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"Reducing Reductionism: A Discourse Analysis of Neuroscientific Literature from the Perspective of Critical Neuroscience"

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I, AUTHORNAME confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Abstract

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Acknowledgements

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Abbreviations

API	**A**pplication **P**rogramming **I**nterface
JSON	**J**ava**S**cript **O**bject **N**otation

Chapter 1

Introduction

This is a brief outline of what went into each chapter. **Chapter 1** gives a background on duis tempus justo quis arcu consectetur sollicitudin. **Chapter 2** discusses morbi sollicitudin gravida tellus in maximus. **Chapter 3** discusses vestibulum eleifend turpis id turpis sollicitudin aliquet. **Chapter 4** shows how phasellus gravida non ex id aliquet. Proin faucibus nibh sit amet augue blandit varius.

Chapter 2

Neuroscience

Chapter 3

Reductionism

3.1 Introduction

Reductionism at the core of a positivist science is said to be the counterpiece to postmodernism, poststructuralism, and holism. Systems biology does no longer want to conceptualise plants, animals, and other beings as the sum of their individual parts but instead focuses on the whole. A holistic approach to medicine has been proposed by Ahn, Tewari, Poon, & Phillips (2006) as a better alternative to understand and improve human health. Similarly, German Gestalt psychologists in the 1920s emphasised the important role of a holistic gaze in order to understand the mind. The fundamental dichotomy that all these movements implicitly address is the one of reductionism and holism. A movement called Critical Neuroscience (Choudhury & Slaby, 2011) has been recently calling for more scrutiny and self-reflectiveness within the neurosciences, especially emphasising the critical role of unrestrained reductionism (see Gallagher, 2011; Raikhel, 2010; Rose, 2011). But what exactly is that apparently problematic reductionism?

It is tempting to reduce the meaning of reductionism to a seemingly succinct and simple definition such as "the attempt to understand a complex system by understanding its parts" but upon inspection, it becomes clear that scientists, and philosophers alike, might actually be referring to a multitude of different things. Relying on the (everyday meaning) of a reduction to define reductionism is reminiscent of what Hacking (2001) calls elevator words, such as "fact", "truth", "reality" or "relativism". He recommends staying away from these "blunted lances with which philosophical mobs charge each other the eternal jousting of ideas." (Hacking, 2001, p.33) Following his advice, this essay is an attempt to define reductionism without letting it become another elevator word.

In what follows, I will mainly use Hacking's book The Social Construction of What? as a guide and reference work to break down reductionism into several meanings, differentiated by the way the term is used by scientists and scholars. Furthermore, I reuse the Wittgensteinian concepts of language-games and family resemblance to address the difficulty of reconciling all the differences between types of reductionisms while also taking their commonalities into account.

3.2 The Reduction of What?

For a long time, the working title of this paper was "What is reductionism?". In addition to being a very boring title, I soon realised that answering the question was like picking up a slick glass bowl placed upside down on a surface. Whenever I tried to lift the bowl in order work with it my fingers simply slipped away. A definition that I had found in one paper was then either objected to or undermined by the next one. Thus, the current title is inspired by Ian Hacking's (2001) famous work The Social Construction of What? in which he early on realises that defining the thing called social construction needs to be understood in terms of individual examples and usages. What are the many authors referring to when they write about the construction of gender, women refugees, or quarks. What about the seemingly synonymous labels constructionism, constructivism, and constructionalism? Roughly speaking, Hacking is doing what Wittgenstein called an ostensive definition:

> "[…] an ostensive definition explains the use — the meaning — of a word if the role the word is supposed to play in the language is already clear. So if I know that someone meant to explain a colour-word to me, the ostensive explanation "That is called 'sepia' " will enable me to understand the word. […] One has already to know (or be able to do) something before one can ask what is something is called. But what does one have to know?" (Wittgenstein, 2010, §30)

In his book Hacking first provides a brief genealogy of the term (social) constructionism and creates a common understanding and delineates it from other usages (in Wittgensteinian terms one might speak of various language games). Only then does he begin to point out and discuss individual examples in the literature. Similarly, I realized that this beast called reductionism takes on many forms and shapes depending on by whom and how it is referred to. While it may be tempting to account the different shapes to a parallax of reductionism viewed from different disciplines, some kinds of reductionism seemed to be fundamentally different than others. This conflation of different kinds of reductionism seems especially tempting when authors expressed their disdain or support for "the reductionist programme" or even just "reductionism" without further qualifiers.

Without any shame (rather I'd say pridefully) I would like to quote from the disambiguation page for the term "reduction" on Wikipedia to provide some examples of different kinds of reductions:

- reduction as part of reduction-oxidation (redox reaction) in chemistry
- complexity reduction in computational theory
- dimensionality reduction in data analysis and statistics
- several types of reduction as special surgeries in medicine
- lithic reduction is the process of creating a blade from a stone in the stone ages
- noise reduction in audio and signal processing

- reduction as the transcription of music into a simpler form to simplify analyses
- accent reduction in linguistics
- eidetic reduction in phenomenology
- reduction as a cooking method
- in the history of Sweden several reductions, a restoration of the power of monarchs, were recorded
- Reduction might also refer to the community in Pennsylvania ("Reduction," 2017)

Figure 3.1: Even after agreeing that we are not talking about sauce reductions[1], it is still required to take a closer look at the reductions present in science and philosophy (Screenshot from the Manga Shokugeki no Soma written by Yūto Tsukuda | Chapter 259, p.13)

While some of these examples are very obviously not of interest to philosophers, neuroscientists, and this course assignment alike, some other cases require more attention, e.g., eidetic reduction, a technique used by philosophers to identify the essence of a phenomenon[2] might be indeed

[1] "Most words ending in "tion" are ambiguous between process and product, between the way one gets there, and the result." (Hacking, 2001, p.36) Here, Hacking is trying to point out a linguistic ambiguity. The noun "construction" might refer to the process of assembling something or to the final outcome of that assembling. I was quite amused by fact that the word reduction in most cases does indeed refer to the process itself instead of the outcome, making it the exception if we take Hacking's word of granted. The only counter-example, thus along the lines of Hacking, that I could come up within the realm of cooking as depicted in this screenshot: reduction can refer to the act of reducing a liquid as well as the final desired product of that act.

[2] The most famous example of eidetic reduction is Descartes' piece of wax which changes its seemingly defining

relevant for a tracing the meaning of reductionism within cognitive science. For some, the search for the essence is equivalent to the search of the soul, i.e., the question of what makes a human being human rather than anything else in this world, a question deeply embedded in cognitive science. Using the rather sloppy connection from eidetic reduction over Cartesian dualism to the hard problem of consciousness in cognitive science (Chalmers, 2007), I merely wanted to emphasise the fact that some reductions might be relevant to this analysis, while others are not. Nevertheless, considering that, first of all, I am no Ian Hacking and, secondly, this is a 5000 word essay rather than a book based on years worth of lectures and research, I will have to selectively focus on a few notions and variants of reductions and reductionism, fully aware that I might be not capturing an exhaustive picture. I have previously introduced Wittgenstein's language games as certain established language practices, such as the use of social constructionism in postmodernism versus metaphysics. Similarly, I believe that it is of crucial to look at the meaning and use of reductionism in context to the social and cultural settings of science and philosophy.

3.3 Which language-games are we playing?

In this chapter I will give a brief overview of the traditional narratives surrounding reduction, as understood and discussed by scientists or philosophers and historians of science. What does reductionism specifically mean in the context of the sciences and philosophy? Using several examples from different sources I show that the meaning of reductionism is best understood in the way Wittgenstein describes family resemblances.

Instead of attempting to distill a definition from the theory and literature, I rather want to inspect how scientists and scholars are defining reductionism for their own purposes. This means that writings that are already deeply rooted in the discussion of reductionism are not within the scope of this enquiry, as a basic definition of the term would either be provided implicitly or even omitted completely as the contribution could be a part of a longer conversation. Fully aware of the fact that this selection might be not exhaustive, I still want to discuss a few concrete examples in order to ground the whole undertaking in actual practice rather than theory and pure philosophy.

3.3.1 Encyclopedic Knowledge

According to the Oxford Companion to Philosophy reductionism is "one of the most used and abused terms in the philosophical lexicon" (Honderich, 2005, p.750). While one of the reasons might be that the words use is widespread across many disciplines and practices in everyday life, we can safely assume that Honderich et al. were not thinking of reducing a broth. Unfortunately, the original authors do not provide more insights, but a quick review of common literature quickly surfaces multiple definitions and qualifiers to describe all types of reductionism. It becomes

properties like shape, consistency, smell when heated, but we are still able to identify it as the same piece of wax

quite apparent that terminology is the first obstacle for anyone striving to achieve an holistic understanding of reductionism. Taking Wikipedia's widespread acceptance among students and laymen into account, we can assume its definition of reductionism ("Reductionism," 2018) is one of the most read ones: "Reductionism is any of several related philosophical ideas regarding the associations between phenomena which can be described in terms of other simpler or more fundamental phenomena" A definition that hardly provides food for thought. The next two famous sources for encyclopedic knowledge about philosophy are the Stanford Encyclopedia of Philosophy (SEP) and the Internet Encyclopedia of Philosophy (IEP). Known for their attempt to strike a balance between encyclopedic and academic knowledge (all articles on both platforms are peer-reviewed), the amount of types of reductionism one encounters across various articles (SEP: Brigandt & Love, 2017; van Riel & Van Gulick, 2016 and IEP: Ney, n.d.;) is still quite surprising and, most importantly, confusing.

The entry for Reductionism in Biology in the SEP does not disappoint and immediately provides a variety of new keywords and special terminology that require further inspection in order to fully grasp the paragraph:

> "The basic question of reduction is whether the properties, concepts, explanations, or methods from one scientific domain (typically at higher levels of organization) can be deduced from or explained by the properties, concepts, explanations, or methods from another domain of science (typically at lower levels of organization)." (Brigandt & Love, 2017, n.p.)

On the other hand the article Scientific Reductionism in the same SEP tries to define reductionism without relying on further external concepts and terms. However, certain expressions and notions expressed in the brief definition would definitely invite logicians and other analytical philosophers to question the usefulness of that definition:

"The term 'reduction' as used in philosophy expresses the idea that if an entity x reduces to an entity y then y is in a sense prior to x, is more basic than x, is such that x fully depends upon it or is constituted by it. Saying that x reduces to y typically implies that x is nothing more than y or nothing over and above y." (van Riel & Van Gulick, 2016, n.p.; emphasis in the original)

On the other hand, the article Reductionism in the IEP attempt to keep it short and simple, and fall prey to a vicious[3] circular definition:

> "Reductionists are those who take one theory or phenomenon to be reducible to some other theory or phenomenon." (Ney, n.d., n.p)

The final entry of an encyclopedia, the already previously referenced Wikipedia article about reductionism, states with a reference to the Merriam-Webster's Encyclopedia of World Religions:

[3] "J.L. Austin and his fellow 1950s philosophers of language are said to have played a game called Vish! You look up a word, and then look up words in its dictionary definition; when you have got back to the original word, you cry Vish! (vicious circle)." (Hacking, 2001, p.23)

> "Reductionism is any of several related philosophical ideas regarding the associations between phenomena which can be described in terms of other simpler or more fundamental phenomena" ("Reductionism," 2018, n.p)

Each of these attempts at defining reductionism comes with its flaws and the overall challenge reminds me of, once again, Wittgenstein and what he called family resemblance (Wittgenstein, 2010, §66ff). In his treatment of the meaning of words Wittgenstein attacks the view that words have definitive meanings grounded in symbols. Rather, using the example of a game he illustrates that one fixed definition will always miss some other meanings, e.g., some games are played for fun and others are played professionally; some games involve physical activity; games might involve other humans or played by a single person. This relation of the word game and its meaning is similar to what Wittgenstein observes among family members' looks. Some family members share common traits with some members, but overall they are still recognizable as one family. I think that the idea of family resemblances can be very useful for an attempt at defining reductionism. Rather than chasing the essence of reductionism (a very reductionist idea in itself) I believe that one has to look at how philosophers and scientists use the term in various settings and situations in order to explicate reductionism for a broader audience.

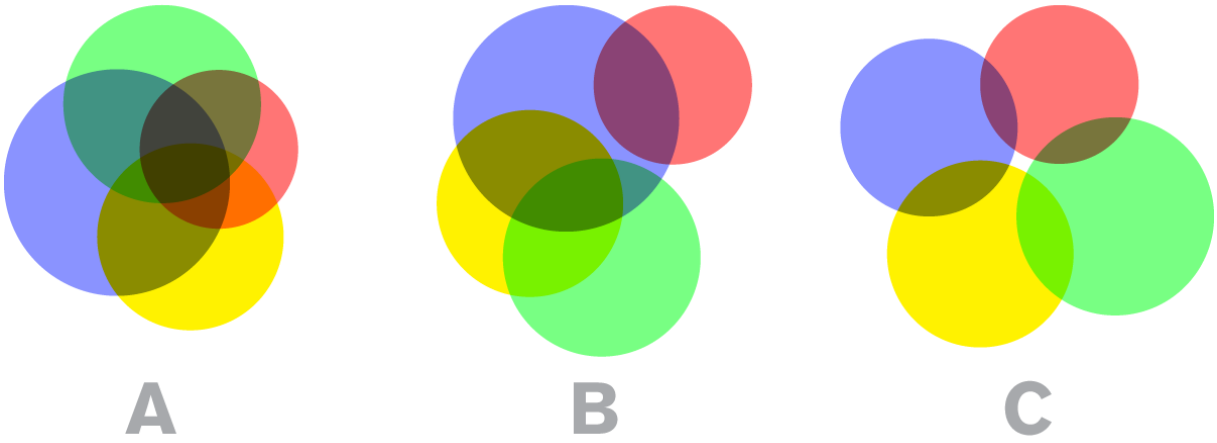

Figure 3.2: (A) displays the common property, the essence, of all four circles, while (C) demonstrates while some properties might only be shared by some of the individual parts. Figure found at Suematsu (2013)

3.3.2 Science and philosophy

"Stop abusing Wittgenstein for cheap references and don't use encyclopedias to define a complex philosophical concept such as reductionism!" some might be thinking and crying at their screen. While I will grudgingly heed the first advice, I can happily provide two more examples of academics addressing the topic of reductionism, viz., the philosopher of mind Thomas Nagel in Reductionism and antireductionism (1998) and the philosopher of science James Ladyman Ontological, Epistemological, and Methodological Positions (2007).

Already in the abstract, Nagel immediately and very directly asserts strong positions about how our world is constructed and the way we are able to access this world by equating reductionism

to the idea of physics as a theory of everything, a term usually used for theories claiming to explain all aspects of reality and nature:

> "Reductionism is the idea that all of the complex and apparently disparate things we observe in the world can be explained in terms of universal principles governing their common ultimate constituents: that physics is the theory of everything." (Nagel, 1998, p.1; italics are mine)

Ladyman too, shows a strong focus on the epistemological properties of reductionism in all three claims of his. While his first claim exerts a strong ontological position, the second one addresses epistemology, clearly confounding two topics that can be viewed very differently within reductionism. Finally, the reference to the unity of science is, similar to a theory of everything, a very strong and disputed position which would not be supported by all reductionists.

> "Fundamental intuitions of reductionism include: (1) The whole is not greater than the sum of the parts. (2) The behaviour of the whole is caused and explained by the behaviour of the parts. (3) There is a unity to the world and to science." (Ladyman, 2007, p.322; italics are mine again)

What we have seen so far is that both laymen explanations as well as expert definitions — ranging from Wikipedia over entries on the SEP to Thomas Nagel himself — are either loaded with epistemological and ontological presumptions or have fallen victim to circular definitions in an attempt to keep it simple. I initially set out to outline reductionism and its use by philosophers and scientists, but it has become clear that we need to increase the granularity of our inspection in order to ensure that everyone is talking about the same reductionism.

3.4 Three kinds of reductionism

I have already hinted at the problems of some of definitions in the previous chapter. In this chapter, I want to clarify what I meant with 'loaded with epistemological and ontological presumptions' by presenting a topology of reductionism that untangles the most common difficulties related to the word. By doing so, I hope to provide a theoretic grounding and common understanding of the term needed to discuss more specific examples within applied research and especially cognitive neuroscience.

Hoyningen-Huene (1989) argues that the big common types of reductionism are ontological, epistemological, and methodological while specifically referring to literature in the life sciences (Ayala 1974; Hull 1981; Mayr 1982, pp.60-63). Another type of reductionism that requires some further elaboration is what analytical philosophers usually refer to as scientific reductionism. Claims and theories about scientific reductionism in some sort relate to the way science works, to the way assumptions and evidence is used, and also about the success of science (van Riel &

Van Gulick, 2016). For our purposes it is sufficient to replace treat the generic term reduction equivalently with scientific reductionism.

In what follows, I will try to briefly introduce the three types of scientific reductionism, which are fittingly named for the kinds of questions they relate to.[4]

3.4.1 Ontological Reductionism

Ontological reductionism is a metaphysical position that in some way asserts that reality consists of a minimal number of substances. While one might, in most cases probably rightly, be reminded of some sort of monism (e.g., materialism — the belief that the world including cognition and consciousness reduces to material exchange of matter) it is important to notice that a commitment to ontological reductionism does not come with a specific number of substances (e.g., monism and dualism) nor preference for one (e.g., materialism and idealism). Most authors seem to agree on the terminology in this case (e.g., Ayala & Dobzhansky, 1974; Hoyningen-Huene, 1989; Ladyman, 2007; Ney, n.d.; van Riel & Van Gulick, 2016) with the exception of Mayr (1982) who talks of constitutive reductionism in biology. "It asserts that the material composition of organisms is exactly the same as that found in the inorganic world" (Mayr, 1982, p.60) which basically constitutes a kind of ontological reductionism with specific qualities, viz., physicalism.

3.4.2 Epistemological Reductionism

This is the one kind of reductionism that most of the literature in philosophy (of science) has been about. Without going into the technicalities and details of analytical philosophy and logics, epistemological reductionism deals with scientific theories which are proven to be special cases of other more general theories or laws. The most famous (or at least most discussed by the philosophers of science) examples are the laws of motion formulated by Kepler and Galileo which were then reduced to Newtonian mechanics, which in turn was then reduced to Einstein's general relativity. While most authors (Ayala & Dobzhansky, 1974; Honderich, 2005; Ney, n.d.; van Riel & Van Gulick, 2016) use these definitions — sometimes also simply called theory or intertheoretic reductionism — a slightly more generalized account is given by Hoyningen-Huene (1989, p.30) who describes the epistemological reductionist position as the one which assumes that "a knowledge of all the (relevant) properties of the elements of one level of the organizational hierarchy, together with a knowledge of how these elements are arranged at a particular higher level, would in principle be sufficient to redefine all the properties of, and derive the laws governing, the entities of this higher level." This broader definition now introduces some vocabulary which has been highly discussed in the recent decades as anti-reductionism has been on the rise (Nagel, 1998). Specifically concepts such as organizational hierarchy, also known as levels of analysis, closely connect to the ideas of causality, emergence, and supervenience. For instance, an epistemological reductionist represents a position that strongly rejects emergence, which is the introduction of new causal power while between levels of analysis, i.e., in Mayr's

[4]It is important to note that these ideas are not named for what they reduce.

words “knowing all properties at a lower level in the organizational hierarchy” would not suffice to explain all properties and laws at a higher one. The topic of emergence and the relation of theories and causality has been quite visible in popular science magazines such as The Scientific American or the Quanta Magazine (Koch, 2014; Wolchover, 2017).

3.4.3 Methodological Reductionism

The third and final type of reductionism relates to the actual practices of science. While ontological reductionist have a certain opinion about metaphysics and epistemological reductionists have certain assumptions about how scientific knowledge is structured, methodological reductionist believe in a certain way of acquiring new knowledge, which is also known as explanatory reductionism (Mayr, 1982, p.60). The traditional mode of scientific enquiry, established throughout the last centuries, has been one that orients itself to a reductionist position, emphasising the importance of the parts rather than the whole. Mayr (1982) provides some examples in the life science: the way genes work was not fully understood until Watson and Crick discovered the structure of DNA. Likewise, our understanding of organs heavily relies on cellular and molecular processes.

Interestingly, the reductionist program has been increasingly under scrutiny, not only in the life sciences where findings on elementary levels may contribute to fundamental laws but often struggle to find application within the rest of the field or much less even in society (see Mayr, 1960). The extreme methodological reductionist position in biology claims that all understanding of biology should be on the level of physicochemical processes (at this point we can see why it can be difficult to draw a line between epistemological, ontological, and methodological reductionism) while anti-reductionists would argue that a more holistic view is required to understand phenomena such as society and culture.

While the previous two types (ontology and epistemology) are the most relevant and highly discussed topics by philosophers and scientists in theory, many actually applied reductionisms should be fittingly treated as methodological reductionism. A great example is the contrast between biological reductionism, environmental reductionism, and experimental reductionism in psychology. Each of these approaches are connected to a specific theory of psychology and a respective methodology. Biological reductionists try to understand behaviour in terms of physiological entities, such as neurons, neurotransmitters, and hormones. Many explanations of psychological disorders are of this kind (typically treatment would work on the same level, e.g., treatment of depression with hormone therapy). Environmental reductionism finds its roots in B.F. Skinner’s behaviorism (Skinner, 2011) which, in simplified terms, explains behaviour in terms of stimulus and response blocks, such as the understanding of learning in terms of classical and operant conditioning (Pavlov, 2010; Skinner, 1990). Finally, experimental reductionism is a very broad approach that tries to isolate variables in experimental settings that explain certain behaviour. This approach partially has been a product of dissatisfaction with the previous models (biological models and behaviourism) and can be connected to the currently en-vogue cognitivist psychology and cognitive science (Miller, 2003).

We have so far addressed three different ways reductionism is used and referred to in a limited set of literature from the philosophy and history of science, but also some more specialized writings in biology. The first step was to separate the scientific usage of reductionism from its everyday uses like, my favourite example, the sauce reduction. Upon closer reading of the literature, both peer-reviewed academic literature as well as encyclopedic entries, it became apparent that three kinds of reductionism stood out from the masses as basic guidelines to understand reductionism. What followed was the elaboration of ontological, epistemological, and methodological reductionism, while keeping track of other terms and cases which usually fit one of the supercategories. Figure 3 shows an overview of this categorisation.

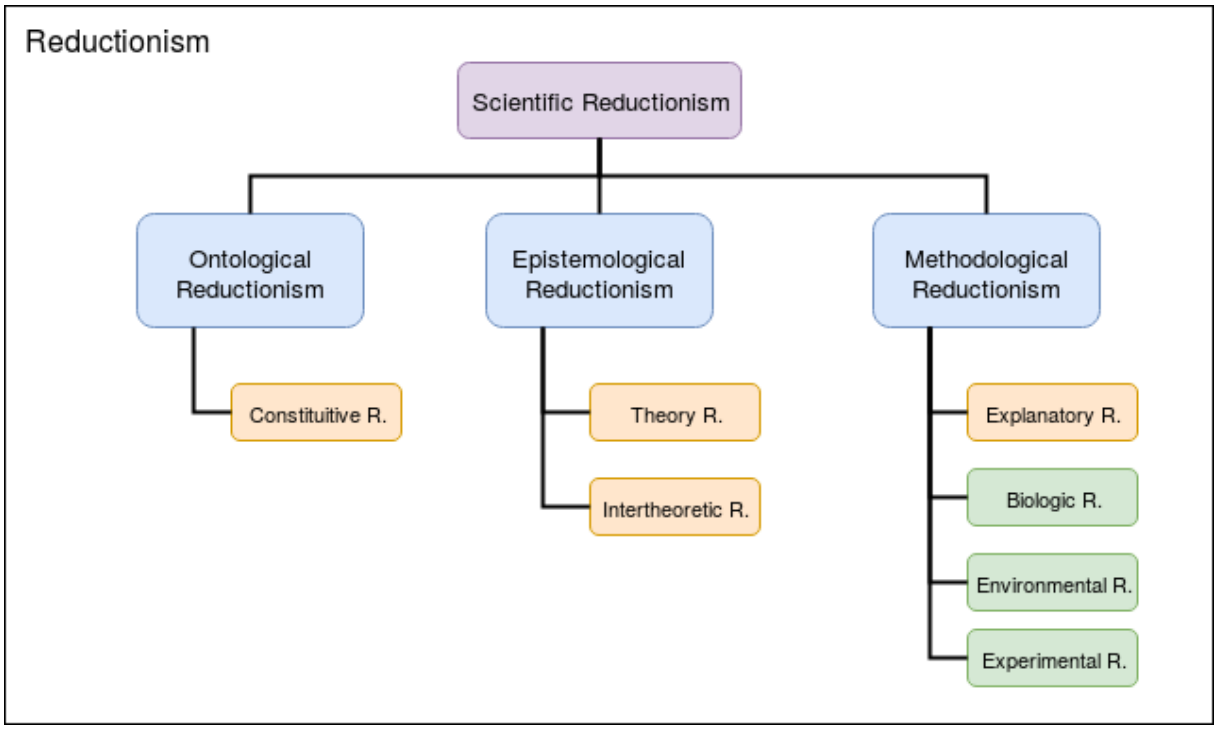

Figure 3.3: Scientific reductionism and three subcategories. Orange terms are often used synonymously with the blue terms. The three green terms are special subterms used in psychology to describe different modes of methodological reductionism.

3.5 Discussion and outlook

I want to provide a brief discussion of the produced overview based on an approach inspired by Ian Hacking's The Social Construction of What? and potential shortcomings. Also, I would like to address the relevance of this work for an investigation of the relation of reductionism and a critique of cognitive neuroscience as provided by Choudhury and Slaby (2011).

While focussing on the practices and real life usage of reductionism might be helpful to identify discrepancies between the theory and practice of reductionism, the reason for these differences might be manifold. As previously outlined, many reductionist traditions work within a single research programme. Deviations in the definition or practice of reductionism might be of trans-disciplinary nature. As definitional drift is a possibility as well, especially under the assumption

that practitioners and theorists within that field do not collaborate on a common basis, deviations might also have intradisciplinary reasons, such as the development of new practices and meanings. John Bickle (2008) recently argued that the theory and philosophy of reductionism needs to orientate itself based on the practiced reality within the sciences and, if needed, redefine the theoretical concepts.

As a matter of fact, the quality of the findings for this approach heavily rely on an exhaustive and thorough reading of the literature, which can be a daunting challenge as the the practice of reductionism is often implicit and ubiquitous in research programmes, while explicit references to the term are rarely used. Hence, a careful selection of the literature and restriction of the areas of research is crucial to ensure a meaningful outcome. This circumstance is even exacerbated by the fact that reductionism, in contrast to Hacking's social constructionism, is not usually applied within a certain discipline and tradition. Reductionism at the core of the traditional, positivist model of science further underlines the importance of a careful selection of the literature.

Critical neuroscience as a movement and self-reflective practice of neuroscientific research is critical of a certain kind of reductionism. It is interesting that while Choudhury and Slaby (2011) do not explicitly — as usual — mention a definition of reductionism, some hints are left that point to a critique of ontological and methodological reductions (e.g., the celebration of neuroimaging as the swiss army knife of the sciences of the mind). Some further literature that might help to outline a critique of reductionism might be Daniel Dennet's (2013) concept of greedy reductionism. Greedy reductionism overzealously removes layers of explanations relying on "skyhooks" (seeking explanatory power or causality in arbitrariness or randomness), in contrast to "good" reductionism which meticulously builds on "cranes" (explanations rooted mechanical, real reasons) to justify their findings. In order to sufficiently restrict the search space, the notion of critical neuroscience and an existing critique of reductionism in the neurosciences will be immensely helpful for future work.

3.6 Conclusion

Inspired by Ian Hacking's book The Social Construction of What? I set out to write small analysis of the term reductionism. Using a few Wittgensteinian concepts I established a small framework to deal with the meaning of reductionism while accommodating theory and practice across various fields and disciplines. I then provided several examples of definitions of reductionism from encyclopedic and expert literature. As these definitions were either operating on implicit epistemological or ontological presumptions or failed to provide succinct definition I then continued to look at these present presumptions. It turned out that the common categorisation of reductionism in epistemological, ontological, and methodological reductionism is legitimately used by a variety of authors. Also, several terms are used synonymously for the three types of reductionism, e.g., theory, intertheoretic, and epistemological reductionism. Other types of reductionism seemed to specifically refer to kinds of methodological reductionism, as shown with the example of different methodological traditions in psychology. The results show that

while the common classification of reductionism into three categories is useful, various additional terms are used either synonymously or as qualifiers for subcategories. Further careful reading of the literature is required, especially within within the the life sciences, in order to draw an final picture of reductionism and its meaning across different language games and practices in the life sciences.

Chapter 4

Chapter 4

Chapter 5

Chapter 5

Chapter 6

Chapter 6

Chapter 7

Conclusion

7.1 Thesis summary

In summary, pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Nunc eleifend, ex a luctus porttitor, felis ex suscipit tellus, ut sollicitudin sapien purus in libero. Nulla blandit eget urna vel tempus. Praesent fringilla dui sapien, sit amet egestas leo sollicitudin at.

7.2 Future work

There are several potential directions for extending this thesis. Lorem ipsum dolor sit amet, consectetur adipiscing elit. Aliquam gravida ipsum at tempor tincidunt. Aliquam ligula nisl, blandit et dui eu, eleifend tempus nibh. Nullam eleifend sapien eget ante hendrerit commodo. Pellentesque pharetra erat sit amet dapibus scelerisque.

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Appendix 1: Some extra stuff

Add appendix 1 here. Vivamus hendrerit rhoncus interdum. Sed ullamcorper et augue at porta. Suspendisse facilisis imperdiet urna, eu pellentesque purus suscipit in. Integer dignissim mattis ex aliquam blandit. Curabitur lobortis quam varius turpis ultrices egestas.

Appendix 2: Some more extra stuff

Add appendix 2 here. Aliquam rhoncus mauris ac neque imperdiet, in mattis eros aliquam. Etiam sed massa et risus posuere rutrum vel et mauris. Integer id mauris sed arcu venenatis finibus. Etiam nec hendrerit purus, sed cursus nunc. Pellentesque ac luctus magna. Aenean non posuere enim, nec hendrerit lacus. Etiam lacinia facilisis tempor. Aenean dictum nunc id felis rhoncus aliquam.

Chapter 8

References