulio, 1998; Lerch, 2017) interdisciplinary studies are convinced that practicing interdisciplinary research can be taught and that interdisciplinary research can also be conducted by individuals (e.g., Szostak, 2013a). A couple of up-to-date textbooks on the theory and process of interdisciplinary research are already available. I think that it is important to raise awareness of this field.

Part III of the present thesis is my contribution to raise awareness of the integrationist conception of practicing interdisciplinary research from the body of knowledge from interdisciplinary studies and to try to situate it in the context of cognitive science. Specifically, I proposed the integrationist interdisciplinary researcher in cognitive science as a T-shaped researcher, whose area of specialization is the theory and process of interdisciplinary research itself. This specialization allows the T-shaped researcher to act as facilitator in complex collaborative inter- and transdisciplinary research projects and work in academic management. This integrationist interdisciplinary approach is well suited for interdisciplinary research on situated/4E cognition.

10.4 Final Thoughts Regarding the MEi:CogSci

Given these confusions, an explicit introduction on how to understand interdisciplinarity and integration, as well as the professional identity of the interdisciplinary researcher in the context of cognitive science and the MEi:CogSci would make clear what the study program can and cannot provide for students and what students can and cannot expect in the course of their studies. Moreover, I think that it is of particular importance to clearly communicate a realistic educational goal of the MEi:CogSci right from the beginning and consistently throughout the program – especially, with respect to developing a professional identity as interdisciplinary researcher in cognitive science, i.e. becoming a T-shaped researcher.

To put it into clear statements, the core messages characterizing the MEi:CogSci with respect to interdisciplinarity and integration would be the following:

1. *In general*, the MEi:CogSci *is not about* learning how to practice (collaborative) interdisciplinary research by drawing on concepts, theories and methods from multiple different disciplines for the purpose of integrating them toward new knowledge about

one's cognitive phenomenon of interest, *but rather about* specializing in one cognitive science research area from one (or at most two) disciplinary perspective(s) while getting acquainted with the basics of other cognitive science disciplines and the philosophy of cognitive science at the same time.

2. *In general*, the "integrative kernel" *is not about* connecting the specific contents of the different disciplinary courses or about learning how to practice (collaborative) interdisciplinary research, *but rather about* becoming aware of the limits of one's own disciplinary perspective, considering one's potential roles in the multidisciplinary research landscape of cognitive science and getting acquainted with the different cognitive science approaches/research programs.
3. *In general*, the "thematic/phenomenon and research oriented phase" *is not about* studying one's cognitive phenomenon of interest from multiple disciplinary perspectives by conducting (collaborative) interdisciplinary research projects, *but rather about* delving into established research areas at the MEi:CogSci partner universities which already study the/a cognitive phenomenon of one's interest or which already provide the context/means to study it.

Of course, students may have the possibility to engage in genuine (collaborative) interdisciplinary research projects, where insights from different disciplines are tightly integrated. For instance, work in computational modeling of cognitive phenomena or in neurophenomenological research are likely to yield such opportunities. However, such endeavors may only have a small share with respect to the more traditional disciplinary based research on cognition at the partner universities.

Overall, the goal for MEi:CogSci students would be to use the structure of the program and the research infrastructure of the MEi:CogSci partner universities to develop their individual profiles as T-shaped researchers. This means to develop a clear focus on a cognitive science (related) research area for specialization, which is actively pursued at the MEi:CogSci partner universities and on the discipline(s) most relevant for it in the course of their studies. The research area for specialization can guide choices on additional disciplinary and methodological courses and on research projects. 'Finding your voice' in the context of the MEi:CogSci means to learn to situate one's own research area of specialization within the overall landscape of cognitive science research programs as well as its specific connections to other cognitive science disciplines and research areas.

The proposed conception of the interdisciplinary researcher in cognitive science as T-shaped researcher and its implications for interdisciplinary practice should inform the educational goal of the MEi:CogSci, the didactics of the 'integrative kernel' as well as the official

presentations of the program (websites, leaflets, information events, consultation/mentoring, etc.) Together with an explicit introduction to interdisciplinarity in cognitive science, these conceptions would provide a coherent framework which can help students to organize their experiences in the course of their studies by structuring their own personal narratives about the development of their professional identities as cognitive scientists. It would also be useful for course instructors and project/thesis supervisors to better understand what the study program is about and to define their own roles and research in its context. Furthermore, if the program would be officially presented in this way, potential applicants could make informed decisions whether the program fits their interests and goals. Conversely, it would be easier to select applicants for admission to the program whose interests and expectations are clearly in line with its educational goal. As a consequence, these measures would contribute to a lowering of the duration of studies and drop-out rates of students and would thus be in the interest of both students and the joint universities.

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12 Appendix

12.1 Abstract

This thesis elucidates how interdisciplinary practice and the professional identity of the interdisciplinary researcher in cognitive science are best understood from the perspective of students in the pursuit of an academic career in cognitive science. These topics frequently cause confusion among students and are neither adequately addressed in the introductory literature on cognitive science nor in the literature on interdisciplinarity in cognitive science. Furthermore, the thesis provides a clear answer to the question of what it means to become an interdisciplinary researcher in cognitive science by studying the Middle European interdisciplinary master's program in Cognitive Science (MEi:CogSci) at the University of Vienna. The thesis thus contributes to improving the quality of education and reducing the duration of studies and drop-out rates of students by managing expectations.

12.2 Kurzfassung

Diese Arbeit erläutert, wie interdisziplinäre Praxis und die professionelle Identität des interdisziplinären Forschers in der Kognitionswissenschaft aus der Perspektive von Studierenden hinsichtlich des Ziels einer akademische Karriere in der Kognitionswissenschaft am besten verstanden werden. Diese Themen sorgen regelmäßig für Verwirrung unter Studierenden und werden weder in der einführenden Literatur zur Kognitionswissenschaft noch in der Literatur über Interdisziplinarität in der Kognitionswissenschaft ausreichend behandelt. Darüber hinaus gibt die Arbeit eine klare Antwort auf die Frage, was es bedeutet, ein interdisziplinärer Forscher in der Kognitionswissenschaft durch das Studium des Middle European interdisciplinary master's program in Cognitive Science (MEi:CogSci) an der Universität Wien zu werden. Die Arbeit leistet damit einen Beitrag, die Ausbildungsqualität zu verbessern und die Studiendauer und Drop-out Quote von Studierenden durch Erwartungsmanagement zu reduzieren.