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The selection of functional values and practices in industry-funded nutrition science

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Abstract:

Industry-funded research in nutrition science tends to generate knowledge that is beneficial to the funder. This effect is known to distort our knowledge of nutrition, and consequently undermine public health policy and the public trust in science. Scholars who study the phenomenon explain it either as an effect of intentional manipulation by food companies and biased researchers, or as the result of an unconscious bias that researchers hold towards their sponsors. In this thesis, I want to investigate an additional mechanism that can explain this phenomenon: the effect of selection on the values and practices in nutrition science. When food companies fund research, they selectively pick researchers who hold pro-industry values and beliefs or use value-embedded concepts and methods that help them produce studies with beneficial outcomes. Modern university departments recruit and promote new nutrition researchers based on their publication record and their capacity to generate external funding, and therefore indirectly select for researchers who possess pro-industry values and practices. These researchers gain in academic prestige, and then teach their values and practices to new generations of researchers, consequently shifting the research culture of the nutrition science community.

To study the possibility and scope of this selection mechanism, I have develop a method based on functionalist sociology and cultural evolution. Robert Merton's structuralist functionalism can offer the methods and theoretical tools to uncover the latent functions of the values and practices in the nutrition science community. The theory of cultural selection can then support Merton's structuralist worldview and provide a framework for empirical research on how selection has shaped the functional values and practices in nutrition science. I have integrated these two fields into a new framework – called structural selectionism – and applied it to the case of Dutch dairy science. By doing so, I demonstrate the benefits of structural selectionism as a methodology, and show that selection can explain why current day nutrition science serves the industry's interests instead of the public interest. Since selection is indeed a relevant factor, a reform of the incentive structure of science is necessary to preserve the public interest in nutrition science.

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Chapter 1: Introduction

In the last thirty years, global nutrition science has become increasingly dependent on funding by the food industry.[1] While industry funding for health-related nutrition science grew, the public funding decreased and governments started stimulating researchers to match public with private funds.[2] This change in funding practice has given rise to concerns about potentially undesirable consequences like the funding effect: the finding that industry-funded research shows higher rates of positive outcomes that are beneficial to the funder.[3] To illustrate, industry-funded research into sugar-sweetened soda drinks finds less evidence for health risks and weight gain than publicly funded research.[4] In addition to the funding effect, industrial funding can also drive the research agenda and guide the knowledge and attention of the field towards certain topics over others. This can be seen in the pronounced focus of industry-funded nutrition research on the health effects of single nutrients and food products that can be commercialized.[5]

The influence of industrial funders on research focus and outcomes can hinder the goal of nutrition science to improve human nutrition and public health.[6] On the most fundamental level, industrial influence can hamper the conceptual and methodological progress in the field.[7] The industry-funded focus on single nutrients and food products might undermine the development of other methodologies that are aimed at topics of higher public relevance like diets and food patterns.[8] In addition, findings from nutrition science are used to inform many guidelines, policy decisions and public health experts like dieticians. If this nutrition knowledge is created and shaped by the interests of the food industry, the resulting policies and recommendations may also align with industrial interests, which could come at the expense of the public interest.[9] Furthermore, when confronted with evidence of these phenomena, the

[1] Mozaffarian, D. (2017). Conflict of Interest and The Role of The Food Industry in Nutrition Research. *Jama*, *317*(17). For the Dutch situation, see: Penders, B., Wolters, A., Feskens, E. F., Brouns, F., Huber, M., Maeckelberghe, E. L. M., …de Vries, J. (2017). Capable and credible? Challenging nutrition science. *European Journal of Nutrition*, *56*(6), 2009–2012.

[2] Broek-Honing van den, N., Schel., M., & Vennekens, A. (2020). *Ontwikkeling derde geldstroom en beïnvloeding van wetenschappelijk onderzoek – Een data- en literatuuronderzoek ter beantwoording van de motie-Westerveld.*

[3] Nestle (2018) provides an overview of an overview of studies and meta-reviews on the funding effect in nutrition science up to 2018. *Unsavory Truth: How Food Companies Skew the Science of What We Eat*. Pp.38-48. Basic Books.

[4] Nestle (2018). *Unsavory Truth.* Pp. 38-48.

[5] Penders. et al. (2017). Capable and credible? Challenging nutrition science.; Fabbri, A., Lai, A., Grundy, Q., & Bero, L. A. (2018). The Influence of Industry Sponsorship on the Research Agenda: A Scoping Review. *American Journal of Public Health*, *108*(11), 9–16.

[6] Nestle (2018). *Unsavory Truth.* Pp. 35-37.

[7] Fabbri et al. (2018). The Influence of Industry Sponsorship on the Research Agenda: A Scoping Review. *American Journal of Public Health*, *108*(11), e9–e16.

[8] Scrinis, G. (2008). On the ideology of nutritionism. *Gastronomica*, *8*(1), 39-48.

[9] Steele, S., Ruskin, G., Sarcevic, L., McKee, M., & Stuckler, D. (2019). Are industry-funded charities promoting "advocacy-led studies" or "evidence-based science"?: A case study of the nternational Life Sciences Institute. *Globalization and Health*, *15*(1), 1-8.

public might recognize that their interest has become a secondary concern in nutrition science, and start to distrust public policy and nutrition scientists.[10]

Beneficial results: a selectionist explanation

Scholars who study the industrial influence on science have suggested several explanations for how or why academic researchers are involved in the production of beneficial results. One part can be explained as an effect of the intentional manipulation by food companies – who might choose to keep certain topics unfunded and unbeneficial findings unpublished – or as an effect of misconduct by researchers who share direct interests with the industry.[11] However, in most cases, the researchers do not appear to be intentionally complicit in the production of knowledge beneficial to the industry. Many scholars therefore use evidence from social psychology to explain their involvement as the result of an unconscious bias that researchers gain due to industrial funding and gifts. Lastly, several scholars in philosophy of science have recently drawn attention to the role of values in the creation of knowledge beneficial to the funder. They argue that the choice of concepts, categories, measurement methods and the interpretation of results are underdetermined by epistemic concerns, and therefore necessarily leave room for the values of researchers to play a role.[12] When researchers hold commercial values over public ones, the research they conduct will incline towards the interest of the industry instead of the public.

Building upon the values-in-science literature, this thesis aims to explore a new mechanism through which industry-interested nutrition knowledge can emerge: cultural selection. When companies have the ability to select what topic and which researcher they are going to fund, they will systematically pick topics and researchers with methods, theories and values that give them a higher chance of obtaining beneficial results.[13] By generating beneficial results, these researchers may gain more funding and publishing opportunities. Because modern university departments recruit new scholars based on their publication metrics and their capacity to generate external funding, they will indirectly select for researchers who hold these pro-industry values and practices. Following recruitment, these value-embedded elements will then be transmitted to new generations of academics, and become integral part of the nutrition science community.

If nutrition knowledge is indeed shaped through selection, this will have important implications for how industrial influence in science should be managed. Current suggestions to manage this influence revolve around increasing the transparency of the research process, and devising guidelines and educational campaigns that raise the norms and integrity of researchers.[14] However, if the cultural selection of values can explain the modern day issues in nutrition science, these measures will not be sufficient: as long as the industry and academia keep

[10] Pinto, M. F. (2020). Commercial interests and the erosion of trust in science. *Philosophy of Science*, *87*(5), 1003-1013.
[11] Nestle (2018). *Unsavory Truth.*
[12] For an overview, see: Elliott, K. C. (2017*). A tapestry of values: An introduction to values in science.* Oxford University Press.
[13] Holman, B., & Bruner, J. (2017). Experimentation by industrial selection. Philosophy of Science, 84(5), 1008-1019.
[14] Elliott (2017). *A Tapestry of Values.*

selecting and rewarding nutrition scientists for holding values and practices that lead to beneficial results for the industry, they will select against these new norms. It is therefore important to study the values and value-embedded practices in nutrition science and the selective processes that might have formed them. Therefore, the first research question of this thesis is: **Can a selectionist account on the development of values and practices in nutrition science explain why nutrition knowledge serves the industry's interests?** This thesis aims to answer this question by proposing a synthetic method composed of cultural evolutionary theory and Robert Merton's structural functionalist sociology, which can uncover and explain the functions of values in nutrition science.

Merton's sociology

Structural functionalism, as developed by Robert Merton, can offer the theory and methods to reveal the values and value-embedded concepts in nutrition science. His sociology suggests that cultural elements like values, roles, norms and practices can have functional or dysfunctional relations with the social system in which they are implicated.[15] An element has a functional relationship if it consistently benefits a system – like a research method that is inclined to create beneficial outcomes for the industrial funder - while dysfunctions point at negative consequences.

The objective consequences of a cultural element for a system constitute the main interest of Merton's sociology, and are described as 'latent' functions.[16] These latent functions are not recognized by the people who exhibit or use them, and are often dissimilar from the subjective intentions and motivations of the actor. For example, an industry-funded scientist might have many epistemic and ethical reasons to use a certain method, but if the method regularly generates beneficial outcomes for the industry it will also harbour an industry-friendly latent function.

The proposal of latent functions has historically been seen as the central weakness of Merton's sociology. In short, the problem with latent functions is that they are hard to explain: if nobody intents or designed these functions, then how do they come about?[17] Fortunately, recent developments in the fields of cultural evolution and philosophy of biology can offer the resources to formulate a selectionist explanation of latent functions, and solve the explanatory gap that threatens Merton's sociology.

Cultural selectionism

Cultural evolution studies the development of culture in humans and other animals from a biological perspective. It holds that social learning in animals can give rise to an additional inheritance system in which cultural phenomena are transmitted and gradually change.[18] A

[15] Merton, R. K. (1968). *Social theory and social structure*. Free Press.
[16] Merton (1968). *Social theory and social structure.* Pp.115-124.
[17] Sztompka, P. (1986). *Robert K. Merton: An Intellectual Profile (Theoretical Traditions in the Social Sciences)*. Palgrave Macmillan.
[18] For an overview of the field, see: Mesoudi, A. (2016). Cultural Evolution: A Review of Theory, Findings and Controversies. *Evolutionary Biology*, *43*(4), 481–497.; Henrich, J. (2015a). *The Secret of Our Success: How Culture Is Driving Human Evolution, Domesticating Our Species, and Making Us Smarter* (pp. 54–83). Princeton University Press

large strand of researchers support the idea that in humans, cultural change itself is guided by selective processes that give rise to functional modifications. When a new cultural variety arises, its chances of transmission will depend on how well it functions within its environment. This environment can be formed by natural surroundings – relevant in the selective transmission of hunting equipment, for example – or it can be constituted by other cultural institutions and elements or aspects of human cognition.

Cultural selectionism can inform the development of values in nutrition science, and substantiate Merton's sociological worldview. However, two issues arise when applying cultural selectionism to real world phenomena. First, philosophers of biology have raised several conceptual challenges against selectionism, with the most fundamental ones holding that selectionist accounts lack explanatory power and do not offer new insight to our understanding of cultural phenomena.[19] Second, the field of cultural evolution rests on mathematical models and quantitative analyses that investigate isolated cultural elements, and lacks a method that could help us study the relations between different elements within a system.[20]

Robert Merton's structural functionalism can offer a solution to these two issues. It can provide selectionism with a concrete framework for studying the relations (or functions) between different cultural elements and systems, and offer selectionism the opportunity to take up a role in explaining how latent functions can emerge. In this way, the theories of cultural selectionism and structural functionalism can mutually reinforce one another and form a new integrated method that I will call 'structural selectionism'. The development and application of this new method can be seen as part of the second research question of this thesis: **Can an integrated method composed of cultural selectionism and Robert Merton's structural functionalism develop powerful selectionist explanations of cultural development?** To answer this question, I first synthesize the two fields theoretically, and then test the newly formed structural selectionist method by applying it to the case of Dutch nutrition science.

Dutch dairy science

The case study of this thesis focuses on Dutch nutrition science, and specifically on the Dutch dairy science community. Dairy is an important export product and research topic in the Netherlands, and this corresponds with a sizeable dairy science community that includes one specialized dairy science department and master's program at Wageningen University, and at least two industrial research institutions.[21] Dutch dairy science receives large quantities of industrial funding and has been implicated in several public controversies surrounding industry-funded science, making it an ideal field to study.

In line with the research questions of this thesis, the case study serves two purposes. The first is to investigate what role selection plays in the development of industry-aligned values and

[19] Lewens, T. (2015). *Cultural evolution: conceptual challenges*. OUP Oxford.
[20] Buskell, A., Enquist, M., & Jansson, F. (2019). A systems approach to cultural evolution. *Palgrave Communications*, *5*(1), 131
[21] The industrial dairy research facilities are the FrieslandCampina Institute in Wageningen and Danone Nutricia Research in Utrecht.

value-embedded concepts in nutrition science. To conduct this study, I use the structural selectionist method described in the subsection above. Applying this method to the case of Dutch (dairy) science allows me to compare its findings with existing explanations and offers the opportunity to test and further develop the structural selectionist method. The testing and development of structural selectionism can thus be seen as the second purpose that is served by the case study.

The case study serves both purposes simultaneously, and contains two empirical parts. First, I study the community's practices, and their values surrounding the public interest by conducting close reading of news articles, policy documents and other primary sources. I pay special attention to the 'dairy matrix' concept and the topic of cow milk allergy, and conduct interviews with several researchers involved in dairy nutrition research. Second, I study the selective pressures that have possibly shaped the values and value-embedded concepts that have been uncovered. For this purpose, I analyse policy documents and conduct background interviews on the competition and reward-system of Dutch nutrition science.

Outline

In chapter 2 I define the contemporary problems in nutrition science as well as its negative consequences for the public, and review the literature on how industry-aligned knowledge emerges. After critically discussing arguments that portray these researchers as biased or unconsciously biased, I adopt the perspective developed within the philosophical literature on values in science. This body of literature explains how values underly researchers' choices and offers ways to manage them, although it does not describe how these values develop. Some researchers have argued that values can develop through selective processes, and at the end of the chapter I expand upon this idea and offer a novel hypothesis on how the selection of values and practices could explain the current day issues in nutrition science.

In order to study the selection hypothesis, I set out to develop an integrated theory composed of Robert Merton's structural functionalism and cultural evolution in the third chapter of this thesis. I start by introducing the reader to these two theoretical frameworks, and will defend the selectionist school within the field of cultural evolution. Then, I argue that these theories can be synthesized and used to study the creation of pro-industry knowledge in nutrition science. Before applying this new method – called structural selectionism – I first lay out what its explanatory aims are and how it can formulate explanations. Several scholars have argued that the role of historical contingency and agency in cultural development reduces the validity and power of selectionist explanations. I discuss these challenges and argue that structural selectionism is able to formulate powerful explanations that can account for these two factors.

In chapter four, I study the selection hypothesis developed in the second chapter by applying the new structural selectionist method to the case of Dutch dairy science. The structure of this chapter follows Merton's sociological method, and therefore starts with the formulation of the problem. Based on preliminary observations and secondary literature, I develop a middle-range theory, which I then use to formulate hypotheses on the values within the research community, and the selective processes that have shaped them. Next, I describe the results of my empirical research in which I have tested these hypotheses.

The analysis and interpretation of my findings is central to the fifth chapter of this thesis. Despite that my findings can be complemented by further empirical research, I conclude that there are clear signs that the selection of values and value-embedded practices plays an important role in steering research towards the industry's interests. I compare this structural selectionist explanation with the most approved alternative explanation: that of unconscious bias. Since my selectionist explanation is more precise and better integrated within existing theory on selection and values in science, it can be said to have more explanatory power. Consequently, I conclude that the current suggestions on how to manage pro-industry values and knowledge in nutrition science are insufficient, and that more drastic reforms of government policy and the reward-system in academia are required.

Chapter 2: Industry-funded nutrition science: problems and explanations

In the nineties, scholars started to note that industry-funded science generates knowledge that benefits the funder.[22] Since then, the share of privately funded science has increased - as well as the evidence that this form of funding shapes nutrition science, medicine and other fields towards the industry's interests. This trend has been shown to have negative implications: it can hinder the conceptual and methodological development in the field, leave topics of high relevance uninvestigated, and undermine public health policy and public trust in science. Scholars from different disciplines investigate how these issues emerge, but they have not yet arrived at a consensus or at effective measures to manage these problems. In this chapter, I offer a new account on why academic researchers create pro-industry knowledge, based on literature about values in science and selection.

I first review the evidence of nutrition research that benefits the industry, and discuss its negative consequences for the public and the discipline itself. The remainder of the chapter focuses on the question how this involvement comes about: why does nutrition science produce knowledge that serves the interest of the industry instead of the public? Most researchers in food studies, science studies and public health research hold that academic researchers contribute to the creation of pro-industry knowledge because they have conflicts of interests that (unconsciously) bias them. I critically discuss these accounts in the second section.

In the third section, I adopt the philosophical view on values in science, and argue that the researchers' complicity in the creation of pro-industry knowledge can best be explained by the values and value-embedded practices within the research community. Although this account is analytically more robust than the literature on unconscious bias, it does not explain how the values and practices of research communities develop. In the last section, I offer such an explanation using the mechanism of selection: the selective funding, hiring and promoting of researchers by both the industry and academia can gradually and subtly shift the values, practices and knowledge of the field towards the industry's interests. I conclude that we need to explore this mechanism theoretically and empirically in order to better understand and manage the negative effects of funding on science.

2.1: The undesirable effects of industry-funded nutrition science

In recent decades, nutrition science has become increasingly dependent on funding from the food industry.[23] While public funding remained stable or decreased, the share of industrial money involved in sponsoring journals, organizing conferences and funding scientific research

[22] Krimsky, S. (2013). Do Financial Conflicts of Interest Bias Research? *Science, Technology, & Human Values*, *38*(4), 566–587.

[23] Mozaffarian, D. (2017). Conflict of Interest and The Role of The Food Industry in Nutrition Research. For the Dutch situation, see: Penders, B. et al. (2017). Capable and credible? Challenging nutrition science.

grew.[24] In a 2020 study it was found that more than 13 percent of the articles in the top ten most-cited nutrition journals report the involvement of food industry, with the *Journal of Nutrition* having the highest rate of involvement with 28 percent.[25] Since industrial funding sources might be underreported in journals, these percentages could be higher in reality. In addition, the funding rates increase when looking at specific nutrition-related topics. For example, of the studies between 2010 and 2019 on the effects of food and diets on blood cholesterol concentrations, 60 percent was funded by the industry.[26]

Similar trends can be observed in other disciplines, and they reflect the global tendency of governments to adopt science policy that aims to stimulate societal relevant research in the shape of innovation and economic development.[27] Encouraging collaboration between academia and industry has been central to this ideal. Examples of policies include reducing the budget for basic science, offering tax cuts to companies that fund academic research, and installing funding programs that compel researchers to match their public funds with private funding.[28] Although these policies have been successful in the governments' goal of increasing collaboration, the expansion of industry-funded research has also lead to criticism. Scholars from a variety of fields, like Marion Nestle, Lisa Bero and Alice Fabbri argue that industrial involvement steers nutrition science towards the interests of the industry, which actually comes at the cost of societal relevance as well as the scientific standards in the field. The critics of industry-funded science point at two signs of the industry's influence.

First, industrial funding has been observed to drive the research agenda and guide the knowledge and attention of the field towards certain topics and questions over others.[29] Industry-funded research tends to generate knowledge on topics with a commercial functionality, like health claims on specific food products or nutrients and conclusions that can influence public policy, while ignoring other topics like diets and food culture.[30] Second, industry-funded research shows higher rates of positive outcomes that are beneficial to the funder than research funded only by public organisations – a phenomenon also known as the funding effect.[31] According to a recent study, more than half of the articles with food industry involvement publish findings that are favourable to food industry interests, compared to less than ten percent for articles that are funded by public institutions.[32] Not only the outcomes, but

[24] Nestle, M. (2001). Food company sponsorship of nutrition research and professional activities: a conflict of interest?. *Public Health Nutrition*, *4*(5), 1015-1022.
[25] Sacks, G., Riesenberg, D., Mialon, M., Dean, S., & Cameron, A. J. (2020). The characteristics and extent of food industry involvement in peer-reviewed research articles from 10 leading nutrition-related journals in 2018. *PloS one*, *15*(12).
[26] Barnard, N. D., Long, M. B., Ferguson, J. M., Flores, R., & Kahleova, H. (2021). Industry funding and cholesterol research: a systematic review. *American Journal of Lifestyle Medicine*, *15*(2), 165-172.
[27] Holman, B., & Elliott, K. C. (2018). The promise and perils of industry-funded science. *Philosophy Compass*, *13*(11), e12544.
[28] Rowe, S., Alexander, N., Kretser, A., Steele, R., Kretsch, M., Applebaum, R., ... & Falci, K. (2013). Principles for building public-private partnerships to benefit food safety, nutrition, and health research. *Nutrition reviews*, *71*(10), 682-691.
[29] Fabbri et al. (2018). The influence of industry sponsorship on the research agenda: a scoping review.
[30] Penders, B. et al. (2017). Capable and credible? Challenging nutrition science.
[31] Krimsky, S. (2005). The Funding Effect in Science and its Implications for the Judiciary. *Journal of Law and Policy*, *13*(1), 43–66.
[32] Sacks, et al. (2020). *The characteristics and extent of food industry involvement*. *PloS One*, *15*(12), e0243144

also their interpretations are more favourable to the industry. For example, in a recent meta-analysis of infant formula trials almost 70 percent of the studies found a favourable outcome, while even 92 percent of the abstracts reported favourable conclusions.[33]

Nutrition science and the public interest

Together, the research agenda effect and the funding effect can have unwanted effects on nutrition science and public health. In contrast to food science – the field that aims to develop new products and technologies for the industry – nutrition science has the goal to generate trustworthy knowledge on human nutrition that ultimately improves public health and wellbeing.[34] This is a daunting task, considering the high prevalence of overweightness and diet-related diseases. Worldwide, dietary risk factors significantly increase healthcare costs and lead to more than 10 million deaths and 250 million disability-adjusted life-years each year.[35] In Europe alone, half of the population is overweight and every year two million deaths are associated with dietary risks.[36] Nutrition science aims to alleviate these issues, but the influence of industrial funding can obstruct this aim in several ways.

On the most fundamental level, industry influence can hinder the conceptual and methodological development in the field.[37] The focus of industry-funded studies on single food products and nutrients has been criticized as a reductionistic way of studying human nutrition, that is prone to generate false positives and contradicting conclusions. To illustrate, studies that use randomized clinical trials to research the health-effects of probiotics are known to contain methodological flaws because they ignore the differences in peoples' diets and microbiomes.[38] Methodological issues like these can complicate the development of consensus on elementary facts in nutrition science. In addition, many approaches and methods in nutrition science with high public relevance, like those that study ecological concerns and diets, tend to remain underdeveloped because food companies do not have an incentive to fund these studies.[39] In obesity studies, for example, the majority of industry-funded studies focus on single nutrients, while there is sufficient evidence that social and diet-focused studies are more useful when studying obesity.[40]

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[33] Helfer, B., Leonardi-Bee, J., Mundell, A., Parr, C., Ierodiakonou, D., Garcia-Larsen, V., ... & Boyle, R. J. (2021). Conduct and reporting of formula milk trials: systematic review. *BMJ.*

[34] Nestle (2018). *Unsavory Truth*. Pp.35-37.

[35] Afshin, A., Sur, P. J., Fay, K. A., Cornaby, L., Ferrara, G., Salama, J. S., ... & Murray, C. J. (2019). Health effects of dietary risks in 195 countries, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. *The Lancet*, *393*(10184), 1958-1972

[36] Feigin, V. L., Roth, G. A., Naghavi, M., Parmar, P., Krishnamurthi, R., Chugh, S., ...Study, R. F. (2016). Global burden of stroke and risk factors in 188 countries, during 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013. *The Lancet Neurology*, *15*(9), 913-924.

[37] Penders et al. (2017). *Capable and credible?* ; Calder, P., Feskens, E. J., Kraneveld, A. D., Plat, J., van't Veer, P., & De Vries, J. (2020). Towards "Improved Standards in the Science of Nutrition" through the establishment of FENS working groups. *Annals of Nutrition and Metabolism*, *76*(1), 2-5.

[38] Zeilstra, D., Younes, J. A., Brummer, R. J., & Kleerebezem, M. (2018). Perspective: fundamental limitations of the randomized controlled trial method in nutritional research: the example of probiotics. *Advances in Nutrition*, *9*(5), 561-571.

[39] Penders et al. (2017). *Capable and credible?*

[40] Fabbri et al. (2017). Study sponsorship and the nutrition research agenda.

Closely related to this, are the issues of scientific ignorance or undone science.[41] These concepts hold that selective research choices can lead to a partial understanding of complex phenomena and blind spots in the knowledge of a community. Since the resources for conducting research are limited and the possible research questions that can be asked are practically infinite, a certain level of ignorance is unpreventable. However, certain blind spots can be identified as undesirable and worthy of research from the perspective of the public and civil society organisations.[42] In nutrition science, these issues are most evident when comparing the enormous amount of research on single nutrients and food products with the relatively small but publicly relevant fields of diet studies and social or cultural food studies.

Further undesirable effects of industry-funded research appear if one looks at how this research is used and applied in society. The results of industry-funded studies, which tend to be overly positive or underestimate the harmful effects of their product, are often used in health claims. For example, industry-funded research into sugar-sweetened soda drinks finds less evidence for health risks and weight gain than publicly funded research, while studies on calcium supplements are more likely to find positive health effects when sponsored by companies that produce these supplements.[43] When such findings are used by companies to substantiate health claims on their products, this can misinform the public and lead to food choices that are damaging to their health or financial situation.

In addition, findings from nutrition science are used to inform countless of guidelines, policy decisions and public health experts like dieticians. If this knowledge is created and shaped by the interests of the food industry, the resulting policies and recommendations may also align with industrial interests, which could come at the expense of the public interest. For example, Coca Cola's research on the role of exercise in childhood obesity has led to policies and public campaigns that emphasize sports and children's own responsibility for their health, while children might have benefited more from soft drink taxations or modified school lunch programs.[44] Analysis of internal documents from food companies shows that the industry intentionally funds research with the specific aim to oppose or reform policies like these.[45]

Lastly, the commercialization of nutrition science has been linked to the erosion of public trust in nutrition knowledge and scientists.[46] Many researchers are visibly affiliated with multinational food companies, and the public is regularly confronted by news articles and

[41] 'Scientific ignorance' has been developed from a philosophical perspective, most notably by Proctor and Schiebinger (2008) in their edited volume: *Agnotology: The Making and Unmaking of Ignorance*. Stanford University Press.
[42] This is the defining aspect of 'undone science', which has been developed by sociology of science and STS scholars. See, for example: Frickel, S., Gibbon, S., Howard, J., Kempner, J., Ottinger, G., & Hess, D. J. (2010). Undone science: Charting social movement and civil society challenges to research agenda setting. *Science, Technology, & Human Values*, *35*(4), 444-473. Closely related to undone science is the sociological study of ignorance, also known as Agnotology. See: Proctor, R. N., & Schiebinger, L. (2008). *Agnotology: The Making and Unmaking of Ignorance*.
[43] Nestle (2018). *Unsavory Truth*. Pp.39-48.
[44] Powell, D., & Gard, M. (2015). The governmentality of childhood obesity: Coca-Cola, public health and primary schools.
[45] Steele et al. (2019). Are industry-funded charities promoting "advocacy-led studies" or "evidence-based science"?
[46] Pinto (2020). Commercial interests and the erosion of trust in science.

popular science books like those written by Marion Nestle that address the issues surrounding industry-influenced research in nutrition science.[47] The public might recognize that a large share of current day nutrition science is skewed towards the interests of the industry instead of their own interests. This could lead to public dissent and distrust of nutrition science and scientists – including that of well-conducted research. Distrust of nutrition science could further undermine public health policy, and also damage the trust in governments and science as a whole.

Towards an explanation

To limit the negative consequences of industry-funded nutrition science, scholars from different fields attempt to understand how nutrition research is steered towards the industry's interests. In some cases, it can be traced back to the actions of the funding organisation. Food companies often have a large say in determining the topic and research question when they contribute funding to it, and sometimes their academic research is preceded by in-house testing to guarantee a positive outcome.[48] They can also influence the execution of a study more directly by changing the design or manipulating the data, or interfere with the publication process by suppressing negative outcomes.[49]

Nevertheless, in most cases the academic researcher is thought to play an important role in steering the research towards the industry's interests. Evidence shows that many studies that benefit the industry do so because of choices that have been made during the design of the research method.[50] For example, the researchers' choices concerning the study size, duration, endpoints and dosage of the tested product can all steer a study towards a positive outcome.[51] To illustrate, in industry-funded pharmaceutical trials, researchers regularly use placebos or active comparators in lower doses as control measures, raising the chance of a positive result.[52] Nutrition studies are even more vulnerable to issues in the design phase. It is hard for researchers to randomize or blind nutrition trials, and they have to account for the complex interaction between different nutrients as well as the abundance of variation in the diets and microbiomes of individuals.[53] Critical nutrition researchers are therefore convinced that clinical trials in nutrition science are likely to generate false positives.[54]

Academic scientists are also the main actors in the execution phase of the study, since it is very controversial for other parties to interfere within this research phase. Here, researchers could arrive at positive outcomes for the funder when they falsify or fabricate data, but it appears that

[47] Nestle (2018). *Unsavory Truth*. .
[48] Krimsky (2013). Do financial conflicts of interest bias research?
[49] Sismondo, S. (2009). Ghosts in the Machine. *Social Studies of Science*, *39*(2), 171–198.
[50] Elliott, K. C., & McKaughan, D. J. (2009). How values in scientific discovery and pursuit alter theory appraisal. *Philosophy of Science*, *76*(5), 598-611.
[51] Lexchin, J., Bero, L. A., Djulbegovic, B., & Clark, O. (2003). Pharmaceutical industry sponsorship and research outcome and quality: systematic review. *bmj*, *326*(7400), 1167-1170.
[52] Lundh, A., Lexchin, J., Mintzes, B., Schroll, J. B., & Bero, L. (2017). Industry sponsorship and research outcome. *Cochrane Database of Systematic Reviews*, *2017*(2).
[53] Nestle (2018). *Unsavory Truth.* Pp.34-35, 45-48.
[54] For an example, see: Zeilstra, et al. (2018). Perspective: fundamental limitations of the randomized controlled trial.

these activities are relatively uncommon.[55] More likely than clear fraud, is that researchers influence the study during the gathering of data or coding of events, or by using questionable research practices during the analysis of the study.[56] For example, researchers can choose to remove certain outliers to increase the p-value of a result, or look for unexpected but significant correlations in the data that can be fitted with a post-hoc hypothesis in order to generate favourable conclusions.

A large share of studies are shifted towards the funder's interest during the interpretation of the research. Several quantitative studies show that the conclusions of industry funded studies do not always correspond with their actual results, and even contain statements that are in conflict with the reported data.[57] In these studies, it is suggested that academic researchers selectively leave out negative findings and choose study outcomes or subgroups that give favourable results, even if these outcomes do not concern the primary aim of the study. Furthermore, the conclusions of industrial studies are given a positive spin by ignoring important uncertainties, framing correlation as cases of causation and by reframing the research question.[58] To illustrate, a study that found no significant results when researching the protective effects of a food product on a disease, can still be spun into a success story by concluding that this product does not increase the disease risk. Lastly, the academic researcher can be involved in the selective publication of research. Evidence shows that industry-funded studies with unfavourable results are less likely to be published.[59] However, many universities and public-private funding programs nowadays compel researchers to publish their findings even when they are negative, potentially reducing the impact of this factor.

To conclude, academic nutrition scientists play an important role in steering research towards the industry's interests, and often at the cost of the societal aims of nutrition science. But why do they do this, and what strategies can we implement to prevent it from happening? In the next section, I critically discuss the most common explanation of the researchers' complicity, which are based on researchers' conflict of interests and (unconscious) bias.

2.2: Conflict of interests and (unconscious) bias

The first explanations for the industry's influence on academic research were developed during the nineties by scholars from the pharmaceutical sciences and public health research, which were later joined by researchers from food and science studies. Most of their scholarship conceptualizes the researchers' involvement in terms of bias, which is defined as "a systematic deviation from the truth, in the results or inferences of studies".[60] They argue that academic researchers are likely to generate biased research when they have conflict of interests -

[55] Doucet, M., & Sismondo, S. (2008). Evaluating solutions to sponsorship bias. *Journal of Medical Ethics*, *34*(8), 627-630.
[56] Lundh et al. (2017). Industry sponsorship and research outcome.
[57] Lundh et al. (2017). Industry sponsorship and research outcome.; See also: Helfer, B. et al. (2021). Conduct and reporting of formula milk trials: systematic review.
[58] Holman & Elliott (2018). The promise and perils of industry-funded science.
[59] Nestle (2018). *Unsavory Truth.* Pp.40-48.
[60] Boutron, I., Page, M. J., Higgins, J. P., Altman, D. G., Lundh, A., & Hróbjartsson, A. (2019). Considering bias and conflicts of interest among the included studies. In *Cochrane Handbook for Systematic Reviews of Interventions* (pp. 177–204). Wiley.

situations where researchers have a secondary interest in a certain outcome of the study.[61] These interests have the ability to override the 'primary' interests of the study, like the use of valid methods and objective interpretation, or – according to some authors - the aims of human welfare and public health.[62] Conflicts of interests arise when a researcher is paid for conducting research by an organisation with non-academic interests, or when the researcher receives gifts or has a paid position within such an organisation. Conflict of interests can influence the researcher's practice consciously or unconsciously, and give rise to bias during all phases of the research process.

Throughout the years, organisations involved in conducting or publishing research started to recognize the criticism generated by this field of literature, and developed management strategies to deal with the issue. First, at the start of this century, many journals and public research funders in medicine and nutrition science began requiring researchers to disclose their funding source. [63] These disclosure statements also list other ties with commercial organisations, like paid functions or gifts, and have the goal of making the researcher transparent and accountable for their conflict of interests.[64] A more recent strategy to increase the transparency of research is through the public preregistration of studies, which makes it visible when researchers change their research design during the study or invent new secondary endpoints.[65] Another strand of strategies aim to increase researchers' awareness of conflicts of interests. For example, many academic societies, journals and universities organize educational programs on scientific integrity, and have drawn up codes and principles that prescribe how researchers should deal with privately funded research.[66] These principles can range from giving studies a clearly articulated goal on how to benefit the public, to restricting the size of gifts given by the funder.

Although seen as helpful, the majority of scholars argue that these strategies are insufficient and do not succeed in addressing the industry's influence on academic researchers.[67] The central problem, they write, is that the measures rest on the assumption that they are dealing with a conscious form of bias in which researchers intentionally steer their research towards the funder's interest.[68] If this were the case, transparency and accountability could help reduce bias. However, evidence from the social sciences shows that most biasing effects occur in a manner that is subtle, unconscious and unrecognized by the researchers. This so-called unconscious bias can influence the researcher during all aspects of the research process, and has been thought to emerge through several psychological mechanisms.

[61] Besley, J. C., McCright, A. M., Zahry, N. R., Elliott, K. C., Kaminski, N. E., & Martin, J. D. (2017). Perceived conflict of interest in health science partnerships. *PLoS One*, *12*(4), e0175643.
[62] The latter definition is for example held by Nestle (2018). *Unsavory Truth.* Pp.194-199.
[63] Krimsky (2005). The Funding Effect in Science and its Implications for the Judiciary.
[64] Nestle (2018). *Unsavory Truth.*
[65] Holman & Elliott (2018). The promise and perils of industry-funded science.
[66] Nestle (2018). *Unsavory Truth.* Pp.198-207.
[67] This is for example argued by Marion Nestle and Lisa Bero.
[68] Nestle (2018). *Unsavory Truth.* Pp.30.

First, when researchers have an interest in reaching a specific research outcome, their judgements can be unconsciously influenced through a self-serving bias.[69] Studies in social psychology show that the judgements of individuals tend to be biased in favour of themselves, and this effect could also occur in academic research, for example when the researcher's future career opportunities depend on the research outcome. Next, unconscious bias could arise when researchers accept gifts, paid functions or even research funding from a company. Observational studies show that gifts and funding can create lasting relationships and strong social obligations to reciprocate and return the given favour, even when these gifts have little financial value like coffee mugs and calendars.[70] Similar evidence emerges from social psychology, where experiments show that physicians are more likely to recommend a pharmacist's drug when their institution is sponsored by it.[71] Although these experimental studies serve as important signs of unconscious bias, it must be noted that they did not study directly the influence of gifts and funding on the conduct and outcomes of academic research.[72]

Despite the possibly large role of unconscious bias in industry-funded academic research, many individual researchers have been found to belief that they can recognize and manage their conflicts of interests.[73] Even when they recognize the existence of unconscious bias, they see it as something that happens to other researchers, and not to themselves.[74] Disclosures statements, integrity guidelines and other measures aimed at increasing transparency and awareness might therefore be ineffective, or even counterproductive when they hold back more substantial institutional change.[75]

Instead, the literature on unconscious bias proposes a variety of additional management strategies. According to Marion Nestle, the most certain but also radical solution would be to prohibit the industrial funding of academic research altogether, or to create a pool of research funding that can be distributed independently by taxing the industries.[76] However, this strategy would face large political resistance from the industry and could therefore be unfeasible. It might therefore be more effective to mitigate (unconscious) bias by improving the cultural research environment through the enforcement of strict integrity policies, she suggests. Journals and academic societies could install regulations that prohibit paid functions at commercial organisations, while universities could ban gifts and adopt strict policies for determining what funding sources can and cannot be accepted. Together with professional training and education in research ethics, these measures could create a fertile ground for

[69] Sah, S., & Fugh-Berman, A. (2013). Physicians under the Influence: Social Psychology and Industry Marketing Strategies. *Journal of Law, Medicine & Ethics*, *41*(3), 665–672.
[70] Doucet & Sismondo (2008). Evaluating solutions to sponsorship bias.
[71] Dana, J. (2003). A Social Science Perspective on Gifts to Physicians From Industry. *JAMA*, *290*(2), 252.
[72] In addition, these studies are slightly dated and derived from a field of psychology that has been implicated in the reproducibility crisis, which complicates their conclusions.
[73] Lipton, S., Boyd, E., & Bero, L. (2004). Conflicts of Interest in Academic Research: Policies, Processes, and Attitudes. *Accountability in Research*, *11*(2), 83–102.
[74] Sharek, Z., Schoen, R. E., & Loewenstein, G. (2012). Bias in the evaluation of conflict of interest policies. *The Journal of Law, Medicine & Ethics*, *40*(2), 368-382.
[75] Dana (2003). A Social Science Perspective on Gifts to Physicians From Industry.
[76] Nestle (2018). *Unsavory Truth.* (pp.210-217).

cultural norms to emerge that prohibit close relations with the industry and guard the scientific integrity.[77]

Given the idea that industry-funded science is steered through many small choices during the different phases of the research process, it appears likely that the involvement of academic researchers is indeed unconscious. In addition, the account of unconscious bias has the advantage of being able to explain the researchers' involvement without assuming widespread fraud and corruption. However, the literature does not offer empirical evidence that it is indeed these unconscious psychological mechanisms that are steering scientific research results towards the industry's interests. Furthermore, the concept of unconscious bias seem too broad to determine what management strategies would be sufficient to prevent the steering of research. Philosophers of science who study the same topic have developed another account of the researchers' unconscious role in the creation of pro-industry knowledge. This account emphasizes the importance of values and value-embedded practices within the research community, and I argue that it is analytically and empirically more robust than the account of unconscious bias. In the following section, I critically discuss and then adopt this value-based perspective.

2.3: Values in industry-funded science

According to recent literature in the philosophy of science, scientific research is full of decisions that are underdetermined by epistemic factors. The choice and use of concepts, categories, methods and the interpretation of results cannot be made based on epistemic premises alone, and therefore leave a necessary role for the researchers' values to influence these choices.[78] Values can be of socio-political, ethical or epistemological origin, and manifest in researchers' choices throughout the various stages of the research process. The majority of this literature is focused on how non-epistemic values influence science during the design, conduct and interpretation of research, since the role of values is most contested in these phases.[79] In this section, I first discuss why non-epistemic values play a necessary role in scientific practice, then further define what values are and how they can be managed.

The indispensability of non-epistemic values

Although the boundary between epistemic and non-epistemic values are debated, most philosophers agree that non-epistemic values are not only present, but also play a necessary role in the practice of research.[80] To make this point, the literature offers both theoretical arguments and observational studies. First, Helen Longino and other philosophers have noted that there exists a necessary gap between scientific evidence and the theoretical statements it is supposed to support, because a limited amount of evidence can never logically prove a hypothesis or theory.[81] This underdetermination of hypotheses and theories leaves room for non-epistemic value-laden assumptions to play a role during the interpretation of studies.

[77] Sah & Fugh-Berman (2013). Physicians under the Influence.
[78] For a recent introduction, see the following work by Elliot (2022). *Values in Science.* Cambridge University Press.
[79] Elliott & McKaughan (2009). How values in scientific discovery and pursuit alter theory appraisal
[80] For a recent article on this discussion, see: Ward, Z. B. (2022). Disagreement and Values in Science.
[81] Elliott, K. C. (2022). *Values in science.* Pp.19-28.

A similar issue occurs when scientists face a risk of error during their research: when faced with uncertainty, non-epistemic values are needed to determine how much evidence is needed to accept or reject a certain hypothesis.[82] This often occurs during the choice of method and the interpretation of data and results, and is especially relevant in studies that test the safety of medicine, chemicals or food products. Here, the amount of evidence that is needed before one can call a product safe for human consumption depends on what level of safety is deemed 'safe enough', and can strongly vary between the public and the producing company. In addition, the required amount of evidence can also be influenced by the availability of resources for research.

Lastly, it has been observed that many concepts and categories used in scientific research contain non-epistemic values.[83] Terms like well-being, species and intelligence can be defined using different conceptual frameworks, and non-epistemic values are needed when choosing between these different conceptual varieties. Some concepts might have positive or negative connotations, while other concepts choices might have important consequences for the design and interpretation of the research. For example, when clinical trials define and measure human well-being using specific biomarkers and intermediary endpoints, positive results might be easier to achieve as when broader definitions of well-being are used that include quality of life and social well-being.

Together, these three points emphasize the necessity and importance of non-epistemic values in science, and serve as a strong objection against the value-free ideal of science. For philosopher Immaculada De Melo-Martin, this also gives reason to argue against the concept of bias.[84] Since 'bias' is defined as "a systematic deviation from the truth", it draws the attention to epistemic problems within a study and creates a dichotomy between value-laden biased science and 'true' value-free science. This dichotomy leads to two issues when analysing industry-funded science. First, when stating that a study is biased, it draws the attention to potential epistemic problems like faulty methodology and scientific misconduct, while obscuring the reality that the industry's influence often emerges through more subtle and unconscious value-laden choices made by researchers. Second, the dichotomy obscures the empirically and analytically robust finding that non-epistemic values are universally present and even necessary in good scientific practice. So, De Melo-Martin argues, it is better to reconceptualize the controversies surrounding commercialized science as a conflict between the different ethical and political values of the public and commercial organisations.[85] Consequently, it would be justified to abandon the bias concept as used by scholars from science studies and food studies discussed in the previous section, and instead adopt the value-

[82] This phenomenon has been extensively explored by philosopher Douglas. For an overview, see Elliott (2022). *Values in science.* Pp.22-28.
[83] Elliott (2022). *Values in Science.* Pp.31-34.
[84] de Melo-Martín, I. (2019). The commercialization of the biomedical sciences: (mis)understanding bias. *History and Philosophy of the Life Sciences*, *41*(3), 1-17.
[85] Several social epistemologists, such as Wiltholt and Jukola, approach this differently and attempt to include ethical values within the epistemology of a field to enlarge the concept of bias. See for example: Wilholt, T. (2009). Bias and values in scientific research. *Studies in History and Philosophy of Science Part A*, *40*(1), 92-101.

perspective.[86] Doing so should increase our capacity to understand the influence of industrial funding on the research community, and to manage its negative consequences.

Defining values: effects, attitudes and value-embedded practices

Before I continue and discuss the philosophers' proposals to manage commercial values in science, it is necessary to further examine what they mean when they use the term 'values'. Within the literature, roughly four overlapping definitions of values can be distinguished.[87] The first one focuses on what role values play within the decision-making process of the researcher, and defines values as reasons that motivate or justify a certain choice.[88] Next, values can be seen as the effects or the things that are affected by the researchers' choices.[89] For example, when a researcher chooses to exclude the reported side effects of a medicine or food product in the conclusion of a study, it could promote the commercial value of the industry while weakening the social value of public health.

The first and second definition do not specify the origin of the values and leave open how the researcher arrives at them, but the remaining two definitions commit to a more tangible concept of values. The third definition holds that values can be seen as conscious or unconscious attitudes or convictions that are possessed by researchers and cause them to make certain value-laden choices. Value-attitudes can both motivate or justify choices, but can also causally influence a decision without motivating or justifying them. The literature is not clear about how these value-attitudes develop, but implies that they are to some extent consistently held by individuals or research communities, and that they can spread and be taught through social interaction.

Lastly, values can be conceived as embedded within scientific practices. Values can be engrained within certain concepts and categories, as discussed earlier, but the literature also refers to values as embedded in methods, beliefs and even whole topics or studies.[90] What it means for a value to be embedded is not clearly defined in the literature, but can be informed by a similar discussion in the philosophy of technology. According to philosopher Langdon Winner, there are two ways in which technologies can inherently contain political values.[91] First, a technology is inherently political when its use requires the acceptance of a certain social-political condition or system, for example, when the use of nuclear power plants requires an authoritarian-technocratic system to manage the operation and safety of the plants. In scientific research, this could be the case when the use of a certain concept, method or other practice requires or contains the acceptance of certain values, like in the definitions of intelligence or well-being.

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[86] This value-based account would still offer room for the psychological mechanism of reciprocity to influence researchers, and can therefore be compatible with the unconscious bias account.
[87] Holman, B., & Wilholt, T. (2022). The new demarcation problem. *Studies in history and philosophy of science*, *91*, 211-220.
[88] Ward (2022). Disagreement and Values in Science.
[89] This use is especially clear in Elliott's work.
[90] For an example, see: Elliott, K. C. (2009). The Ethical Significance of Language in the Environmental Sciences: Case Studies from Pollution Research. *Ethics, Place & Environment*, *12*(2), 157–173.
[91] Winner, L. (2007). Do Artifacts Have Politics? In *Computer Ethics*. Routledge.

Second, Langdon argues that technologies are inherently political when they are strongly compatible with certain social or political conditions. Compatibility, he suggests, holds that the technology has a structural tendency to lead to certain social-political applications or relationships.[92] For example, when translated to the practice of nutrition research, topics and methods that focus on the limited health-benefits of single food products could be considered inherently value-laden when they consistently generate knowledge that is used to sell more of these products. This account of value-embeddedness can therefore be regarded as a variety of the effects-definition of values.

Demarcating and managing values

Although philosophers of science and values now reject the value-free ideal, this does not mean that all values in science are legitimate. To the contrary, one of the current main objectives of the field is to conceptually separate the legitimate from the illegitimate values in science, and devise strategies to promote the former ones. Some philosophers define values as appropriate only when they influence the research outcomes indirectly instead of directly, or when they align with the values of the public and other stakeholders. However, most philosophers address the demarcation problem by focusing on the actual content of the values, and have developed elaborate accounts of what they consider appropriate values for science.[93] These accounts can be based on democratic values (Helen Longino and Philip Kitcher), and values for 'socially responsible science' that answers the needs of society (Kourany), or values that serve the public interest and increase human well-being (Hans Radder).[94]

These different answers to the demarcation problem have led to a large variety of suggestions to promote legitimate or reduce illegitimate values in science.[95] Most philosophers share with the literature from science and food studies that disclosing conflicts of interests is insufficient and argue for more education in research ethics and additional transparency-focused measures. Kevin Elliot, for example, argues that researchers should make their values transparent so that they can be criticized and aligned with the social and ethical priorities of society.[96] Another strategy philosophers suggest is to stimulate engagement between researchers and their publics. This could be achieved by creating forums where researchers can engage with philosophers, civil society organisations and the public, and discuss the values that underlie the research project at hand.[97]

When considering which of these strategies work best, it is important to note that the different suggestions all depend on assumptions about what values are, and how they spread and develop. The suggestion to manage values by engaging researchers with the public and

[92] Note that Langdon only focuses on the consequences for the "form and quality of human associations" through the ways of organizing power and authority. Since my definition of values goes beyond this narrow definition of political values, I will also consider commercial and other values.
[93] Holman & Wilholt (2022). The new demarcation problem.
[94] Radder, H. (2021). *The Commodification of Academic Research Science and the Modern University* (pp. 231–258). University of Pittsburgh Press.
[95] It is beyond the scope of this thesis to discuss and select which of these concepts best describe public values, especially since most conceptualizations show large overlap.
[96] Elliott (2017). *A Tapestry of Values*. Oxford University Press..
[97] Elliott (2017). *A Tapestry of Values*. Oxford University Press.

launching educational campaigns, for example, all assume that values can be held by the research community and primarily transmitted through discussion and teaching. Although most philosophers conceptualize values as attitudes and value-embedded practices, the literature has not developed an explicit theoretical or empirical account of how these values develop and shift towards the industry's interests. The development of values is sometimes linked to (industrial) funding, but even then it is unclear how funding influences the communities' values. However, some researchers have proposed that the research communities' culture could develop through the mechanism of selection. This mechanism suggests that the values of the research community can gradually shift towards the industry's interest through the selective funding and hiring of researchers. If this mechanism is indeed relevant, many of the suggestions to manage values in science might have to be reconsidered. I therefore explore and further develop this mechanism in the next section.

2.4: Values and selection

At least two separate articles have suggested a role for selective mechanisms in the development of scientific practices. The first article that I discuss employs the 'industrial selection effect' to explain that selective funding can lead to biased research despite unbiased researchers.[98] The authors – Holman and Bruner - describe a historical case of two researchers who were convinced of the therapeutic benefits of a certain class of antiarrhythmic drugs, and who promoted the use of a surrogate endpoint to measure the efficacy of these drugs. Although there were researchers with different convictions who suggested other methods, the pharmaceutical companies who produced these drugs selectively funded the former two researchers. The industrial funding gave them the opportunity to publish several articles and organize a conference which one of the researchers was allowed to chair. While the researchers who held alternative views became occupied with teaching, other projects or had to leave academia, the two industry-funded researchers gained in academic prestige and their method was slowly accepted by the research community. Only decades later it was found that this method is insufficient and that the antiarrhythmic drugs actually increased the chance of patients dying to cardiovascular disease.

Holman and Bruner argue that in this case, the researchers were not necessarily 'corrupted' or biased through their ties with the pharmaceutical companies: they already held their views before they were noticed and funded by the industry. The industry's ability to selectively distribute their funding can therefore bias the research community on a structural level, while leaving the integrity of the researchers untouched. This phenomenon only requires that there exists a range of researchers with different methods and views from which the industry can select the most beneficial one, and a merit-based academic structure in which industry-funded researchers generate more publications and academic prestige than other scientists.

The second article, written by Smaldino and McElreath, describes how the universities' practice of selectively recruiting new researchers based on publication metrics can explain the persistence of low power methodologies in science.[99] The authors argue that misunderstanding

[98] Holman & Bruner (2017). Experimentation by industrial selection.
[99] Smaldino, P. E., & McElreath, R. (2016). The natural selection of bad science. *Royal Society open science*, *3*(9), 160384.

statistics and using bad methods with low statistical power can lead to more false positives and a higher publication rate. Since publication metrics play an important role in the hiring system of modern universities and the competition for academic positions is very high, researchers with these methods will have a significant advantage and will structurally outcompete other researchers. Consequently, they will gain in academic prestige and their methods and misunderstandings will be copied by new researchers who see the academically successful researchers as role-models. Gradually, this selective process can degrade the quality of the methods and methodological knowledge within the research community, even if new researchers are well-educated and have high standards of scientific integrity when they finish education. The authors substantiate this account by a formal evolutionary model, which has later also been used to explain the lack of risky and controversial research approaches in science.[100]

Although both the articles do not directly refer to the values-in-science literature, they clearly complement it. The authors describe methods and methodological beliefs that are strongly compatible with the interests of the pharmaceutical industry or the researchers' careers, and these practices can therefore be seen as value-embedded. In line with the description in the previous section, value-embeddedness does not require the individual researchers to intend or be aware of these values – they are after all embedded within the practices and beliefs themselves. Furthermore, it would not be unreasonable to suggest that industrial funders and universities can also select for other value-embedded practices, like topics, theories and concepts, or even the researchers' value-attitudes. Industrial funders might socialize with, and selectively fund researchers who have low integrity standards and who are susceptible to their suggestions, or researchers who hold pro-industry beliefs. In addition, universities might hire researchers based on the amounts of external funding they can secure for their department. When the industry and academia indeed selectively fund and hire researchers on these criteria, pro-industry value-attitudes and practices might gradually accumulate and spread throughout the research community.

If the hypothesis set out above – which I call the selection hypothesis - can indeed explain the development of pro-industry values in research communities, then what does this entail for how these values can be managed? The authors of both articles argue that to effectively address the negative effects of selection, most of the currently suggested measures will not work. According to Holman and Bruner, all measures that focus on the integrity of individual researchers will be insufficient since selection biases the community and not the individual. Policies that guarantee the researchers' freedom to publish or stimulate engagement with public stakeholders will also be unsatisfactory: as long as academia and the industry fund researchers using inappropriate criteria, the community remains biased. The alternative they suggest is to fund research by an alternative, independent agency based on other criteria than publication count. Similarly, Smaldino and McElreath suggest that the only way to address the negative effects of selection, is to change the incentive structure within science through institutional change. They recommend to adjust the selective pressures by assessing and hiring researchers based on qualitative criteria instead of quantitative ones. Other measures, like stricter

[100] O'Connor, C. (2019). The natural selection of conservative science. *Studies in History and Philosophy of Science Part A*, *76*, 24-29.

publication standards or education measures, might slightly reduce the effects of selection, but will still incentivize and reward scientists for having incorrect methodological beliefs and using inappropriate methods, they argue.

Conclusion

In summary, if the values and practices of scientific research are indeed shaped through selection, this will have important implications for how the industrial influence on nutrition science and other fields should be managed. Many of the measures suggested by scholars in science studies, food studies and philosophy of science might not work. Increasing the transparency of research, creating avenues for public engagement, drawing up integrity principles and organizing educational campaigns: they won't help as long as researchers are rewarded and selected for ignoring or undermining these measures. If researchers' values indeed develop through selection, far-going measures like changing the recruitment policies of universities and prohibiting industry-funded research in certain fields will be necessary. It is therefore very important to work out the mechanism of selection conceptually – and since the current accounts of selection lean mostly on formal models – explore empirically to what extent selection shapes the values and practices of research communities. For this purpose, I have developed a new integrated method composed of Robert Merton's structural functionalism and the theory of cultural selection in the following chapter.

Chapter 3: Structural selectionism: an integrated methodology

In the previous chapter, we saw that the unwanted influence of industrial funding on nutrition science can best be seen as a conflict between different commercial and public values. These values can be held by the researchers in the form of attitudes and convictions, or they can be embedded within the theories, concepts and methods of the research community. The literature on science and values suggest that inappropriate values can be replaced by public values through education, transparency measures and public engagement. However, some researchers have proposed that values develop through the mechanism of industrial and academic selection – also known as the selection hypothesis – and if this is correct, more severe institutional reforms will be necessary. In this chapter, I therefore develop an integrated method consisting of Robert Merton's sociology and the theory of cultural selection that is able to test the selection hypothesis, as well as study other sociological problems.

In the first section, I introduce Merton's structural functionalist sociology and describe how its focus on social structures and functions makes it an ideal framework for studying values in science. However, it also has one important flaw: the latent – or unrecognized – functions that Merton proposed lack a clear origin and explanation. Who or what designs these latent functions? An answer can be found in the selectionist school of the field of cultural evolution, which proposes that selective processes can lead to complex culture without intentional human design. In the third section, I develop and defend the selectionist school, and argue that cultural elements like values, institutions and scientific methods can change through selective processes similar but distinct from natural selection in biology.

Next, I argue that Merton's sociology and cultural selectionism can be synthesized into one integrated framework. Evidence from cultural evolution suggests that culture consists of interrelated elements, and can therefore help explain the existence of Merton's latent functions and validate his approach. Conversely, Merton's sociological approach can offer cultural selectionism an extensive methodology to study the relations between different cultural elements and systems. I call this methodology structural selectionism, and in the fifth section I discuss how it can formulate selectionist explanations. Lastly, I discuss some of the philosophical criticisms that have been raised against structuralism and selectionism. It has been argued against both fields that they do not account for human agency, historical contingency and social power – issues that can stifle the explanatory promises of structural selectionism. I argue that my new method can account for these issues, and then test its utility by applying it to the case of Dutch nutrition science in the next chapter.

3.1: Merton's structural functionalism

Before the selection hypothesis can be explored empirically, a concrete method is needed that can uncover the value-attitudes and value-embedded practices in academic research

communities. Within the literature on values in science, most philosophers study the values in research through textual analysis. Kevin Elliot, for example, searches studies for value-judgements: choices for certain concepts, topics or methods that are explicitly or implicitly informed by a certain value or affect a certain value.[101] Although effective, it has been noted by some philosophers that values cannot be seen independently from social institutions and research policy, and these aspects should also be included in the research of values. For example, in a review of Elliot's work, Heather Douglas calls attention to the fact that values depend upon the social relations between academic researchers as well as the institutional and cultural frameworks of research communities.[102] In a similar fashion, the selection hypothesis also suggests a relation between the values and social structure of the research community.

In order to account for this institutional aspect of values in science, I suggest to make use of Robert Merton's structural functionalism. This sociological approach studies the consistent effects – also called functions - of norms, values, organisations, beliefs and traditions within social systems. This method could incorporate Elliot's textual analysis, and expand the scope of inquiry to include analysis of the social roles of researchers, science funding policies and integrity measures. In addition, the methodological pluralism of structural functionalism offers a way to get at the values of a research community directly through the use of observational research and focussed interviews. This section lays out the theoretical foundations of Merton's structural functionalism, and discusses its sociological methodology.

Structural functionalism and Merton's postulates

Robert Merton's sociological approach was developed and regularly updated in his book *Social Theory and Social Structure* (1968), and consists of two complementary parts: structuralism and functionalism.[103] Structuralism proposes that social groups (or systems) are implicated in interrelated cultural practices that influence the social behaviour and relationships within the group. These practices include norms (including roles and regulations), beliefs and opportunities (material resources like money and power), and are seen as functionally integrated, which means that they positively reinforce each other or the cultural structure they are part of.

Each individual cultural element can have a functional, dysfunctional or neutral relationship with other elements and systems. An element can be said to have a function when it repetitively entails positive consequences for another cultural element or group, while dysfunctions point at regular negative consequences. By analysing different sources of empirical data on these patterned consequences, Merton aimed to describe the functions of cultural practices as well as the social systems they are embedded in. This allowed him to construct middle-range theories on diverse topics, like friendship and bureaucracy, which lead to workable hypotheses that can be tested through further empirical investigation.[104]

[101] See for a clear example: Elliott, K. C. (2020). Framing conservation:'biodiversity'and the values embedded in scientific language. *Environmental Conservation*, *47*(4), 260-268.
[102] Douglas, H. (2018). From Tapestry to Loom: Broadening the Perspective on Values in Science. *Philosophy, Theory, and Practice in Biology*, *10*(8).
[103] Merton (1968). *Social theory and social structure.*
[104] Merton (1968). *Social theory and social structure.* Pp.68-70.

In his sociology, Merton identified and rejected three problematic postulates that were implicit to previous versions of structural functionalism.[105] Earlier functionalists like Herbert Spencer, Bronislaw Malinowski and Emile Durkheim adhered to the idea that society can be compared to the bodies of organisms, and saw social institutions like kinship bonds and religion as the indispensable 'organs' of society.[106] Malinowski, for example, had proposed that the different parts of society work together in harmony, and that cultural elements are functional for the culture as a whole and thus for all members of society. Merton dismissed this first postulate by arguing that societies do not show this kind of functional unity. He suggested that cultural elements can have different functions with respect to different subsystems within society: some practices, norms or rules may benefit certain groups or institutions more than others. Societies are never perfectly integrated, Merton argued, and individual cultural elements can have multiple functions and even dysfunctions. Dysfunctional relations can emerge when an individual is implicated in a social system that has incompatible norms, values or other elements – something that is especially likely to happen in the case when two social systems meet. When dysfunctions accumulate, they can lead to conflict and social change – something that the earlier versions of functionalism could not account for.

The second assumption of earlier functionalists holds that all norms, beliefs, traditions and other elements have a positive or even vital function. Merton disagreed and argued that it is plausible that cultural elements exist that have no function at all, or lost their function during the course of history.[107] Lastly, Merton rejects the postulate of functional indispensability. His functionalist predecessors often suggested that societies and groups have essential functional requirements that need to be fulfilled with specific, indispensable cultural elements. Malinowski, for example, wrote that without the social order created by religion and worship, societies would not be able to persist. In contrast to this, Merton argues that the suggested indispensability of cultural elements is empirically hard to demonstrate, and that in many cases, different 'functional alternatives' can fulfil the functional requirements of a society or other social system. The cultural structure of a system might constrain and stimulate some alternative elements over others, but does not determine them.

Besides the rejection of the postulates, Merton's sociology also distinguishes itself from its predecessors by arguing that people are often not or only partially aware of the functions that are served by their actions and social institutions. He therefore makes a distinction between manifest and latent functions.[108] The consequence of a cultural element for a social system can be seen as a manifest function when the participants intend and recognize the function, while latent functions point at consequences that are not intended and unrecognized.[109] For example, most people who eat caviar and purchase expensive cars will decide to do so because they want a pleasant dining or driving experience, but when looking at the effects of these actions, one can see that they also increase one's social status and stimulate economic growth – the latent

[105] Merton (1968). *Social theory and social structure.* Pp.79-90.
[106] Bannister, R. C. (2003). Sociology. In Porter. T. & D. Ross (Eds.), *The Cambridge History of Science* (pp. 329–353). Cambridge University Press.
[107] Merton (1968). *Social theory and social structure.* Pp84-90.
[108] Merton (1968). *Social theory and social structure.* Pp114-123.
[109] Merton's distinction does not imply that functions are either clearly latent or manifest: he suggests the existence of intermediate possibilities.

functions.[110] In the case of nutrition science, an industry-funded scientists might have many epistemic and ethical reasons to use a certain method, but if the method regularly generates beneficial outcomes for the industry it will also harbour a latent function towards the industry. Latent functions thus enable the sociologist to access areas of research that lie beyond the common-sense experience of the social world, and therefore form the main interests of Merton's sociological method.[111]

Merton's disciplined method

In order to study the functions of elements and the social structures they are embedded in, Merton used a pragmatic but consistent methodology.[112] He envisioned the relation between scientific theory and empirical research as one of constant cross-fertilization, and therefore developed a disciplined research method that alternates between observation and theory. He starts with the formulation and conceptual development of a problem, based on either theoretical considerations or derived from empirical observation. Reflection on the problem at hand is necessary because problems can be based on false or biased assumptions derived from a common-sense understanding of society, he argued. In addition, the choice for a problem is not neutral, because they are always problematic from the perspective of a certain social group.[113] Next, Merton's method prescribes the stage of conceptual development: the researcher needs to develop clear concepts that are supported by empirical observations in order to develop testable hypotheses and enable useful data gathering. Third, based on preliminary data derived from observation, content analysis and secondary literature, the researcher develops a local or middle range theory that aims to describe the problem at hand in terms of functional roles, norms, institutions and other elements within a social system. Based on this theory, the researcher is then able to deduce several hypotheses.

Next, the researcher starts to empirically test these hypotheses. Merton is a methodological pluralist and suggests to choose methods based on their capacity to test the specific hypothesis at hand – a choice that is also dependent on the availability of data. Possible methods include quantitative analysis, ethnographic or guided observation, qualitative analysis of primary research material, surveys, regular interviews and so-called focussed interviews. The focussed interview is unique to Merton's sociology and is designed to test hypotheses about the functions of elements by asking non-directive questions on how the subject experienced a specific situation. The questions are non-directive in the sense that they are not asking for specific responses, but instead leave room for unanticipated responses that can confirm or refute the hypotheses. Ultimately, this methodology aims to explain and develop robust theories on the patterns and uniformities of social behaviour.

Using structural functionalism to study values in science has several advantages. First, the distinction between latent and manifest functions can help observe beyond the motivations that researchers give for making certain choices during their research process, and focus on the

[110] Merton (1968). *Social theory and social structure.* Pp123-125.
[111] Sztompka (1986). *Robert K. Merton: An Intellectual Profile* Pp.134-136.
[112] For this sub-section, I build mostly on the work by Sztompka. Sztompka (1986). *Robert K. Merton: An Intellectual Profile* Pp.93-118.
[113] Certain sociological problems do not need to be recognized by the group members and are described as 'latent problems' by Merton.

actual effects of these choices instead. This can be helpful when the given motivations are misleading, when researchers lack self-knowledge, and when the motivation does not coincide with the effects of a choice.[114] Next, since Merton's sociology focuses on the patterned consequences of cultural elements, its concept of function coincides with the effect-focused definitions of values. To recall, the effects-definition holds that values can be seen as the things that are harmed or promoted by researcher's choices, while value-embedded practices can be defined as such when they are compatible with (and thus promote) certain social or political conditions. Thus, when structural functionalist research finds that an attitude, norm, method, policy or other cultural element has a function towards a certain group or institution, it can also be described as a value or value-embedded. An additional advantage is that Merton's methodological pluralism goes beyond textual analysis and offers the opportunity to also study the social roles, norms and policies of research communities. By using ethnographic observation and focussed interviews, it can even uncover the value-attitudes of researchers directly. Merton's sociology is therefore fit to study values in research communities and other social systems.

Before Merton's sociological method can be applied to study values in science, several philosophical and conceptual issues that need to be overcome. One of the more severe criticisms is aimed at Merton's proposal that social behaviour, institutions and other cultural elements can possess latent functions.[115] In brief, the problem with latent functions is that they are hard to explain. If nobody intents or designed these functional elements – how do they come about? In the sociological literature, it is often suggested that latent functions arise and persist because of the effects they have on a social system. The commercial function of certain scientific concepts and methods in nutrition science, for example, would then be explained through the positive effects they have on the industrial funders or the researchers' careers. However, by explaining latent functions through its consequences, they appear to be self-explanatory and therefore illegitimately teleological, or even suggest that cultural practices and social systems possess goals or innate tendencies of their own accord.

To circumvent the issue of teleology, Merton and other sociologists abandoned the goal of functionalist explanation and instead argued that it is an interpretative heuristic. In order to explain the causes of latent functions, a separate historical analysis was required, they said.[116] Merton himself did not bother with this kind of analysis, and argued that he was concerned with giving structural explanations instead.[117] These accounts attempt to explain the functions of certain cultural variations by referring to how they fit with the structures they are embedded in. However, since the concept of social structure depends on the existence of latent functions, this approach was seen as a circular and problematic move, severely decreasing the scope and explanatory strength of structural functionalism.[118] A stronger solution to the problem of teleology is by offering an evolutionary explanation for the existence of latent functions. At

[114] However, when hypotheses require it, focussing on manifest functions is still useful according to Merton.
[115] Sztompka (1986). *Robert K. Merton: An Intellectual Profile* (pp.136-143).; Barnes, B. (2013). *The Elements of Social Theory*. Routledge.
[116] Sztompka (1986). *Robert K. Merton: An Intellectual Profile*. (pp.149-150).
[117] Turner, S. (2014). Robert Merton and Dorothy Emmet. *Philosophy of the Social Sciences*, *44*(6), 817–836.
[118] In addition, despite his claim that he did not use functionalist explanations, he often still referred to functions in an explanatory manner.

the time, this kind of explanation was controversial and ridden with many conceptual problems. Fortunately, recent developments in the fields of cultural evolution and philosophy of biology can offer the resources to formulate a strong response to these issues, and solve the explanatory gap that threatens Merton's sociology. In order to do so, I first discuss recent findings in the field of cultural evolution and argue that culture can develop through selective processes.

3.2: Cultural evolution and cultural selection

The suggestion that culture evolves is as old as the theory of evolution itself. In the Decent of Man (1870), Darwin already noted similarities between the evolution of species and human languages.[119] In the decades following Darwin, scholars like Herbert Spencer and Edward Tylor followed up on this idea and used evolutionary thinking in their studies of culture and human societies. However, this approach fell out of favour due to conceptual and ideological issues.[120] The evolutionary view of human society was seen as too generalist, and was used to validate conservatism, laissez-faire economic policies, nationalism, and the racist eugenic policies of Nazi Germany – all of which led to a sharp decline in evolutionary studies of human culture. More than half a century later, philosophers like Karl Popper and David Campbell dared to flirt with the idea of cultural evolution again, and developed influential evolutionary accounts of scientific knowledge.[121] However, cultural evolution remained controversial until the early nineties, when it was established as a proper scientific field.[122]

The current discipline of cultural evolution studies how social learning in humans and non-human animals like songbirds and cetaceans can give rise to transmittable artifacts, skills, norms and other forms of behaviour – or in short: culture. Much attention is paid to humans, as they strongly rely on culture for their survival and because the fidelity of their social learning is high enough to accumulate complex cultural modifications. Interdisciplinary evidence suggests that culture has also affected the genetic evolution of the human species. Besides research on culture in non-human animals and in human prehistory, there exist many subdisciplines that study the evolution of historical and modern cultural phenomena, ranging from art history to economics, media studies, linguistics and technology studies. In linguistics, for example, phylogenetic methods have been used to trace back the geographical origins of certain language groups and study the diversification of language, while evolutionary studies of religion research how competition between different religious groups can give rise to prosocial norms and large-scale cooperation in humans.[123]

Although the literature on cultural evolution agrees that culture 'evolves', there is disagreement on how deep the analogy with biological evolution runs. One school of researchers – the selectionists - defend the idea that culture itself is subject to evolution, and argue that culture exhibits the criteria to develop through natural selection. The so-called populationists,

[119] Darwin, C. (1870). The Descent of Man and Selection in Relationship to Sex. D. Appleton.
[120] Mesoud (2016). Cultural Evolution: A Review of Theory, Findings and Controversies.
[121] Bradie, M., & Harms, W. (2020). "Evolutionary Epistemology". In Zalta, E.N. (Ed.), The Stanford Encyclopedia of Philosophy. Metaphysics Research Lab, Stanford University.
[122] This can be attributed to the publication of the book on cultural evoltuion by Boyd & Richerson (1985): *Culture and the Evolutionary Process.* The University of Chicago Press.
[123] For these – and more – examples, see this edited volume: Richerson, P. J., & Christiansen, M. H. (2013). Cultural Evolution: Society, Technology, Language, and Religion (Vol. 12). MIT Press.

however, do not commit themselves to cultural selection and instead study how psychological mechanisms shape the development of culture on a populational level. Some of them, together with several philosophers of biology, have raised issues with cultural selectionism and argue that culture does not evolve through selection. If cultural selection is indeed conceptually flawed, it might not be able to explain the existence of Merton's latent functions and integrate with his structuralist theory. Furthermore, it might weaken the selection hypothesis on values in science directly. This section therefore offers an overview how the field of cultural evolution conceives of human culture, and then adopts and develops the selectionist interpretation of cultural evolution.

The evolution of human culture: an overview

Perhaps the most paradigmatic problem for the field of cultural evolution is to explain how humans and non-human animals have developed the capacity to possess culture.[124] This question is especially interesting when considering humans, since culture enabled us to cooperate in large groups with non-relatives – something that is very unlikely to happen from a biological perspective. In addition, cultural tools and institutions allowed humans to become an ecologically very successful species that can thrive in empty deserts, beyond the Arctic circle, dense cities and even survive in the Earth's orbit. The most foundational requirement for culture is biologically evolved social learning, which is the ability of vertebrates as well as many insect species and molluscs to imitate and learn from their conspecifics. If the accuracy is high enough, social learning can lead to an additional inheritance system in which organisms transmit not only genes, but also skills like tool use, migration routes and forms of social behaviour. This transmission is often from parents to offspring and near relatives, and can lead to cultural differences in local populations of whales, elephants and primates like chimpanzees.

Our early human ancestors also depended on these basic social learning skills. According to archaeological evidence, the first signs of human culture appeared more than three million years ago in the form of rudimentary stone tools.[125] However, starting around 120 thousand years ago, human culture appears to have gained in social and technological complexity, which allowed them to slowly leave the African continent and become a global ecological force. The cultural complexity increased even further in the last 12 thousand years, when the first shrines, buildings and signs of agriculture appeared. Researchers in cultural evolution often describe this relatively sudden burst of cultural prowess as a result of cumulative cultural evolution: a process where cultural modifications are stacked upon each other and lead to gradual improvement. They agree that there are at least two components to understand the emergence of cumulative cultural evolution in humans. The first one holds that cultural development and biological evolution can stimulate each other, which resulted in a feedback loop that is known as gene-culture coevolution.

[124] For an accessible introduction to the field, please see: Mesoudi (2016). Cultural evolution: a review of heory, findings and controversies, and: Henrich (2015). The secret of our success.
[125] Richerson, P., Baldini, R., Bell, A. v., Demps, K., Frost, K., Hillis, V., … Zefferman, M. (2016a). Cultural group selection plays an essential role in explaining human cooperation: A sketch of the evidence.

According to the theory of gene-culture coevolution, the presence of culture itself became adaptive and started to influence the biological fitness of early humans.[126] Evidence from primatology, palaeontology and archaeology suggest that early inventions like fire-making, hunting and food processing techniques like cooking increased the nutrition uptake and survivability of humans. Thanks to these new skills, humans developed smaller jaw muscles, a shorter gut and a diet high in energy that allowed for tripled brain size.[127] In addition, selection for tool use increased hand-eye coordination and better muscle control in human hands. Through these adaptations, ancestorial humans became increasingly reliant on cultural traditions to survive. Furthermore, researchers agree that our ancestors evolved physical characteristics that accelerated cultural evolution itself, like fine-tuned facial muscles and adjustments to the thorax that help with communication.

The second component that has been employed to understand the cumulative culture of humans, involves our exceptionally well-developed social learning abilities. Based on evolutionary models, Boyd and Richerson have shown that cultural modifications can only accumulate and be preserved when social learning is highly accurate, and when the learners are biased in who they learn from.[128] The most important transmission biases are conformity bias – where individuals copy the most common behaviour in the group – and payoff bias, where individuals copy people that show some degree of success.[129] Payoff bias is thought to be reinforced by prestige – a cultural symbol of high status that is conferred to successful individuals and so helps group members identify who to copy from. The existence of advanced social learning abilities and biases is supported by experimental studies in developmental psychology and primatology. One such a study shows that the cognitive capacities of human toddlers, adult chimpanzees and orangutangs are all very similar - except for the extraordinary ability of toddlers to imitate others.[130] In contrast to other great apes, human children as young as 18 months are known to quickly adopt social norms and rules, and cooperate from a young age without being motivated by any reward.[131]

However, the nature and origin of these social learning strategies are contested. The populationist school in cultural evolution argues that they are primarily inherited through genes, similar to many of the physical changes that have been linked to gene-culture coevolution, and see them as domain-general cognitive instincts. Several scholars from the selectionist school of cultural evolution have objected to this genetic interpretation. Although genetic evolution might have increased the cognitive abilities of humans, the social learning strategies proposed in the evolutionary models could also be culturally transmitted, they argue. Cultural evolution itself could have produced the learning abilities that lead to the accumulation of complex cultural forms.

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[126] Richerson et al. (2016). Cultural group selection plays an essential role in explaining human cooperation.
[127] Henrich (2015). *The secret of our success.* Pp.54-83.
[128] Boyd & Richerson (1988). *Culture and the evolutionary process.*
[129] Mesoudi (2016). Cultural evolution: a review of theory, findings and controversies.
[130] Herrmann, E., Hernández-Lloreda, M. V., Call, J., Hare, B., & Tomasello, M. (2010). The structure of individual differences in the cognitive abilities of children and chimpanzees. *Psychological Science*, *21*(1), 102-110.
[131] For a review of these studies, see: Legare, C. H., & Nielsen, M. (2015). Imitation and innovation: The dual engines of cultural learning. *Trends in cognitive sciences*, *19*(11), 688-699.

Observational and experimental evidence support this cultural view. Cecilia Heyes, for example, has shown that human infants are taught to imitate adults, and argues that many other 'cognitive gadgets' like pedagogical skills and the ability to infer the thoughts and feelings of others, are also culturally transmitted.[132] Many of these cognitive gadgets are enhanced by language and teaching skills, which clearly have a strong cultural component. Scholars have also raised issues with the domain-general view of social learning, and note that transmission biases involve specific, context-dependent cognitive processes instead. Alberto Acerbi has for example argued that a general prestige bias is prone to missing its target when it is too rigid: individuals might copy prestigious individuals in the wrong situations, or copy the wrong cultural forms from them.[133] Prestige bias therefore needs flexibility and additional information to make cumulative cultural evolution possible.[134]

3.3: Positioning cultural selection

In the previous section, we encountered significant disagreements between different schools of cultural evolution on the respective roles of culture and genes in human evolution. Another important point of contention is the question whether culture itself can be said to evolve. Should the 'evolution' of culture be seen as a loose analogy, or are there selective processes that can guide cultural development? In this section, I describe this distinction and further develop the selectionist interpretation of cultural evolution.

In the first chapter of his book *Cultural Evolution: Conceptual Challenges* (2015), philosopher Tim Lewens sketches a fourfold distinction within the literature on cultural evolution.[135] He starts with the historical approach, which acknowledges only a metaphorical resemblance between cultural development and biological evolution.[136] As a loose synonym for 'development', its concept of evolution does not commit to any role for populational or selectionist processes in cultural change, and its broad permissiveness does not offer us any details or tools for studying culture. A second, stronger version of cultural evolution is the populationist approach, also called the 'kinetic' approach.[137] Populationalists see cultural change as the aggregated effect of many small scale learning events on the level of individuals - which Lewens compares to the kinetic behaviour of gas particles. The populational approach is not committed to or focused on the role of selective processes in cultural development, but rather studies how biologically evolved cognitive mechanisms influence the transmission of culture. The 'evolution' component of populationist cultural evolution thus refers to the evolution of these cognitive mechanisms, and not to culture itself. Within the populationist approach, Lewens includes the Paris school, but he portrays the early work of Richerson and Boyd - the Californian school - as its main exemplar.

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[132] Heyes, C. (2018). *Cognitive gadgets: The cultural evolution of thinking*. Harvard University Press.
[133] Acerbi, A. (2019). *Cultural evolution in the digital age*. Oxford University Press. Pp.49-70.
[134] For a more severe version of this argument that argues against the use of prestige bias as a whole, see: Chellappoo, A. (2021). Rethinking prestige bias. *Synthese*, *198*(9), 8191-8212. I will discuss Chellappoo's agency-based view more elaborately in section 3.6.
[135] Lewens (2015). *Cultural evolution: conceptual challenges*. (pp.7-24).
[136] Lewens (2015). *Cultural evolution: conceptual challenges*. (pp.8-9).
[137] Lewens (2015). *Cultural evolution: conceptual challenges*. (pp.15-20).

Although Lewens sees the populationalist approach as the most promising version of cultural evolution, this thesis will focus on his third strand of cultural evolution, which he calls cultural selectionism.[138] Cultural selectionists holds that, under certain circumstances, culture develops through selective processes similar to natural selection in biology. Selectionists are therefore committed to the idea that the three key conditions of natural selection - variation, faithful inheritance of variants and their differential reproductive success – are present in culture. Lewens makes a distinction between informal and formal appeals to cultural selection. In the informal appeal, selection is used as a heuristic device that helps guide the investigation of cultural phenomena by asking questions on how variation arises and why some of these variations are selectively retained. Examples include Karl Popper's and Donald Campbell's evolutionary accounts of scientific development, as well as George Basalla's history of technology. Lewens seems to equate the informal appeal with qualitative studies, and suggests that they have much in common with the historical approach because they use selection mostly as a non-explanatory heuristic.

The formal approach on the other hand does aim for selectionist explanations. It includes the work of Mesoudi, Acerbi and Heyes, and draws a more systematic analogy between biological and cultural evolution that relies on quantitative analysis to study the evolution and spread of single cultural elements.[139] Together with some of the informal selectionists like Basalla, they argue that the fidelity of cultural transmission is high enough to enable the accumulation of functional modifications over time. A new modification might start of as recombination of earlier cultural elements by a creative individual, or arise as a random, historical accident. In many cases, the subsequent transmission of this new modification is not random, but depends on how well they fulfil certain functions with respect to their environment.

The environment of cultural elements can be split up into roughly three categories, with the first being the external environment. The development of bow and arrows, for example, is heavily dependent on the availability of crafting material, the local climate and vegetation, and the target animal it is used against.[140] The external environment can also include other cultural artifacts: the functionality of a certain skill or practice that one uses when sailing a boat depends on the form and size of the boat. Second, cultural elements can adapt to other cultural elements that have been preserved by individuals or groups at an earlier stage. For example, beliefs and other forms of knowledge are more likely to be memorized when they fit pre-existing knowledge – an effect which is described in psychology as confirmation bias.[141] Cultural elements can also become selectively adopted when they fit people's personal values and culturally-influenced preferences, as well as their social institutions. Different forms of culture can therefore become functionally dependent on each other, and form cohesive systems of functionally interrelated elements. Lastly, cultural elements may adapt to biologically evolved aspects of human cognition. A clear example is the ability of the human eye to observe certain wavelengths of red light better than other wavelengths – a psychophysical fact that has been

[138] Lewens (2015). *Cultural evolution: conceptual challenges*. (pp.11-15).
[139] For reference, see the work of Mesoudi (2016): Cultural evolution: a review of theory, findings and controversies.
[140] Mesoudi (2016). Cultural evolution: a review of theory, findings and controversies.
[141] For an example, see: Blancke, S., Boudry, M., & Pigliucci, M. (2017). Why do irrational beliefs mimic science? The cultural evolution of pseudoscience. *Theoria*, *83*(1), 78-97.

used to explain the observation that the languages of many unrelated societies independently evolved words to describe red hues, while leaving blue and yellow hues undefined.[142]

Cultural elements compete with each other for how well they fulfil functional positions across the different levels of the environment. For example, one study on love in literary history has found that this theme has convergently evolved in pre-modern societies when they adopted intensive agriculture, and prospered economically.[143] They explain this correlation by proposing that economic prosperity increases the parental investment in children, and liberates individuals from family ties. In addition, they suggest that the emergence of love could have played a role in the shaping of religious marriage and chastity norms. This example study makes clear that selectionists put specific cultural elements central to their studies, and aim to formulate selectionist explanations about their form and content. Nevertheless, selectionists agree that selection is not always relevant, and certainly not always the only relevant factor in cultural development. Elements that have less functionality than its competitors can still spread better when they are affected by coincidental historic events, or when they are attached to and piggyback along with a more successful cultural phenomenon.[144]

Although selectionists suggest a resemblance between biological and cultural evolution, there are also some important differences worth pointing out. First, cultural evolution has a faster generation time, which has allowed it to decouple from genetic evolution.[145] Next, cultural evolution is multi-layered, which means that cultural elements can compete within individuals, among individuals and among different layers of groups. Within individuals, trial-and-error learning can be seen as a selective process that helps to develop functional practices, skills and even scientific theories. Mesoudi and his colleagues describe the example of Watson and Crick, who repeatedly constructed possible models of DNA until they stumbled upon the double helix structure.[146] Cultural elements can also compete among individuals when they selectively adopt varieties based on their functionality, and among groups when similar cultural systems compete for followers or resources.

Third, cultural evolution shows more interchangeability than biological evolution: A biological species cannot transmit its trait to other species, but in cultural evolution, individuals are able to non-randomly recombine ideas from different origins.[147] A religion might adopt certain management or communication strategies from governments, while companies can adopt or foster certain religious values. A difference with biology that might allow for these recombinations is the lack of replicators in culture. Cultural replicators – called 'memes'- are hypothetical entities that replicate cultural forms in a fashion similar to the gene. Memetics, as this selectionist approach is called, is considered by Lewens as the fourth strand of cultural

[142] Deutscher, G. (2010). *Through the language glass: Why the world looks different in other languages*. Metropolitan Books.
[143] Baumard, N., Huillery, E., Hyafil, A., & Safra, L. (2022). The cultural evolution of love in literary history. *Nature Human Behaviour*, *6*(4), 506-522.
[144] This will be discussed in more detail in section 3.5
[145] See the end of section 3.2 for a more elaborate discussion.
[146] Mesoudi, A., Whiten, A., & Laland, K. N. (2004). Perspective: Is human cultural evolution Darwinian? Evidence reviewed from the perspective of The Origin of Species. *Evolution*, *58*(1), 1-11.
[147] Mesoudi, A., & Thornton, A. (2018). What is cumulative cultural evolution? *Proceedings of the Royal Society B*, *285*(1880), 20180712.

evolution, and he includes Richard Dawkins and Daniel Dennett among those who are committed to the idea of cultural replicators.[148] However, evolutionary models have shown that replicators are not necessary for cultural evolution, and up until know, it is unknown what these hypothetical entities are and how they would operate on a cognitive or neurobiological level.[149] Many selectionists do therefore not appeal to memes or other replicating entities in their studies, and in this thesis I do also not take up this view.

Throughout the first two chapters of his book, Lewens refers to several counterarguments against cultural selectionism. He notes that philosophers of biology have argued against the idea that culture possesses the three ingredients required for natural selection, and raises several complications for the possibility of selectionist explanations of culture. Before I address these criticisms, I first describe how functionalism and selectionism fit together and argue for their theoretical and methodological integration in the next section.

3.4: Synthesizing selectionism and structuralism

Besides the dated views of Herbert Spencer and his contemporaries, there are several modern-day scholars who have proposed to use evolutionary theory within social research. In the nineties, sociologist Walter Runciman proposed a 'selectionist sociology' in which sociologists could generate selectionist hypotheses about cultural phenomena.[150] More recently, scholars like Tibor Rutar and Jonathan Turner have suggested that the field of cultural evolution has much in common with sociology, and argue that selection can help with some of the theoretical issues within functionalism.[151] However, evolutionary approaches in current day sociology do not receive much attention, and most of this literature sticks to theoretical discussions. In addition, the authors in evolutionary sociology do not specifically aim to use Robert Merton's structural functionalist approach.

There are nevertheless sufficient reasons to synthesize structural functionalism and cultural selectionism. First, to study the selection hypothesis on values in science – which asks to what extent values in science develop through selective processes – one needs a method that can both study the (functional) content of values, as well as their origins. A methodological synthesis between Merton's sociology and selectionism would fit this goal.[152] Next, and on a more general level, the fields of structural functionalism and selectionism both contain their own internal needs and consistencies that point towards a methodological synthesis. Within this section, I explore these characteristics in further detail and describe how they enable integration between these two fields.

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[148] Lewens (2015). *Cultural evolution: conceptual challenges*. (pp.12-15).

[149] Mesoudi (2016). Cultural evolution: a review of theory, findings and controversies. *Evolutionary biology*, *43*(4), 481-497. See also the evolutionary model of Bourrat (2014): From survivors to replicators: evolution by natural selection revisited. *Biology & Philosophy*, *29*(4), 517-538.

[150] Chattoe, E. (2002). Developing the selectionist paradigm in sociology. *Sociology*, *36*(4), 817-833.

[151] Turner, J. H., & Machalek, R. S. (2018). *The new evolutionary sociology: Recent and revitalized theoretical and methodological approaches*. Routledge.; Rutar, T. (2021). Sociological limits and prospects of contemporary cultural evolutionary theory. *Journal for the Theory of Social Behaviour*, *51*(4), 636-653.

[152] In section 3.1, it is argued why Merton's sociology would be suitable to study values in science.

Cultural evolution benefits from structural functionalism

As noted in the previous section, cultural evolutionists propose that culture consists of many interrelated elements that can form dynamic systems. Nevertheless, most of contemporary research in cultural evolution – as well as in the school of cultural selection – leans on mathematical models and quantitative methods to focus on isolated aspects of culture. Populationalists study how single transmission biases shape culture on a population-wide level, while selectionists often study the development of single cultural elements – two approaches that are both susceptible to critique of reductionism. As a result, researchers like Andrew Buskell and colleagues have argued that the field needs a system-based approach.[153] Such an approach should be able to study the relations between different cultural elements and systems, and be better suited to deal with the complexities of social reality and historical details.

Fortunately, Robert Merton's structural functionalism can offer cultural evolution with such a systems-based approach. As can be seen in section 3.1, Merton's sociology also sees culture as consisting of elements that can have multiple functions towards each other, and form cultural structures. However, unlike cultural evolution, Merton also offers an elaborate sociological methodology to study these functional relations and systems. This disciplined approach can help cultural evolution to discover interesting problems, develop local theories and hypotheses, and offer a wide range of effective methods to study these hypotheses. The field of cultural evolution can therefore strongly benefit from adopting Merton's sociology.

Cultural selection substantiates structural functionalism

Reversely, the theory and evidence within cultural selectionist literature can substantiate Merton's sociology by supporting its ontological view of reality with its emerging body of empirical evidence. In line with Durkheim and other structural sociologists, Merton suggested that societies possess a specific social subject matter or social reality.[154] This social matter consists of the structural regularities that emerges from the actions and behaviour of people, and possesses a certain consistency. Emergence, in this sense, implies that this social matter contains something more than just the aggregate of human behaviour. Cultural elements like norms, roles, institutions and beliefs can therefore be studied as real entities that can hold needs and functions, and which cannot be reduced to the behaviour of individuals.[155]

This ontological view, also called social or structural realism, can be supported by evidence from cultural selection. Selectionist researchers observe that the complexity of culture requires it to develop through a gradual accumulation of modifications.[156] Languages, values, technological artifacts and other cultural phenomena are too complex to be invented by single

[153] Buskell, A., Enquist, M., & Jansson, F. (2019). A systems approach to cultural evolution. *Palgrave Communications*, *5*(1), 1-15.
[154] Sztompka (1986). *Robert K. Merton: An Intellectual Profile*. (pp.123-126, 159-161).
[155] In this sentence, it is suggested that culture consists of real entities that can hold certain properties, but this does not mean that I commit to any view on what these entities are formed of. Some cultural evolutionists implicitly or explicitly state that culture consists of 'memes' or information, but I would like to suggest that more cognitive and neuroscientific research is needed to make a claim about this. For now, it is sufficient to accept that culture can contain a certain historical consistency that can be traced and investigated.
[156] Mesoudi (2011). *Cultural evolution: How Darwinian theory can explain human culture and synthesize the social sciences.* (pp.2-24). University of Chicago Press.

individuals and require many generations of people to develop. Cultural evolution therefore regards culture as consisting of entities that are the result of long-term historical processes, and that possess their own evolutionary trajectory that can be investigated.

Next, research on cultural selection can also help structural functionalists account for the existence of latent functions. As described at the end of section 3.1, latent functions are seen as a weakness of Merton's sociology since they are hard to explain without using teleological or selectionist reasoning. However, observational research by cultural selectionists also suggests that culture possesses latent functions, and they naturally choose selection as the way to explain them. Anthropologist Joseph Henrich has for example used selection to explain the complex process of cassava preparation in Amazonian societies.[157] Before consuming cassava roots, Amazonian people first scrape, wash, separate and boil them, which reduces the amount of toxic cyanide that they contain and helps prevent these people from slowly becoming ill. However, Henrich observed that these people do not know why this process is needed or how it works, despite it having a clear function for them. He then argues that this complex processing ritual has probably developed through cultural selection, since the Amazonians appear to have been selectively copying the practices of the healthiest members within their society.

The previous example illustrates that people do not need to understand how or why a certain cultural element functions: the only requirement is that it is (selectively) copied. This lack of causal understanding is referred to as the 'causal opaqueness' of culture, and cultural selectionists use an expansive body of literature from developmental psychology and other behavioural sciences to argue that causal opaqueness is a pervasive aspect of human culture. To illustrate, in one study it is shown that when children have to copy an adult in conducting an instrumental task, they tend to imitate actions that appear causally irrelevant to the goal of this task – also called overimitation.[158] Developmental psychologists and selectionists point out that within the same experimental setup, chimpanzees and other primates do not copy these unnecessary actions.[159] It has been suggested that overimitation can help humans copy functional norms, rules and values – cultural elements that do not contain an obvious instrumental or causal goal.[160]

The existence of causal opaqueness has also been suggested in an experimental study with adult humans.[161] In this study, a chain of participants optimized a physical system (a rolling wheel with adjustable weights) using individual trial-and-error learning as well as the results of the previous participant. It was found that participants at the end of the chain achieved better results, without increasing their causal knowledge about how the physical system worked. The authors of this study and other selectionists therefore argue that complex cultural phenomena

[157] Henrich, J. (2017). *The secret of our success: How culture is driving human evolution, domesticating our species, and making us smarter*. (pp.97-99). Princeton University Press.
[158] An overview of this literature can be found here: Legare, C. H., & Nielsen, M. (2015). Imitation and innovation: The dual engines of cultural learning. *Trends in cognitive sciences*, *19*(11), 688-699.
[159] Henrich (2015). *The secret of our success.* (pp.13-17).
[160] Hoehl, S., Keupp, S., Schleihauf, H., McGuigan, N., Buttelmann, D., & Whiten, A. (2019). 'Over-imitation': A review and appraisal of a decade of research. *Developmental Review*, *51*, 90-108.
[161] Derex, M., Bonnefon, J. F., Boyd, R., & Mesoudi, A. (2019). Causal understanding is not necessary for the improvement of culturally evolving technology. *Nature human behaviour*, *3*(5), 446-452.

– especially social institutions - can evolve without people being aware of how or why they work.[162]

Although the concepts of causal opaqueness and overimitation need more empirical testing and conceptual development, they at least point towards a strong theoretical compatibility between cultural selection and Merton's structural functionalism. After all, the concept of causal opaqueness lies very close to Merton's latent functions. In addition, the empirical work that has been done until now does suggest that cultural knowledge and skills can spread and gradually change through selective imitation. Even though this does not prove that cultural elements with latent functions are ubiquitous in modern day society, it does suggest that they can exist and that they could be explained as the result of selective processes.

The cultural view of science

Lastly, it is important to note that both cultural selection and structural functionalism share a view of science as a deeply social and cultural enterprise. In his sociological work on science, Robert Merton rejects the heroic-inventor myth of science and argued that scientific knowledge develops only gradually, thanks to a wide set of social institutions. His PhD thesis, for example, defended the idea that the ethics and values of Puritanism contributed to the emergence of science in the early modern period.[163] In addition, he argued that science depends on methods of communication, institutionalized criticism, clearly differentiated roles, and an elaborate reward system based on references, awards and honorary degrees. Literature from cultural evolution suggests a similar view of science. In one article, it is argued based on cognitive research that human minds tend to be too biased and ill-suited for scientific research.[164] Instead of mere individual rationality, the authors argue that science rests on a complex conglomerate of educational, social, economic and political arrangements, as well as measures that secure criticism, an elaborate educational system, and inventions like the printing press and mathematical symbols. Both fields therefore show a strong overlap in their view of science. In addition, this view also appears to coincide with much of the philosophical literature on values in science discussed in section 2.3 of this thesis.

To conclude, cultural selection and Merton's sociology are not only mutually supportive but also share a distinctive view on science and the ontology of social reality. Together, these arguments make it plausible and attractive to integrate these fields into a new methodology, which I call structural selectionism. This name indicates that selection happens on multiple levels and leads to the emergence of cultural structures, and also implies that cultural phenomena are selected based on how their functions fit existing structures. In the next section, I discuss how structural selectionism can formulate explanations of cultural phenomena.

[162] Despite this conclusion, most authors admit that causal knowledge can still help with understanding and developing new cultural innovations. Henrich for example argues that causal knowledge often evolves in tandem with technological innovations, and that this causal knowledge is essential to modern scientific advancement. Henrich (2015). *The secret of our success.* (pp.372-375).
[163] Sztompka (1986). *Robert K. Merton: An Intellectual Profile*. Pp.67-70.
[164] McCauley, R. N. (2013). Scientific Method as Cultural Innovation. In *Cultural Evolution* (pp. 175–192). The MIT Press.

3.5: How to formulate structural selectionist explanations?

In order to integrate Merton's sociology and turn it into something more than a mere heuristic, structural selectionism should be able to formulate explanations of cultural elements with (latent) functions.[165] The aim of such an explanation is to explain the spread of certain cultural elements - like values or artifacts - through the functions they serve towards social structures as well as other elements. These functions are often latent, but not necessarily so. Since the spread of elements depends on both its functions and the structures they interact with, structural selectionist explanations aim to offer knowledge about the role of both functions and structures in the spread of specific cultural elements. Now that the explanatory aims of structural selectionism are clear, we can ask ourselves how to actually formulate such an explanation.

To start, it is important to note that since the eighties, the role and importance of selection in biology has been heavily discussed. Adaptationist explanations were readily proposed and accepted by biologists before that time, but this came to a halt when philosophers of biology – most notably Stephen Gould and Richard Lewontin – started to criticize them.[166] They argued that the role of selection in adaptation was smaller than originally thought due to the important roles of specific historical factors. A function might for example emerge long after the initial evolution of a trait – called exaptation.[167] Although many bird species achieve flight thanks to their feathers, the fossil records show that feathers have already been around long before birds' predecessors could fly. Thus, to explain the origin of feathers in a bird species, it does not suffice to describe their function for flight. Next, some traits might spread not because they serve a certain function, but because they are attached to another trait that does – or they spread because of contingent historical accidents or genetic drift. The latter especially tends to happen during environmental changes and disasters, when a random part of a population gets wiped out, and in small isolated populations in which differential reproduction is more susceptible for random incidents instead of selection. Lastly, the evolution of an organism's traits can be constrained by its evolutionary past, which can lead to the preservation of functionless, vestigial traits like the small legbones found in many whale species.

It appears that structural selectionism can account for such complications, as Robert Merton and selectionist authors have described similar instances in their studies of culture. Merton's account of the Puritanist values and ethics that enabled the development of pre-scientific scholarship in the early modern period, can for example be seen as an example of exaptation.[168] In addition, functionless elements that are vestigial or have spread by attaching to other elements are described by Merton's functionalist postulates. The existence of piggybacking and vestigial elements are even more explicitly discussed and described within the selectionist literature. Cultural vestiges have been described in language, where letters that lost their phonetic significance are still used in written form, and in technological artifacts like the QWERTY-layout of keyboards, which once prevented the jamming of keys in old

[165] To recall, in order to synthesize with Merton's sociology, cultural selectionism needs to be able to account for and explain latent functions – the main weakness of Merton's method.
[166] Gould, S. J., & Lewontin, R. C. (2020). The spandrels of San Marco and the Panglossian paradigm: a critique of the adaptationist programme. In *Shaping Entrepreneurship Research* (pp.204-221). Routledge.
[167] Sterelny, K., & Griffiths, P. E. (2012). *Sex and death: an introduction to philosophy of biology*. (pp.217-250). University of Chicago press.
[168] Please see section 3.1

typewriters.[169] Similar to genetic drift in biology, contingent historical events in culture can favour the spread of an element even though it might be less adaptive than its competitors.[170] It is argued that this is more likely to happen when culture spreads over a short duration or population, and when different varieties fulfil the exact same functions, which reduces the effect of selection on their differential reproduction.[171]

With this abundance of historical factors, how is it still possible to arrive at a valid selectionist explanation? According to philosopher Kim Sterelny, contemporary biologists develop such an explanation in roughly two ways.[172] The first is to infer an argument to the best explanation using adaptive thinking and reverse engineering. Adaptive thinking involves predicting how the current structures and behaviours of an organisms relate to its environment and ecological challenges, and is then followed by a functionalist study on whether these relations indeed exist. Next, the biologist tries to reverse engineer what kind of historical circumstances could have led to the evolution of these functional structures and behaviours. This involves proposing many historical statements on for example when a specific trait first emerged, what varieties of the trait existed at the time, and in what environmental and ecological circumstances this occurred.

Since the fossil record and other historical sources are limited, many of these proposed historical statements cannot be tested. Nevertheless, explanations that use these statements are still accepted when they form the best or only explanation for a certain trait. Although this way of reasoning can work, it is seen as a crude method that cannot deal with more detailed evolutionary questions. The evolution of the human brain has for example become subject of many theories and explanations that are hard to evaluate since there is insufficient historical evidence.[173] Sterelny, as well as most contemporary evolutionary biologists, therefore prefer to use the comparative method.[174] Here, biologists investigate whether a certain structure or behaviour evolved convergently in different species that faced similar environments, like the flying membranes that have convergently evolved in both the marsupial sugar glider and the (mammal) gliding squirrel. In addition, the biologist can make phylogenetic comparisons in which they compare species who share a common ancestors for similarities, and crosscheck this with their environmental and ecological situations.

When changing the subject matter of this discussion from biological to culture phenomena, it appears that the comparative method has limited use. Culture is easily re-combinable and interchangeable, which makes it hard to find certain cases of convergent evolution – especially in a globalized modern world. For these same reasons, it is quite rare to find clear 'phylocultural' trees that can be used for studies that compare cultural elements with a common

[169] Mesoudi (2011). Cultural evolution.
[170] I will discuss contingency more elaborately in sections 3.5 and 3.6.
[171] Mesoudi, A., & Lycett, S. J. (2009). Random copying, frequency-dependent copying and culture change. *Evolution and Human Behavior*, *30*(1), 41-48.
[172] Sterelny & Griffiths (2012). *Sex and death.* (pp.234-250).
[173] Consequently, there might be a large role for value-laden background assumptions to play a role in deciding between these theories.
[174] This is for example also argued by Godfrey-Smith and Wilkins: Wilkins, J. F., & Godfrey-Smith, P. (2009). Adaptationism and the adaptive landscape. *Biology & Philosophy*, *24*(2), 199-214.

ancestor.[175] When studying a certain functional element in British nutrition science for example, it might not prove useful to see whether similar elements have evolved in the pharmaceutical sciences or another country's nutrition science, since they are likely to have influenced each other. Instead, it might prove more useful to apply the first method of adaptive thinking and reverse engineering. While in biology historical sources are scarce, human culture has left us plenty of historical sources that can be used to test theories on how certain functional elements evolved. To take the example of nutrition science again: if one proposes that certain functional elements have evolved in nutrition science, one should expect that these elements only have spread after the selective practices of the industry and academia took hold.

Consequently, if structural selectionism is to develop explanations of functional cultural elements, it has to add a historical component to its methodology. Although Merton did factor in historical development, he never made history a standard part of his sociology. For structural selectionism however, I suggest to add a historical dimension to the development of the middle range theory and the hypotheses that are drawn from it. To recall, the middle range theory aims to describe a sociological problem in terms of functional roles, norms, institutions and other cultural elements within a social system. Now, instead of offering only a theory of the current state of the cultural problem, the middle range theory should also include suggestions on the history of the structures and functional elements it tries to explain. In the case of nutrition science for example, the theory should not only contain statements on what values there are and how they relate to certain social systems, but also how selective processes as well as contingent historical facts have led to the emergence of these values.[176] Before structural selectionism can be put to use and formulate explanations, there remain several conceptual challenges that have to be overcome. I discuss these challenges in the following section.

3.6 The challenges of structural selectionist explanations: contingency and agency

Philosophers and other scholars have for long contested evolutionary and structuralist approaches to human cultural phenomena, and this is not different in the present. In this section, I discuss the two arguments against cultural selectionism that have had the most impact in the literature on these topics. The arguments hold that (1) historical contingency and (2) human agency make selectionist explanations of culture either theoretically impossible or negligible due to their lack of explanatory power. In response, I argue that historical contingent factors and agency do not disable, but are instead compatible with and can complement selectionist explanations. Furthermore, I argue that depending on the research question that is asked and the specific explanatory context, selectionist explanations can have more explanatory power than historical or agent-based accounts.

The challenges that are discussed within this section can be divided into roughly two categories. In the first category, philosophers argue that due to theoretical reasons, selectionist theory does

[175] Methods similar to the phylogenetic comparative methods have been used however in linguistics and archaeology. See: Richerson et al.(2016). *Cultural group selection plays an essential role in explaining human cooperation.*

[176] Note that contingent historical facts are therefore included within the theories and explanations of structural selectionism.

not have the ability to form valid explanations of culture at all. I define these arguments as arguments against the explanatory capability of (structural) selectionism. Other philosophers, however, do accept that selectionist explanations can be formed, but argue that the explanatory power of these explanations is lower than conventional or existing explanations. Explanatory power is in these cases often taken to be the likeliness of an explanation to be true, given the total amount of empirical evidence. However, for accurately gauging these claims about explanatory power, it is necessary to develop the concept of explanatory power in further detail.[177] For this purpose, I adopt the interventionist framework of causation and explanation developed by James Woodward.

According to Woodward's interventionist theory of causation, X can be said to cause Y if (and only if) manipulating X in the right way leads to a change in Y.[178] Furthermore, this intervention needs to cause Y to change directly via X, and not via another route. Woodward uses this account of causation to develop his theory of counterfactual explanation, which holds that a good explanation remains stable when interventions are used to test the causal relations it proposes. Testing is done by asking counterfactual what-if questions about what happens to the explanandum Y when one manipulates its explanans X. If explanation A can answer more what-if questions than explanation B, the former explanation will offer more information that is explanatorily relevant and can therefore be seen as having more explanatory power.

Since it is hard to flat-out compare the amount and importance of the what-if questions between different explanations, Jan Baedke and his colleagues have suggested to focus on explanatory standards instead - the values that researchers hold as standards of good explanations.[179] Due to the scope of this thesis, I will not go into full detail and first only introduce three of them: precision, non-sensitivity and idealization. The precision of an explanation consists of the amount of detail that is offered in both the explanans and the explanandum, and is often traded off by researchers against the non-sensitivity of an explanation: the ability of the explanation remain stable when the background conditions change. Next, idealization refers to the standard of generalizing the details of an explanation in order to grasp complex phenomena – a standard that aligns with non-sensitivity but often conflicts with the standard of precision. By comparing the ways in which two explanations fit these standards, a researcher can decide on what basis one explanation has more power than the other. This decision is heavily informed by the explanatory context of these explanations: within some research questions and scientific problems, precision might for example be more important than non-sensitivity or generalizability.

Contingency and social power

Now that the concepts of explanatory capability and power have been clarified, we are equipped to deal with the challenges raised against cultural selectionist explanations. The first challenge is that of contingency, and holds that history contains too many particular and unique

[177] Since it is beyond the scope of this thesis to thoroughly review and discuss the philosophical literature on scientific explanations, I will only offer a brief review of this field's theory here.
[178] Woodward, J. (2005). *Making things happen: A theory of causal explanation*. (pp.94-102). Oxford university press.
[179] Baedke, J., Fábregas-Tejeda, A., & Vergara-Silva, F. (2020). Does the extended evolutionary synthesis entail extended explanatory power?. *Biology & philosophy*, *35*(1), 1-22.

factors to be subjected to evolutionary explanations – especially when history is influenced by powerful individuals. An elaborate version of this argument can be found in an article by Lewontin and Fracchia, where they use it to argue against Runciman's selectionist sociology.[180] Their argument is mostly aimed against the explanatory power of cultural selection, and can be split up into roughly three versions.

The first version of their argument holds that evolutionary explanations of culture cannot account for non-selective historical accidents like plagues and natural disasters. In many cases, these events cannot be neglected because they are exactly what is of interest to the historian, the authors argue, and as an example they describe the important role of transmittable diseases in the European conquest against native American people. However, as proposed in section 3.5, selectionist explanations of biological phenomena and culture are both capable and required to account for such historical accidents. The evolution of life on remote islands can for example be very vulnerable to historical accidents. If through a storm or flooding one pregnant individual from a predator species becomes a castaway and manages to reach the island, its offspring could significantly alter the island's ecology. In addition, diseases and geological processes can also significantly change or isolate populations, having long term effects on the evolution of species. Testable statements on contingent historical facts can therefore be essential in the evolutionary explanations of traits in certain species. Similarly, structural selectionism should also propose and test contingent historical facts if found necessary, or encounter and include them later in the research process.

Next, Lewontin and Fracchia argue that history develops through decisions and ideas that are made by historically and culturally situated individuals that would be stripped from their intentions and unique particularities if one would apply evolutionary methods.[181] Evolutionary approaches would thus illegitimately reduce the history of individuals to general trends. Structural selectionism could respond by stating that it generally does not aim to explain an individual's decisions and ideas, but aims to investigate the selective dissemination of these ideas and other cultural elements. The initial emergence of an idea might indeed be a very specific result of individual deliberation combined with a certain cultural environment, like the authors claim, but the spread of the idea ultimately depends on its environment. In a small population, one or several contingent events can strongly steer the dissemination of cultural elements towards one direction or another. However, when a cultural element spreads over a longer duration and population, the number of contingent events increases and start to cancel each other out. This, in turn, leaves more room for structural selective factors to guide the dissemination and development of the element.

Furthermore, structural selectionists could respond to this argument by emphasizing the importance of path-dependency in cultural development. Lewontin and Fracchia suggest that the uniqueness of historical events will also lead to unique consequences in the present and future, which defeats the purpose of trying to develop general statements on the evolution of culture. However, when looking at evidence within anthropology, linguistics and other social sciences, it appears that culture often shows structural regularities that beg for explanation.

[180] Fracchia, J., & Lewontin, R. C. (2005). The price of metaphor. *History and Theory*, *44*(1), 14-29.
[181] Fracchia & Lewontin (2005). The price of metaphor.

Plenty of telling examples can be found in pre-Colombian Meso-America, where several societies evolved a rich cultural diversity that shows structural similarities with those of Eurasia and Africa.[182] Independent from the rest of the world, the Aztecs and Maya developed a writing system, complex bureaucracies, religions, and a hierarchical class system. These similarities suggest that there is a certain sense of path-dependency in the cultural structures that are likely to evolve when civilizations develop.[183] This path-dependence, in turn, can be seen as evidence that culture actually shows certain structural regularities and characteristics that are worth investigating.

The third version of Lewontin and Fracchia's argument revolves around power.[184] They argue that unlike biology, cultural development can become heavily influenced by single individuals that have amassed large amounts of political or social power. As an example, they suggest to look at the influence of Adolf Hitler on Germany's fascist ideology, the Nazi party and the Second World war as a whole – and argue that if Hitler would have died an early death, these cultural phenomena and events would have played out very differently. Structural selectionists could respond to this by first nuancing the role of leaders in culture development. Humans do not randomly end up in powerful positions, but struggle with competitors or are selected based on very specific requirements. Consequently, when someone ends up in a powerful position, he or she also has to behave according to the cultural role that this society assigns to it.[185] Some selectionists like Joseph Henrich therefore argue that people tend to overestimate the power of rulers over the masses.[186] In addition, structural selectionism could respond by again emphasizing that it studies not the individual, but the cultural elements themselves and their dissemination. The life of Hitler is full of contingent details, but the spread of his ideology over a large population still depends on how well it fits with the existing ideas, problems, norms, institutions and other cultural characteristics of this population at that time.

A complete explanation could therefore include both historical evidence on how Hitler's ideas emerged and how he tried to spread it, as well as a selectionist account of what functional relations with other cultural elements and structures increased their spread. In this sense, the historical and the selectionist approaches can complement each other: they have the potential to be compatible.[187] I define explanatory compatibility as a situation in which two (or more)

[182] Boyd, R., & Richerson, P. J. (1992). How microevolutionary processes give rise to history. *History and evolution*, 179-209.
[183] Note, however, that this does not mean that culture is determined by this path-dependency. Instead, it would be better to speak of selection constraining the possible cultural phenomena by cancelling out a wide range of elements and structures that do not spread well. Within these constraints, cultural development can develop in an open-ended fashion guided by historical contingency.
[184] Fracchia & Lewontin (2005). The price of metaphor.
[185] In the example of Hitler, it has been noted by historians such as Ian Kershaw and Hans Mommsen that structural characteristics of the Nazi regime – like bureaucratic power struggles and the social hierarchy within the Nazi elite – have played an important role in the Holocaust. Kershaw, I. (2018). „Cumulative Radicalisation "and the Uniqueness of National Socialism. In *Von der Aufgabe der Freiheit* (pp. 323-336). Akademie Verlag.
[186] Henrich (2020). *The WEIRDest people in the world.*
[187] I define explanatory compatibility as a situation in which two (or more) explanations offer information on different aspects of the same topic or problem without contradicting each other. These explanations can and use different disciplinary angles to do so, and can be compatible as long as their explananda focus on a different aspect of the topic, and their explanations (explanans as well as explanandum) contain no conceptual or empirical disagreements.

explanations offer information on different aspects of the same topic or problem without contradicting each other. These explanations can use different disciplinary angles to do so, and can be seen as compatible as long as their explananda focus on a different aspect of the topic, and their explanations (explanans as well as explanandum) contain no conceptual or empirical disagreements. When two explanations have explananda that near each other's content, and are thus attempting to explain the same problem or topic, the likelihood that they are incompatible increases. After all, their explanatory content will have more overlap. When this happens, researchers might raise questions about their explanatory power: which explanation has the most power – and based on what explanatory standards?

In sum, the three arguments by Lewontin and Fracchia all point out that history contains specific details that are hard to cover using selectionist explanations. In terms of explanatory standards, they appear to highly value precision while attaching less importance to the standards of non-sensitivity and idealization. The selectionist, on the other hand, points out that there are many regularities and patterns in culture that might be fit for explanation and they seem to value the standards of non-sensitivity and idealization more than precision. Which of these two approaches – the historical or the selectionist - has the most explanatory power cannot be answered on the abstract level and ultimately depends on the available evidence, context and the research question of specific cases. However, it appears that when asking questions about specific historical events that involve the actions of (powerful) individuals, the historical emphasis on precision is more important and historical explanation have more explanatory power, while questions about the regularities between cultural phenomena or the spread of cultural elements seems to require selectionist standards and explanations. Despite the prevalence of contingent factors in human history, it is therefore still possible for selection to develop powerful explanations.

Agency

In their article, Lewontin and Fracchia also argue that culture cannot be approached through evolutionary methods because it is the product of conscious deliberation. This can be considered as one of the many variations of the agency argument – a problem that has pervaded both cultural evolution and structural functionalism.[188] Philosophers have argued against both theoretical frameworks that they either neglect agency, or that human agency denies them the ability to formulate explanations. Because there are many variations of this argument, I have categorized them within three categories, starting with the argument on non-random variation.

According to Lewontin and Fracchia, culture cannot be approached through evolutionary methods because cultural variation is the product of conscious deliberation – and not random like biological genetic mutations.[189] Philosopher Steven Pinker argues in a similar fashion that non-random variation cancels out any possibility of natural selection in culture – and therefore sees selection as having no explanatory capability.[190] However, several other scholars have argued that these arguments do not hold. In his discussion of Pinker's position, Joseph Henrich

[188] The concept of agency or intentionality holds that an organism – in most cases a human - can act or operate on its own accord, according to its own interests.
[189] Fracchia & Lewontin (2005). The price of metaphor.
[190] Pinker, S. (1997). *How the mind works* (Vol. 524). Norton: New York. Pp.209.

has stated that selection can still act on variants when they are produced non-randomly: selection can occur in all cases where there is a heritable variation that leads to a different rate of transmission.[191] Similarly, Godfrey-Smith notes that most accepted definitions of natural selection do not require variation to be random.[192] In a paper by Mesoudi et al., the authors reverse the discussion and note that much of the variation in biology can also be seen as non-random.[193] Since variations in species are constrained by their developmental and historical constraints, they are to a certain degree directed – although not by a specific agent. This argument can be supported by recent research into evolutionary biology, which has found that epigenetics and the physical characteristics of genes in plants can severely limit the mutation frequency in specific regions of the genome.[194]

Having dealt with variation, the second argument addresses one of the other key requirements of natural selection: high-fidelity inheritance. According to philosopher Peter Godfrey-Smith, cultural inheritance is too dissimilar from biological inheritance – effectively disabling the ability of cultural selectionist approaches to formulate valid explanations.[195] He first describes how biological inheritance creates patterns of heredity like asexual lineages or family trees. Within these lineages, the parent or parents are causally responsible for their offspring's similarity. In culture however, people themselves are causally responsible for actively copying and practicing cultural phenomena, and are constantly transforming and modifying it. People can integrate cultural elements from multiple sources, and customize them based on their own interests, which erases the causal parent-offspring relation according to Godfrey Smith: "… once general intelligence intervenes in such a way that a vague and disparate set of models all make blended and customized contributions … the Darwinian pattern is lost."[196] He thereby refers to Lewontin and Fracchia, who have argued that the passage of culture can only be studied when they can be contained in simple transmission models.

In response, structural selectionists can first address Godfrey-Smiths emphasis on the extra causal factor that is added to cultural development through individual reproduction and modification. Against this kind of argument, Acerbi and Mesoudi have responded that cultural reproduction is compatible and even necessary for selection to work.[197] They argue that without the active role of agents in copying and modifying cultural elements, successful new varieties would hardly emerge and the fidelity of cultural transmission would be far too low to effectively accumulate modifications. Intentional transformation of culture is therefore necessary to create stable varieties on which selection can act. One could compare this with the

[191] Henrich, J., Boyd, R., & Richerson, P. J. (2008). Five misunderstandings about cultural evolution. *Human Nature*, *19*(2), 119-137.
[192] Godfrey-Smith, P. (2007). Conditions for evolution by natural selection. *The Journal of Philosophy*, *104*(10), 489-516.
[193] Mesoudi, et al. (2004). *Is human cultural evolution Darwinian.*
[194] Monroe, J., Srikant, T., Carbonell-Bejerano, P., Becker, C., Lensink, M., Exposito-Alonso, M., ... & Weigel, D. (2022). Mutation bias reflects natural selection in Arabidopsis thaliana. *Nature*, *602*(7895), 101-105.
[195] Godfrey-Smith, P. (2009). *Darwinian populations and natural selection*. Oxford University Press. Pp.151-162.
[196] Godfrey-Smith, P. (2009). *Darwinian populations and natural selection*. Pp.155.
[197] They argue this in response to a discussion on cultural transformation raised by the Paris school. Godfrey-Smith bases his argument on this discussion. See: Acerbi & Mesoudi (2015). If we are all cultural Darwinians what's the fuss about? Clarifying recent disagreements in the field of cultural evolution.

developmental process of organisms in biology. Although an organism has a direct causal relation with its offspring, many additional causal factors that are situated in the environment are needed before the adult form of the offspring is 'reproduced' and is able to produce offspring itself. In addition, many intentional choices made by organisms might become causal factors in their own or in their offspring's development – for example through niche construction and epigenetic changes.[198]

Structural selectionists could also argue against Godfrey-Smiths notion that a clear parent-offspring relation is necessary for selection to occur. Godfrey-Smith is certainly right when he states that cultural recombination can lead to a large number of parents and a vague parent-offspring relationship, and it is also true that this vagueness can complicate the formulation of selectionist explanations that are based on phylogenetic comparisons and convergent evolution.[199] However, if the method of adaptive thinking and reverse engineering is used, one can study historical sources to investigate whether a specific cultural element has a stable pattern of heredity or not. Godfrey-Smiths argument is then turned into a case-specific research question that is suited for empirical research. Furthermore, the structural selectionist could point at the fact that parent-offspring in relations in biology can be vague too. Some plant species are able to produce tri-parental offspring, like maize for example, while many species of bacteria actively exchange parts of their DNA and create even fuzzier family trees.[200] Nevertheless, no biologist has yet stood up to argue that the laws of natural selection do not apply to these organisms.

The third agency argument has recently been developed by philosopher Azita Chellappoo.[201] Chellappoo accepts that cultural selectionist approaches have the capability to formulate explanations, but she argues that in many cases, their explanatory power is relatively weak and outperformed by goal-directed explanations. Using Schupbach and Sprenger's account of explanatory power, she starts by arguing that selective explanations have the most power when they explain culture that possess functional design without having a clear designer. Although these selectionist explanations are often needed in biology, many design-like features in culture can be explained by an agent-based goal-directed account. Next, she argues that when a cultural phenomenon can be explained by both a goal-directed and a selectionist account, the goal-directed account should be preferred. The main reason for this is because goal-directed accounts tend to be very successful in predicting human behaviour: "we are often able to successfully explain aspects of our human social world in terms of … goal directedness." Consequently, the role of selectionist explanations is limited to explain only the unintended functions – or latent functions – within culture.

Although intuitively appealing, Chellappoo's account runs into certain difficulties when adding a historical dimension to it. To illustrate, if a corrupt nutrition science professor invents a

[198] Suggested by Laland, for example: Laland, K. N., Odling-Smee, J., & Feldman, M. W. (2000). Niche construction, biological evolution, and cultural change. *Behavioral and brain sciences*, *23*(1), 131-146.
[199] See section 3.5
[200] Grossniklaus, U. (2017). Polyspermy produces tri-parental seeds in maize. *Current Biology*, *27*(24), R1300-R1302. ; Lang, A. S., & Beatty, J. T. (2000). Genetic analysis of a bacterial genetic exchange element: the gene transfer agent of Rhodobacter capsulatus. *Proceedings of the National Academy of Sciences*, *97*(2), 859-864.
[201] Chellappoo, A. (2022). When can cultural selection explain adaptation? *Biology & Philosophy*, *37*(1), 1-23.

method that will lead to positive results for the industry, we can – and should, according to Chellappoo – use a goal-directed account. However, if this person passes away, but the method remains being used and transmitted by new generations of nutrition scientists that are unaware of its origin and function – what explanation should then be used? The goal-directed account cannot explain the use of the method by the new researchers, so according to Chellappoo we should gravitate towards a selectionist explanation. However, it appears that the goal-directed account still has an important role to play in explaining the origin of this practice. The problem gets worse when we reverse the example. Take the latent function of the cassava processing techniques of Amazonian people, for example. Chellappoo discusses this case and agrees that cultural selection is the best explanation here, but what if someone would tell these people that their techniques remove cyanide from the cassava roots? How should one then explain the continuation of this practice? According to Chellappoo's argument, the goal-directed account should now gain priority, but the historical evidence will still show that selection is the best way to explain the initial spread of this practice.

The above issues can be solved by seeing goal-directed accounts and selectionist accounts as having different explanatory aims. The goal-directed account can explain why a certain agent chooses to invent or use a cultural artifact, or behave herself according or in opposition of specific cultural norms or roles. The selectionist account is instead occupied with explaining the spread of cultural elements. Selectionist explanations can include details on how, when or why a certain cultural element was invented, but is ultimately concerned with how it spreads through its environment based on its (dys)functions towards structures and other elements. To illustrate, a goal-directed account can explain well why a PhD student chooses to use a certain method, but in order to explain why this method spread through the academic community and ended up being part of the PhD student's toolbox, we should look at selective processes and historical events.

In the above case, the goal-directed and the selectionist account are compatible: they have a different explanandum and do not seem to contradict with each other conceptually or empirically. Even if the PhD student's reason for choosing a certain method doesn't match up with the functions for which the method is selected, these explanations could still be compatible: the explanatory standard of idealization allows structural selectionism to have some outliers. An explanatory account of why a cultural element spreads could therefore also include a combination of selective processes and several important goal-directed events. However, goal-directed accounts and selectionist accounts might also become incompatible when their explananda are very similar, or when they contradict each other. This can for example happen when both a goal-directed account and a selectionist account are used to explain the use of a method in a group of PhD students or research community. If both explanations are supported by a similar body of empirical evidence, this situation would raise the question of explanatory power.

In terms of explanatory power, it appears that Chellappoo attaches more importance to the explanatory standard of precision, while the selectionist prefers non-sensitivity and idealization. Moreover, the account of explanatory power that she adopts seems to highly value the standard of cognitive salience: the degree of how easily an explanation is understood

through humans in general or researchers that have been trained in a specific discipline.[202] Since goal-directed accounts lie close to our own experience of the world and are easy for humans to grasp, this explanatory standard is served more by goal-directed explanations than the abstract and population-level explanations of cultural selectionists. However, which explanation has more power once again depends on the explanatory context and the question that is asked. Like noted above, if a researcher is interested in studying how a specific cultural element was developed, or why a single individual or institution chose to use it, the precise goal-directed accounts will have more explanatory power. However, when studying what structural factors enabled the spread of a cultural variety through a larger population or set of institutions over a longer time period, the cultural selectionist explanation will probably have more power.

Lastly, besides these three arguments against selectionist explanations, both cultural evolution and structural functionalism have also faced the criticism that they neglect the existence or importance of agency. Especially in structural functionalism, Merton's proposal of latent functions and the existence of supraindividual structures that guide social behaviour have been contested for this reason.[203] Within his writings, Merton does indeed attribute a large role to structures in steering behaviour: structures can socialize people into certain roles, motivate them through reward systems, and shape their needs, habits and personality.[204] However, he still leaves room for human agency. Merton argues that cultural structures can either constrain or encourage certain forms of social behaviour, but not determine it. In a similar fashion, cultural selectionism describes and explains culture as developing through an evolutionary process, but still allows for individuals to choose between different evolved varieties.

Conclusion

To conclude, in this chapter I have laid out the foundations of cultural selectionism and argued that it can be integrated with Merton sociology. The two frameworks are able to synthesize with each other on an ontological and methodological level, and form a new framework called structural selectionism. This framework can form selectionist explanations on the spread of cultural elements, based on their functional relations with other elements as well as cultural structures. These explanations focus on identifying relevant functions and selective processes, and can be compatible with - and include - contingent historical events and agent-based based accounts. Structural selectionism can help investigate to what extend selective processes are responsible for the values and value-embedded practices in nutrition science, and potentially study other sociological problems. In order to test this new methodology and research the role of selection in nutrition science, I use it to conduct a case study on Dutch nutrition science in the following chapter.

[202] Ylikoski, P., & Kuorikoski, J. (2010). Dissecting explanatory power. *Philosophical studies*, *148*(2), 201-219.
[203] Harper, D. (2011). *Structural-functionalism: Grand theory or methodology.* Leicester: University of Leicester.
[204] Sztompka (1986). *Robert K-Merton: An Intellectual Profile*. (pp.143-150, 227-239).

Chapter 4: The case of Dutch dairy science

The following chapter constitutes the empirical part of this thesis, and studies the development of values in Dutch nutrition science and specifically dairy science. This chapter serves two purposes, with the first being to test the selection hypothesis that has been set out in chapter 2. In short, this hypothesis holds that the selective funding and promotion of nutrition researchers shapes the values and practices of the research community, which in turn steer the research topics and results towards the industry's interests. I study this hypothesis with the structural selectionist method set out in the previous chapter. By doing so, I test whether this integrated method is able to research how selective processes shape culture, and explore its advantages, challenges and potential future applications. This can be seen as the second purpose that is served by this chapter.

This chapter closely follows Robert Merton's disciplined research method, and therefore starts with an analysis of the problems in Dutch nutrition science.[205] Based on primary and secondary sources on Dutch research funding policy and several recent controversies surrounding nutrition science, I define the problem as a conflict between public and commercial values. In the second section, I use the results of this preliminary review to develop a structural selectionist middle-range theory on the development of values in nutrition science. This theory will be used to develop several concrete hypotheses and a fitting method to test them by zooming in on the case of Dutch dairy science. I study the values and value-embedded practices of the dairy science community in the fourth section, and then examine the selective pressures and historical circumstances that have contributed to shaping them in the last section.[206]

4.1 Industry-funded Dutch nutrition science and it's discontents

In section 2.1, I have reviewed the different problems that are linked to industry-funded nutrition research: it tends to create knowledge that serves the interests of the industry, which can then hinder the conceptual and methodological development of the field, overlook topics that are relevant for the public, undermine public health policy, and harm public trust in science. However, when zooming in on the local case of Dutch nutrition science, it quickly becomes clear that nutrition scientists, the government and the public conceptualize these problems in different ways. Like Merton observed, societal problems are always problematic from the perspective of a certain social group, and can be unrecognized – or latent. Because of this, he recommends that social researchers should first define, choose and conceptually develop the

[205] I have chosen to limit my study to Dutch nutrition science because of the Netherland's large food industry and nutrition science community, as well as the accessibility of Dutch primary resources and interview candidates.

[206] The last step of the selection hypothesis – the transmission of values through the educational system – falls without the scope of my case study. Instead, I prefer to focus on its most novel suggestions: values, practices and their development through selection.

societal problem that they want to study.[207] I start this section with describing several controversies Dutch nutrition science, and then develop the problem from the public perspective.[208]

Research agenda bias and the funding effect

In line with international trends, Dutch industrial funding shapes the research agenda of nutrition science and generates results that are often beneficial for the funder.[209] The effect of funding on the research agenda has been discussed in several Dutch news outlets, and is said to involve a narrow research focus on the health effects of specific products.[210] Many studies involve patentable products – like yoghurt with specific bacteria strains – or so-called 'functional food' products that offer potential health benefits to the consumers. These studies tend to use qualitative methods to test intermediary endpoints - like blood pressure and cholesterol level – and are able to deliver clear results in a relatively short time period.

A fitting example is the research done on the Souvenaid drink that has been funded by Nutricia, a branch of the food multinational Danone. Based on three clinical trials, Danone claimed that this drink could improve the memory of early Alzheimer and dementia patients.[211] However, the studies were criticized for their methods and the far-reaching involvement of the funder. Similar controversies that concern specific products have emerged in response to research funded by Redbull - which claimed that the energy drink reduces people's alcohol consumption – and industry-funded research on the health benefits of alcohol.[212] In the news, prominent Dutch nutrition researchers regularly argue that this focus on single products neglects topics of high societal relevance, like long-term trials and cohort studies that investigate the effects of diets and lifestyle on human health by studying clinical endpoints. Additionally, they argue that the social aspects of food consumption are generally ignored, as well as the role of nutrition in disease prevention. In sum, the problem of research agenda bias is pervasive in Dutch nutrition science**.**

In addition, Dutch news outlets have also written about the link between industrial funding and beneficial research outcomes.[213] This can be seen in the Souvenaid case, but perhaps even more clearly in a 2020 report on the relation between Dutch nutrition scientists and the sugar industry, published by the non-profit organisation.[214] The organisation notes that sugar industry-funded research finds an important role for saturated fat in obesity and cardiovascular disease, effectively drawing the scholarly attention away from the consensus that sugar plays

[207] See section 3.1.
[208] I've selected these controversies and trends based on a scan of nutrition science-related Dutch news articles between 2010 and 2022.
[209] For a discussion on these phenomena on the global level, please see section 2.1.
[210] See for an example: Versprille, H. (2016, October 1). Voedingswetenschap kan niet zonder geld van het bedrijfsleven. *Parool*.
[211] Scheltens, P., & Twisk, J. W. R. (2013, August 15). Medische dieetvoeding bij Alzheimer: het onderzoek. *Nederlands Tijdschrift Voor Geneeskunde*.
[212] Ophef over door Red Bull gesponsord onderzoek. (2012, November 28). Digitaal Universiteitsblad.; Korthals, M. (2007, January 18). Het opgepoetste imago van alcohol. *Resource: Weekblad Voor Wageningen UR*.
[213] Kamsma, M. (2021, January 5). Flinke invloed industrie op onderzoek naar voeding. *NRC*.
[214] Stichting foodwatch Nederland. (2020). *Big sugar in Nederland*.

even more important roles in these health issues. Furthermore, meta-scientific research on the funding effect and beneficial research outcomes regularly features in Dutch newspapers.[215]

Dutch research funding policy

In most articles, the shortcomings of current day Dutch nutrition science are linked to the Netherlands' research policy, which made it increasingly reliant on industrial funding. Since the eighties, the Dutch government has been stimulating cooperation between industry and academia in order to increase the technological innovation and economic competitiveness of the country.[216] Where research funding was first steered toward solving social-economic problems, it now aimed to increase economic growth and help the Dutch industry.[217] At the start of this period, the ministry of Economic Affairs took over the role of organizing research funding from the Ministry of Education and Science, and designed funding policies like tax cuts that could stimulate companies to invest in research.

In the last three decades, the government took up an even more active role in stimulating cooperation between industry and academia.[218] The convergence between industry, academia and the government has been described as the "golden triangle" – and is aimed to create a competitive knowledge-based economy.[219] The government established research institutes focused on specific themes, like biomedical sciences and agriculture, in which the three parties could assign research funding to specific projects. In addition to this so-called top sector policy, the Dutch government has established many research funding instruments that rely on fund matching.[220] These funding instruments require researchers to find an external funder to contribute to their project before they can apply for public research funding, and are aimed to stimulate industrial investment in research.

Various news articles have linked these fund-matching projects – or 'public-private alliances' - to the industry's influence on the research agenda and the ubiquity of pro-industry research results, and therefore criticize this form of research funding. Because universities are obliged to use their public research funding within these fund-matched research programs, the relative amount of money that is available for basic and researcher-determined research has been steadily declining.[221] This decline has accelerated because of an overall decrease in governmental research funding, and as a result, academia has become increasingly reliant on industrial funding.[222] At Wageningen University & Research for example, where the majority

[215] Kamsma (2021, January 5). Flinke invloed industrie op onderzoek naar voeding.
[216] Broek-Honing van den, N., Schel., M., & Vennekens, A. (2020). *Ontwikkeling derde geldstroom en beïnvloeding van wetenschappelijk onderzoek – Een data- en literatuuronderzoek ter beantwoording van de motie-Westerveld.* .
[217] Versleijen, A. (2007). *Dertig jaar publieke onderzoeksfinanciering in Nederland 1975-2000*.
[218] Wal, A. , van der. (2016, October 15). *Wageningen wordt een verlengstuk van de voedingsindustrie*. Follow the Money.
[219] In the literature on research policy and in STS, the interweaving of these three parties is also called the "triple helix" of innovation.
[220] Broek-Honing van den (2020). *Ontwikkeling derde geldstroom en beïnvloeding van wetenschappelijk onderzoek*.
[221] Broek-Honing van den (2020). *Ontwikkeling derde geldstroom en beïnvloeding van wetenschappelijk onderzoek*.
[222] Wal (2016, October 15). *Wageningen wordt een verlengstuk van de voedingsindustrie*.

of the Netherlands' agricultural and food research is conducted, around sixty percent of the nutrition science is funded by external funders.

Developing the problem

When looking more closely at the problem that is raised in the previous section, it appears that various actors conceptualize it differently. Public organisations like Foodwatch, and some individual researchers like Martijn Katan and Marion Nestle mostly emphasize public health. They state that nutrition science should aim to improve (global) public wellbeing and take issue with the evidence that a large share of current day nutrition science serves the interests of food companies instead. The Foodwatch report, for example, underlines the importance of well-founded public policy using research that is free from industrial influence, and states that nutrition research should aim to solve societal problems.[223] However, most nutrition researchers view the problem mainly as one of decreased public trust and perceived reliability. In an interview about integrity in nutrition science, the director of the Dutch Academy for Nutrition Science (NAV) states that the current discussions about nutrition science are not the result of low integrity, but are instead caused by (social) media, who convey a negative image of nutrition science.[224]

Within this thesis, I have adopted the problem as developed and seen by the public and public organisations. This public point of view encompasses the interests of a large group of people, and not only that of the nutrition scientists.[225] In addition, several philosophers have defined legitimate science as science that serves the interests of the public, that increases human well-being or that answers the needs of society.[226] The public point of view discussed above holds a similar goal for (nutrition) science, and therefore coincides with these accounts.

By picking up the public point of view, the most pressing challenge for a social researcher is to explain the observation that nutrition science does not serve the public interest. How and why do nutrition researchers produce knowledge that serves the interest of the industry, instead of the public? Most Dutch journalists and other authors do not attempt to answer this question, or point towards the role of (unconscious) bias. Although they suggest a clear link between industrial funding and the problems at hand, they do not elaborate on how funding influences research. In section 2.3 of this thesis, I have argued there are good empirical and theoretical reasons to conceptualize these questions as questions about values and value-embedded practices, which can subtly steer research towards questions and outcomes that serve the industry's interests.

The most obvious value difference between the nutrition scientists and the public concerns the relation between science and the public interest. Where the public view holds that science is 'good science' when it serves societal goals and human well-being, the nutrition scientists do not seem to be very vocal about these aims. Instead, they argue that good science involves

[223] Stichting Foodwatch Nederland. (2020). *Big sugar in Nederland*.
[224] Peters, S. (2020). "Mijn missie: een gezondere voedselomgeving". *VoedingsMagazine.*
[225] Furthermore, I have based this choice on my personal utilitarianist ethical convictions.
[226] See the second subsection of section 2.3

transparent research that uses trustworthy methods, and critical interpretation.[227] Although they do not mention the interests of either the public or the industry, it could be that they hold commercial values, since they occasionally underline the importance of working with and for companies. In such cases, they argue that there would be insufficient funding to conduct research without industrial funding, and that that the industry makes nutrition research more relevant for society. It therefore appears that nutrition scientists equate the public interest with commercial interest and economic prosperity, something that is also frequently done by the government.[228]

The difference in views on the public interests becomes clearer when zooming in on the concept of scientific integrity. Many nutrition scientists see scientific integrity mainly as a question about empirical accuracy and robust methods, and therefore appear to accept the industry's influence when it comes to determining the topic and research question of studies. In the Foodwatch report, for example, several researchers who conducted research for the sugar industry state that their research is value-free, even when the industry determines their research topic.[229] However, as discussed in section 2.3, the choice of topic and research question can certainly be value laden, and is able to influence the method and outcomes of a study down the line. Therefore, through their emphasis on transparent methods, they seem to adhere to a view of scientific integrity that leaves much room for pro-industry values to act within the nutrition science community. The public and public organisations, on the other hand, see topic choice as something that should be primarily in line with the public interest. To illustrate, Foodwatch argues that research on the health effects of sugar should be independent, and thus free from industrial funding. In an example involving a controversial study on the benefits of Redbull, the rector of Utrecht University argues that nutrition scientists should reject research topics when they fail to address a societal issue.[230]

In sum, the public problem with Dutch nutrition science holds that it serves the public interest insufficiently, which is probably related to the observation that nutrition scientists hold different values than the public. Preliminary observations show that the public highly values science that directly contributes to the public interests, while nutrition researchers and the government tend to equate the public interest with commercial interest. In addition, the nutrition researchers exclude the public interest from their concept of scientific integrity, and therefore leave room for industrial values in the research process. How did these values develop? And how do these values relate to the practice of research funding and the institutional and organisational aspects of nutrition science? Based on the observations within this section and the literature review of chapter 2, I will now develop a middle range theory on the structure and values of nutrition science that can answer these questions.

[227] For an example, see Stichting Foodwatch Nederland. (2020). *Big sugar in Nederland* ; Nederlandse Zuivel Organisatie. (2013). *VoedingsMagazine*.
[228] Engelshoven, I. van. (2020). Ontwikkeling derde geldstroom en beïnvloeding van wetenschappelijk onderzoek.
[229] Stichting Foodwatch Nederland. (2020). Big sugar in Nederland.
[230] Zwaan, B. van der. (2013, October 16). Crisis binnen de universiteiten? Die conclusie is te gemakkelijk. Digitaal Universiteitsblad.

4.2: A middle-range theory of Dutch nutrition science

Within functionalist terms, the societal problem laid out in the previous section can best be described as a dysfunctional relation between the knowledge created by the nutrition science community and the public. This relation is dysfunctional in at least two ways. Since nutrition science is partially funded using public money collected via taxes, nutrition science can have negative consequences for the financial means of the public. Although this effect is small, it is sometimes recognized as a dysfunction when these scientific studies do not lead to any substantial benefit for the public.[231] Next, industry-funded nutrition science that serves the industry's interests could influence public health policy and change the scientific consensus on nutrition science, which then could harm public health and wellbeing – leading to additional dysfunctions towards the public.

In both cases, the core of the problem is that the knowledge created by nutrition scientists insufficiently serves the public's interests. As argued in chapter 2, the creation of knowledge depends on the values-attitudes and beliefs of researchers, as well as the values that are embedded within the methods, interests and concepts they use.[232] Together with the roles and statuses, these values and value-embedded practices are part of the social structure of the nutrition science community. So, if we want to investigate how these values develop and contribute to dysfunctional nutrition knowledge, we first have to understand what the social structure of the nutrition science community look like and how it relates to other structures.

Structural relations between government, nutrition science and food industry

Perhaps the most important structure that has shaped the social structure of the nutrition science community is the government. As described in the previous section, the government has actively stimulated cooperation between the (food) industry and (nutrition) science by establishing different funding institutions and funding instruments in the last four decades. The institutions and instruments appear to serve an important economic function for the government, since they are often substantiated with arguments about how they stimulate the 'knowledge economy' and economy-focused technological innovation. An even clearer sign of this economic function appears when looking at how the government tries to evaluate their funding policy – namely by gauging their economic impact.[233] The government also regularly emphasizes that cooperation between the industry and nutrition science serves the function of formulating trustworthy public health policy, as well as addressing societal issues. However, at least in the Dutch case, the government regularly conceives societal issues in terms of employment or economic growth, and thus as having an economic character.[234]

As a result of government policy, the (nutrition) research departments and the (food) industry have become structurally integrated. Although their relation can be traced back to the early 19th century, when Dutch food companies played an important role in the research on vitamins,

[231] See for an example: Kuijpers, K., & Thomas, C. (2016, March 2). De juiste yoghurt. *De Groene Amsterdammer*.
[232] See section 2.3 for the discussion on values and value-embeddedness.
[233] Rathenau Instituut. (2021, April 13). Onderzoeksevaluaties worstelen met maatschappelijke waarde.
[234] Wal (2016, October 15). *Wageningen wordt een verlengstuk van de voedingsindustrie*.

their financial and functional co-dependence seems to have emerged during the last several decades.[235] This can for example be seen in the ancillary activities of professors. In recent years, the amount of Dutch professors which such extra occupations has risen to eighty percent, the majority of which is paid for by private parties.[236] In addition, more than a quarter of professors occupy an endowed chair, which holds that their position is financed by a company, NGO or other organisations.[237] In nutrition science, endowed professors funded by food companies or branch organisations are a very common occurrence, although clear numbers are lacking. Furthermore, structural integration can also manifest in a more physical manner. The campuses of Wageningen University and Utrecht University for example both contain multiple industrial research facilities, and it has been recorded that these two universities compete for accommodating such facilities – as was the case with a research facility of Danone.[238]

For universities and their nutrition science departments, the food industry's primary function appears to be a financial one. By accepting endowed chairs from the industry, universities gain an annual sum of fifty thousand Euro, as well as new networking opportunities that can lead to new co-financed research projects.[239] Accepting industrial research facilities on their campus can offer universities similar benefits. Since governmental funding has been gradually decreasing and is required to be matched with private funding, universities and their research departments have become more and more dependent on connections and funding from private parties to survive and compete with other universities. Furthermore, integrating with the food industry might help researchers gain access to the right materials, equipment and knowledge for conducting large scale trials and other nutrition research.

In turn, likely the most important function of universities and nutrition research for individual food companies is to increase their long term revenue. By cooperating with universities, they can build up knowledge and a network of skilled scientists that can be contacted when needed. In the competition for accommodating Danone's research facility, for example, the bidbook of Utrecht promised Danone the scientific expertise to "preserve its long term competitive advantages" – which ultimately lead to Utrecht University winning over the multinational. Cooperation can also lead to short term benefits, for example when researching the health benefits of a specific product in order to substantiate health claims and increase its sales. To illustrate, the production and sale of functional foods like Danone's Souvenaid can result in very high profit margins thanks to their health claims, especially when these products are covered by medical insurance.[240] In cases like these, nutrition science not only helps create knowledge, but also confers a certain sense of credibility to the company and its product. This can for example be inferred from the pervasiveness of allonymous science: the practice of

[235] Theunissen, B. (2013). Pim Huijnen, De belofte van vitamines. Voedingsonderzoek tussen universiteit, industrie en overheid 1918-1945. BMGN - Low Countries Historical Review, 128(1), 21.
[236] Gennip, N. van, Homolova, A., Koevoets, S., Kuijpers, K., Metze, M., Thomas, C., & Waarden, B. van. (2014, November 26). Ondernemende professoren. De Groene Amsterdammer.
[237] Broek-Honing van den, N., Schel., M., & Vennekens, A. (2020). Ontwikkeling derde geldstroom en beïnvloeding van wetenschappelijk onderzoek – Een data- en literatuuronderzoek ter beantwoording van de motie-Westerveld.
[238] Kuijpers & Thomas (2016, March 2). De juiste yoghurt. *De Groene Amsterdammer*.
[239] Wier, M. van de. (2014, September 11). Leerstoel te koop. *Univers: The Independent News Source of Tilburg University*.
[240] Katan, M. B. (2021, May 12). Medische voeding: noch medicijn, noch voedsel. *NRC*.

industrial researchers in public-private research projects to renounce their authorship in favour of academic researchers.[241] This change in authorship can make a study look more academic and therefore allows food companies to make use of nutrition science's credibility.

In sum, academia can grant individual food companies with useful and credible nutrition knowledge that help them increase their revenue, while the industry can offer external funding that can keep nutrition science departments afloat. Because of these mutual functional relations, one can see these two structures as a semi-integrated whole.

Values, practices and selection in nutrition science

Due to the structural integration, one can see the nutrition science community as being implicated in both the food industry and academia. By regularly creating credible knowledge that is beneficial for the industry, the nutrition researchers fulfil the functional requirements of both structures and keep the integration intact. Underlying the creation of this knowledge that fit these requirements lies a variety of values, beliefs and practices. Evidence for such values can be found in the previous section. First, we have seen evidence that nutrition researchers value commercial and economic goals, which are seen as mostly compatible with the public interest. And second, their beliefs on scientific integrity revolve around empirical accuracy, and therefore leave room for industrial values to play a role in determining their research setup. Furthermore, such pro-industry values can also be directly embedded within the concepts and methods of the research community, as can be seen in the one-product trials with intermediary endpoints that are likely to deliver positive results. In sum, values and value-embedded practices are central to the development of knowledge that is beneficial to the industry and dysfunctional towards the public, but how did these values emerge and become part of the research community?

According to the selection hypothesis, the values and value-embedded practices of a research community can gradually develop and stabilize through selective processes.[242] The hypotheses starts with a generation of freshly graduated academic nutrition scientists. The food industry selectively funds some of these nutrition scientists based on their topic of interest, methods, concepts and values – factors that increase the chance of generating an outcome that is beneficial for the funder.[243] This chance can increase even further if the researchers accept the industry's input and suggestions regarding the research question, design and interpretation of the study – a factor that depends on the researchers' integrity and public interest values. On average, researchers that generate beneficial results because they hold pro-industry values and value-embedded practices may gain more funding and publishing opportunities than other researchers. Researchers that hold other values and use other practices have a lower chance of not delivering the right results, and are therefore not as likely to see their funding prolonged.

[241] Penders, B., Lutz, P., Shaw, D. M., & Townend, D. M. R. (2020). Allonymous science: the politics of placing and shifting credit in public-private nutrition research. *Life Sciences, Society and Policy*, *16*(1), 4.
[242] For a literature review on this hypothesis, please see section 2.4.
[243] These values, beliefs and practices might initially be transmitted from the industry to the research through social interaction, and maintained through close personal relations.

In addition to the industry, academic nutrition science departments can also exert an additional selective pressure on the research community. Since modern university departments recruit new researchers based on their publication metrics and their capacity to generate external funding, they will indirectly (and perhaps unintentionally) select for researchers who hold pro-industry values and practices.[244] When these researchers gain in academic prestige, their views, values and practices will be taught to new generations of researchers and slowly become part of the research paradigm of the nutrition science community. Consequentially, the values and value-embedded practices that serve the public interests are inclined to be outcompeted and gradually become diluted.

In order to test this theory, I have conducted a two-part case study. I start by zooming in on a specific nutrition science community – that of Dutch dairy science – in order to confirm and further analyse the values in nutrition science. After identifying the values and value-embedded concepts within this community, I investigate whether their emergence can be linked to the selection-like practices in the Dutch food industry and academia.

4.3: Values and value-embedded practices in Dutch dairy science

There are several reasons to choose Dutch dairy science for conducting a case study on the values in science. First, dairy is an important export product and research topic in the Netherlands, and this corresponds with a sizeable dairy science community that includes a specialized dairy science department and master's program at Wageningen University. In addition, the Dutch university campuses host at least three industrial research institutions, the largest two being the research facilities of Danone in Utrecht and Friesland Campina in Wageningen. These research institutions are a clear sign of structural integration between the dairy industry and nutrition science – something that is also evident from the large amount of private-public nutrition studies they publish.

Lastly, (Dutch) dairy nutrition science is known for producing results beneficial for the industry, and has been involved in several public controversies. For example, the field has produced many results that emphasize the positive health effects of saturated milk fat – assumedly because of the public's negative perception of (saturated) fat.[245] In addition, the field produces many positive results on the health effects of single food products and nutrients, like pro-biotic yoghurts and infant formula.[246] Nevertheless, the dairy nutrition science is not as controversial as research on sugar or alcohol, making it an ideal field for a case study.

From the middle-range theory set out in the previous section, I have drawn several hypotheses on the values and value-embedded practices in nutrition science that I expect to find in the Dutch dairy nutrition community. First, I expect to encounter topics, methods and concepts that consistently enable researchers to create results that suit the industry's interests. I study this

[244] Note that this does however not mean that everything goes: nutrition researchers also have to adhere to certain academic standards and research methods in order to maintain their credibility and ensure acceptance by the research community. Furthermore, not every researcher or research project might fit this pattern. Sometimes research projects fail, deliver unexpected results, or the industry might choose to fund a research topic that will turn out to be detrimental for their aims.
[245] Katan, M. B. (2010, January 30). Hoe melkvet gezond wordt. *NRC*.
[246] Helfer et al. (2021). Conduct and reporting of formula milk trials: systematic review.

hypothesis by zooming in on the research and discussion surrounding two controversial topics encountered during my preliminary research: the cases of saturated milk fat (hypothesis 1a) and cow milk allergy (hypothesis 1b). Next, I expect to find value-attitudes and beliefs that contribute to creating positive research results, and focus specifically on studying how the researchers conceive of the public interest (hypothesis 1c). I study these values by scanning the media appearances of Dutch dairy nutrition scientists in the last ten years, and conducting focussed interviews with three dairy nutrition researchers.[247] What follows are the results of this empirical research.

Hypothesis 1a: Saturated fat and the 'dairy matrix'

Starting from the mid-19th century, many trials and cohort studies have shown that the consumption of saturated fat is linked to high cholesterol levels, and cardiovascular disease – shaping the scientific consensus that this nutrient should be avoided. However, in the last ten years, several studies – including Dutch research projects - have found that this is not the case for saturated fat in dairy products. Instead, they find that saturated milk fat has beneficial effects against diabetes type 2, and can improve people's body weight and cardiometabolic health.[248]

According to several critical Dutch nutrition scientists like professor Martijn Katan, this change in perspective can best be attributed to the large influence of the dairy industry on nutrition research. In a public opinion piece he notes that in 2008, the branch organisation Global Dairy Platform had taken up the aim to improve the negative image of milkfat in dairy products – especially as perceived by regulators and medical professionals.[249] Similar to Katan, nutrition professor Edith Feskens also rejects the conclusions of the recent positive findings on saturated milk fat, and they both stick to the existing consensus that saturated fat is detrimental to cardiovascular health.[250] They argue that the interaction between saturated fat, cholesterol and cardiovascular disease can be attributed to a clear biological mechanism that is empirically confirmed using extensive cohort studies and intervention studies, while most industry-funded studies use short term clinical trials.

One recurring concept that can be found in the industry-funded milk fat studies is the so-called 'dairy matrix'. This term is used to describe the complex interactions between the different nutritional components of dairy, which according to most accounts can cancel out the negative effects of saturated fat and increase the nutritional value of dairy products. The 'dairy matrix' concept was first suggested in 2006 by an American literature review, paid for by the California Dairy Research Foundation.[251] In the following years, the concept got picked up by professor Lisette de Groot - who at the time occupied an industry-funded endowed chair at Wageningen

[247] For a description of Merton's focussed interview technique, please see section 3.1.
[248] Thorning, T. K., Bertram, H. C., Bonjour, J.-P., de Groot, L., Dupont, D., Feeney, E., … Givens, I. (2017). Whole dairy matrix or single nutrients in assessment of health effects: current evidence and knowledge gaps. *The American Journal of Clinical Nutrition*, *105*(5), 1033–1045.
[249] Katan, M. B. (2010, January 30). Hoe melkvet gezond wordt. *NRC*.
[250] Pols, M. (2017, June 9). *Onderzoek naar verzadigd vet bewijst niets, zegt Wageningse hoogleraar*. Expertisecentrum Voedingsmiddelenindustrie.
[251] German, J. B., & Dillard, C. J. (2006). Composition, structure and absorption of milk lipids: a source of energy, fat-soluble nutrients and bioactive molecules. *Critical reviews in food science and nutrition*, *46*(1), 57-92.

University - and then appeared in several PhD theses and literature reviews.[252] Not long after, the concept was taken up by other European dairy researchers, became regularly employed in studies on the health benefits of dairy products, and featured in a series of industry-funded conferences between 2017 and 2020. Furthermore, the dairy branch organisations organized two expert symposia, which ultimately led to several prominent European nutrition researchers using the concept to argue for changing the WHO public health guidelines on full fat dairy in 2019.[253]

When scanning the scholarship, it appears that the dairy matrix is mostly used in industry-funded studies to explain positive findings of studies on the health benefits of dairy. Besides cardiovascular diseases, the concept has also been employed to explain the positive effects of dairy on body weight and musculoskeletal health.[254] However, when looking more closely at the contents of the concept, it appears that there is a lot of scientific uncertainty. In many studies, the dairy matrix is not further defined than a "complex effect" that occurs when different (which?) nutrients interact with each other. The researchers do not seem to have identified a clear mechanism that could explain the positive health effects they found, and instead build upon each other's use of the concept to validate and use it themselves.[255] In this way, the concept appears to be used as a tool that helps to attribute positive research findings to the product that is being studied, and implicitly rule out that the positive findings could possibly be caused by some other factor.[256]

Despite these uncertainties, the concept does seem to have a positive function for the industry – and can therefore be seen as a value-embedded concept. The dairy matrix is used for lobbying against certain public health policies – as can be seen in the article send to the WHO – and features on websites and in conferences aimed at health professionals, for example on osteoporosis and bone health.[257] Furthermore, dairy trendwatchers have noted that the market value of dairy fat has been increasing in recent years, and attribute this to the recently changed view on the health effects of saturated fat.[258] It is however not certain whether the public also benefits from the dairy matrix, and it is possible that the concept is dysfunctional towards them. If the saturated fat in dairy products do not carry the beneficial effects that dairy researchers ascribe to them, the ability of health professionals and the public to foster healthy diets might be jeopardized. In addition, controversy surrounding the dairy matrix might lead to

[252] See, for example: German, J. B., Gibson, R. A., Krauss, R. M., Nestel, P., Lamarche, B., Van Staveren, W. A., ... & Destaillats, F. (2009). A reappraisal of the impact of dairy foods and milk fat on cardiovascular disease risk. *European journal of nutrition*, *48*(4), 191-203.
[253] Astrup, A., Bertram, H. C., Bonjour, J.-P., de Groot, L. C., de Oliveira Otto, M. C., Feeney, E. L., … Soedamah-Muthu, S. S. (2019). WHO draft guidelines on dietary saturated and trans fatty acids: time for a new approach? *BMJ*, l4137.
[254] Geiker, N. R. W., Mølgaard, C., Iuliano, S., Rizzoli, R., Manios, Y., Van Loon, L. J. C., ... & Astrup, A. (2020). Impact of whole dairy matrix on musculoskeletal health and aging–current knowledge and research gaps. *Osteoporosis International*, *31*(4), 601-615.; Thorning et al. (2017). Whole dairy matrix or single nutrients in assessment of health effects: current evidence and knowledge gaps.
[255] This is also the case for more recent research into the concept, see: Geiker et al. (2020). Impact of whole dairy matrix on musculoskeletal health and aging–current knowledge and research gaps.
[256] For similar reasons, nutrition researchers like Katan have remained sceptical toward the dairy matrix.
[257] Astrup, A. (2019, April 4). Bone health and dairy products: from the latest scientific news on the matrix effect. Beyond Nutrients: Health Effects of the Dairy Matrix.
[258] Zessen, T. van. (2017, August 1). Trendbreuk in de zuivelindustrie, weinig mis met melkvet. Veeteelt

contradicting news articles on the health benefits of saturated fat, which could then give rise to public confusion and a loss of trust in nutrition science.

Hypothesis 1b: Cow milk allergy

The Dutch dairy research facilities regularly fund research on the beneficial effects of dairy products on inflammatory diseases and (childhood) allergies.[259] Cow milk allergy (CMA) is one of them, and it can be seen as another value-embedded research concept.[260] Children who have CMA suffer from gastrointestinal problems and rashes when they drink cow milk, or breast milk from mothers that have consumed cow milk themselves. To prevent and alleviate this problem, industry-funded research suggests that the infant should be introduced to cow milk at an early age, and be fed with specialized infant formula that can help with building tolerance.[261]

However, several public health experts have criticized the medicalization of CMA, and have pointed out that the industry is benefiting from the rampant overdiagnosis of the allergy.[262] The clinical guidelines suggest to identify CMA based on symptoms that are very common to occur in infants, like non-specific rashes, loose stools and occasional vomiting, which makes overdiagnoses likely to happen. Many of these guidelines are created or initiated by infant formula companies, and consequently taught to health professionals in industry-sponsored educative programs. The guidelines often prescribe treatments using specialized infant formula milks, and are thought to be the driving force in the sales of these products, which increased with 700 percent between 2006 and 2016.

Although functional for the industry, the public does not seem to benefit much from the concept: although it might help some children who genuinely suffer from CMA, many parents and medical insurance organisations will suffer financially by buying an unnecessary product. In addition, health experts have recorded that mothers whose child has been diagnosed with CMA often stop breastfeeding. Nevertheless, the topic of cow milk allergy is still studied by several Dutch nutrition scientists in private-publicly funded research projects, where it is framed as a severe allergic reaction that needs to be cured, ideally with a product-based solution.[263]

Hypothesis 1c: The value of public interest

In addition to the existence of value-embedded practices, the focussed interviews confirm the hypothesis that the dairy nutrition science community holds value attitudes that are functional towards the industry. The focussed interviews show that all three interviewees to some degree

[259] FrieslandCampina Institute (2023). *Publication Library.* Via: https://www.frieslandcampinainstitute.com/education/scientific-library/
[260] Note that CMA is not related to lactose intolerance.
[261] Chatchatee, P., Nowak-Wegrzyn, A., Lange, L., Benjaponpitak, S., Chong, K. W., Sangsupawanich, P., ... & Peroni, D. (2022). Tolerance development in cow's milk–allergic infants receiving amino acid–based formula: A randomized controlled trial. Journal of Allergy and Clinical Immunology, 149(2), 650-658.
[262] van Tulleken, C. (2018). Overdiagnosis and industry influence: how cow's milk protein allergy is extending the reach of infant formula manufacturers. BMJ, k5056.
[263] Kuijpers & Thomas (2016, March 2). De juiste yoghurt. ; Chatchatee et al. (2022). Tolerance development in cow's milk–allergic infants receiving amino acid–based formula: A randomized controlled trial.

equate the public interest with commercial or industrial interests.[264] Interviewee C, who as an assistant professor has been involved in CMA research, beliefs that industrial funding of nutrition science does not conflict with the public interest, even though they admit that it is hard to receive funding for some topics.[265] When asked about the importance of his CMA research, they argued that the societal interests and the interest of the industry intersect within this topic: studying CMA could help children prevent from becoming allergic or help them overcome their allergy, which could lower the burden of disease. Next, researching CMA could also help the industry to develop and adjust their products to this disease.

Interviewee A have researched dairy as a potential immunotherapy against CMA as a post-doc researcher, and holds similar views as interviewee C. When asked about the importance and aims of this study, they argue that the rapidly growing prevalence of CMA – as well as its severe symptoms – increases the societal relevance of the topic. The industrial partner contributes to this public goal by offering testing equipment and expertise, and by offering a way to directly use the knowledge to create a tangible product.[266] Nevertheless, they are aware that the industrial interest can conflict with other interests, and are especially concerned about the preservation of academic freedom. They define academic freedom as the researchers' ability to freely determine their study topic, and see it as a requirement for societal progress. Since fund matching is very common, most study topics must have direct practical relevance for the industry to step in and fund it, which limits the academic freedom of researchers. Although they still see their own research as academically free and relevant, they disapprove of a colleague who recently started a project that didn't fit their research group. This researcher would not have picked up this topic himself, they argue, and the study does not contribute to the accumulation of relevant knowledge or expertise.

Lastly, the value of public interest appears to be excluded from the dairy nutrition scientists' concept of scientific integrity. When talking about scientific integrity, dairy nutrition researchers tend to emphasize values like transparency, diligence and the trustworthiness of the scientific method.[267] Interviewee A for example emphasizes the Dutch academic guideline that industrial funders cannot block publications, even when the outcome has a negative influence on the company. Moreover, when asked about scientific integrity, both interviewees A and B said that their industry-funded research does not make use of specific guidelines to prevent bias, since "everyone" benefits from unbiased results. These statements indicate that their concept of scientific integrity does not include the public interest, and therefore allows compatibility with the industry's interests.

4.4 Selection in Dutch nutrition science

To explain the values uncovered in the previous section, I will look at the selective factors that

[264] The three interviewees included one post-doc (Interviewee A), one PhD student (Interviewee B) and one assistent professor (Interviewee C) – all involved in dairy nutrition research.
[265] For the sake of anonimity, I use gender-neutral pronouns.
[266] This view is shared by interviewee B, who currently occuppies a PhD position fully paid by one of the Dutch dairy research facilities. They argue that industrial funding serves the societal interest better than publicly funded research because it almost always involves a concrete food product.
[267] For an example, see: Blom, J. (2013). Wetenschap moet blijven werken aan geloofwaardigheid. *VoedingsMagazine.*

act upon the Dutch dairy science community. The selection hypothesis holds that the values of nutrition science are shaped through the selective funding of research by industrial funders (hypothesis 2a), as well as the selective promotion and recruitment practices of universities (hypothesis 2b). I test these hypotheses by studying secondary literature, as well as primary sources like news articles, academic policy documents and industrial reports on the competition and reward-practices in Dutch nutrition science. Furthermore, I have used my focussed interviews and background interviews to ask questions on the reward-practices in nutrition science and on how public-private nutrition studies are established.[268] I start by describing my findings on industrial selection.

Hypothesis 2a: Industrial selection

Perhaps the most direct way of studying industrial selection in dairy science is to research the funding policies of industrial research institutes like those of Danone and Friesland Campina. However, since their decision processes and funding practices are often shrouded in secrecy, it is hard to gain a grasp on their practices. Nevertheless, general reports by the industry occasionally indicate that the main purpose of the research facilities is to generate knowledge that benefits their economic competitiveness. In a report by the Dutch dairy branch organisation (NZO), for example, it is emphasized that the two dairy research facilities are essential to the Netherlands' strong economic dairy sector.[269] It lauds their cooperation with the local universities, and states that dairy research can help the industry maintain its global dominant position and respond to consumers' demand for healthy food. Statements like these hint that economic benefits are one of the important factors in funding dairy nutrition research.

More details on the industrial selection process appear when looking at how nutrition researchers establish and initiate their research projects. Interestingly, it is not always the academic researcher who initiates a study, according to science studies scholar Bart Penders.[270] Although the academic research is formally in the lead, interviews show that it is regularly the industry who conceives and develops the research project. These informal agreements are often built upon existing relations between the industrial funder and the researchers. In my own interviews with dairy nutrition researchers this phenomenon did not appear. When asked about the start of their research project, interviewee A described that most private-public studies start with an academic research question, which is then cooperatively developed into a project through regular contact with the industry.

As an assistant professor who regularly writes research proposals, interviewee C could offer a more detailed account of how dairy nutrition research projects get off the ground. They argue that the starting point is an academically interesting idea with a potential practical application, written down on a single piece of paper, which is then proposed to a company's science officer. Since researchers often meet these companies at congresses, conferences and other events, they are already aware of their business model and scientific interests. In order to increase their

[268] As described in sections 3.5 and 3.6, selective explanations can also contain historical elements and events. However, due to the limited scope of this thesis, I have focused mainly on studying the selective factors.
[269] Nederlandse Zuivel Organisatie. (2015). *De witte motor: de kracht en de uitdagingen van de Nederlandse zuivelsector*.
[270] I have paraphrased this from a background conversation I had with Bart Penders on October 13th, 2022.

funding opportunities and create consortia with multiple companies, researchers propose their ideas to multiple companies at ones. According to interviewee C, not every academic idea is suitable, and for every seven or eight ideas they have only two of them will eventually turn into a research proposal. Which ideas are selected depends on the industry's interests: some topics are very hard to get funded because they lack an obvious practical application. Although interviewee C considers this as an unpleasant situation where the industry limits the researcher's academic freedom, they are willing to accept it because in the end they can still work on an idea they proposed themselves. This interesting example shows that industrial selection can involve more than the industry selecting researchers and practices: researchers learn and internalize the interests of individual companies, and then use it to internally select the topics, concepts and methods that are likely to be selected by the industry.

The initial research proposal is followed by regular meet-ups and exchanges of suggestions in order to further develop the project. The company is therefore not only closely involved in deciding on the topic and research question, but also in devising the method of the study, which could strongly guide the direction and outcome down the line. By accepting and freely talking about this involvement, the interview with interviewee C suggests that they see the industry's input as highly compatible with the public interest. After a half to one year, the project is jointly proposed to a public research funding organisation. However, interviewee C states that in half of the cases, the company or the researcher decides to discontinue because their interests do not overlap: the expectations of the company do not fit the researchers academic question or vice versa. This shows that researchers are not only selected, but are also selectors themselves that might decide to reject certain topics because they do not fit with their standards or interests.[271]

However, if researchers are too selective, they might not be able to muster sufficient funding to continue their career. The three interviewees agree that since practically all governmental research projects consist of grants that require fund matching, industrial funding is necessary for publication. They state that they experience freedom in choosing a research topic, but also that this freedom is limited to the industry's interests. Interviewee B, for example, describes this as a "give-and-take" situation. However, since their 36 hour contract leaves time for doing more fundamental and academically interesting research during their free time, they still experience academic freedom. Furthermore, interviewees A and C both state that negative research findings do not stop the industry from funding them – although they do acknowledge that positive findings are necessary for good publications with many citations. These accounts contradict with the observations of the critical Swedish dairy nutrition researcher Karl Michaëlsson, who has stated that the funding of most dairy researchers is not prolonged when they deliver results that do not suit the industry's interests.[272] Future research could use quantitative methods to study the possible relationship between positive findings and continued industrial funding.

Additional finding: Governmental selection

Although originally not part of the selection hypothesis, during my research process evidence

[271] Interestingly, the public interest is not mentioned as a reason to reject a proposal.
[272] Collier, R. (2016). Dairy research:"Real" science or marketing?. *Canada medical association journal.*

emerged of an additional selective pressure: that of the public research funders. In private-public funded research projects, the public funder plays a determining role in deciding which consortia gain funding. Since the government sees economic growth and preserving the competitive economic position of the Netherlands as the most central aims of its research policy, one can assume that the selection of public funding organisations will be loosely based on the capacity of the proposed research project to serve this goal.[273] According to interviewee C, the requirements of public research funders are less flexible than industrial funding, because most public-private research grants are assigned based on certain economic or societal themes, and even specific topics. Public research funders could therefore have more influence on the direction and the content of the research than food companies, and can even be seen to steer they industry's choice on what to research.

Moreover, the three interviewees all agree that receiving public research funding is the hardest part of starting up a private-public cooperative research project. They mention that the competition with other research applicants is high, and that the public research funder is generally the toughest party to convince of the necessity or utility of a research project. In addition, they note that the majority of projects – some say more than two third of the projects – are rejected. Consequentially, this could indicate that the government might even exert more selective pressure on the research community than the industry – even though it might largely overlap with the commercial interests of the industry. Future research should aim at uncovering on what basis the government selectively funds nutrition research projects, and how they relate to the values and practices of the nutrition science community.

Hypothesis 2b: Academic selection

In contrast to industrial and governmental selection, academia shapes the values and practices of the research community through the hiring and promotion of researchers.[274] It is well-known that academic jobs are scarce – especially for positions in the higher echelons of the academic pyramid - and that the competition for them has intensified in recent decades.[275] In addition, many academic institutions base their recruitment and promotion on qualitative measures, like the researcher's publication record and high-impact citations. During the focussed interviews, two of the three interviewees brought up these trends, and agreed that the current recruitment and promotion system increases the pressure to publish and pursue grants in academia. This selective process could therefore exert strong selective pressures on the research community. But does it also select researchers based on their connections with the industry and their ability to generate external funding – like the selection hypothesis suggests?

A certain level of selection on the researcher's ability to generate external funding seems unavoidable. Since most nutrition studies are funded using private-public fund matching constructions, researchers require industrial funding to generate scientific publications. The

[273] See section 4.1 and 4.2.

[274] I have switched my focus from Dutch dairy science to Dutch nutrition science in this part because of the availability of sources. It is assumed that the national selective processes described in this part also act upon the Dairy science community in specific.

[275] Waaijer, C. J., Teelken, C., Wouters, P. F., & van der Weijden, I. (2018). Competition in science: Links between publication pressure, grant pressure and the academic job market. *Higher education policy*, *31*(2), 225-243.

interviewees all recognized the need for external funding, but thought that universities value external and public funding equally well. Interviewee C described that even though their own department doesn't recruit new researchers based on their external funding record, they still recommend their early-career researchers to boost their academic career chances by applying for many funding opportunities.

These results correlate with research done by the Dutch Centre for Science and Technology Studies (CWTS), which has studied academic recruitment and promotion extensively. For example, in one large scale survey, researchers indicated that external grants are an important criterion for continuing one's academic career.[276] This implies that the academic recruitment and promotion system also (indirectly) selects for researchers with the skills, dispositions and connections to acquire these external grants. In a study on the recruitment of biomedical researchers in Sweden – where the recruitment criteria are fully transparent – it has been found that funding from commercial entities are highly valued, especially when they are consistent.[277] However, the researcher should not rely only on commercial funding, since it might indicate that the researcher is not committed to 'pure' research.

Lastly, based on their structural criteria, academic recruiters might select researchers directly for their connections with the industry. When skimming the vacancies of Dutch nutrition research departments, the requirement of external connections is not explicitly mentioned, but there are signs that it is part of the hidden curriculum of nutrition research. According to Bart Penders, connections with the industry are highly valued within Dutch nutrition science departments, and as a consequence, the identities of academic and industrial nutrition researchers have significant overlap. This can for example be seen at Wageningen University, who has at least three dairy science professors that either have ancillary activities at an industrial research facility or occupy an industry-funded endowed chair.[278] Hiring industrial researchers for these high academic positions suggests that industrial connections (and funding) are highly valued and selected for by academic recruiters. Consequently, it is likely that hiring these specific professors has had far-going implications for the values and practices within the dairy science community.

[276] Arensbergen, P. V. (2014). Talent proof. selection processes in research funding and careers (Doctoral dissertation, *Amsterdam: Vrije Universiteit Amsterdam, Faculteit der Sociale Wetenschappen*).
[277] Hammarfelt, B., Rushforth, A. D., & de Rijcke, S. (2020). Temporality in academic evaluation:'Trajectoral thinking'in the assessment of biomedical researchers. *Valuation Studies*, *7*(1), 33-33.
[278] The three endowed professors are Lisette de Groot and Joost van Neerven. The professor with ancillary activities at the Friesland Campina Institute is Thom Huppertz.

Chapter 5: Concluding analysis

Having used the structural selectionist method to study Dutch nutrition science, the following step is to analyse its findings and answer my research questions. This chapter starts with answering the first research question: **Can a selectionist account on the development of values and practices in nutrition science explain why nutrition knowledge serves the industry's interests?** The selectionist account will be assessed using the findings on the values and selective processes from the previous chapter. Consequently, it is compared with its most popular competitor: the explanation of unconscious bias. After arguing that the selectionist explanation has more explanatory power, I reflect on the second research question of this thesis: **Can an integrated method composed of cultural selectionism and Robert Merton's structural functionalism develop powerful selectionist explanations of cultural development?** After answering the question, I use the case study to briefly reflect on its advantages, weaknesses and potential future applications. I then conclude this thesis by discussing how the findings of this thesis can be used to prevent the current day issues in nutrition science.

Values in nutrition science: a cultural selectionist explanation

According to the first part of the selection hypothesis, nutrition science communities hold value-attitudes and value-embedded practices that steer nutrition research towards the interests of the industry. The evidence discussed in section 4.3 suggests that such values indeed exist in the Dutch dairy science community. Both the 'dairy matrix' and cow milk allergy can be seen as value-embedded concepts that have spread through the dairy nutrition science community through their latent functions towards the industry (and in extension, academia). The dairy matrix (hypothesis 1a) concept helps nutrition researchers explain positive findings in studies on the health benefits of full-fat dairy products, and so increases the healthy image and sales of these products. The topic of cow milk allergy (hypothesis 1b) helps the industry increase their sales of specialized infant formula by reinforcing the medicalization of mostly harmless symptoms. Furthermore, the evidence shows that dairy nutrition researchers hold value-attitudes and beliefs about the public interest (hypothesis 1c) and scientific integrity that allow for the commercial interests of the industry to steer their research.

The second part of the selection hypothesis proposes that these values and value-embedded practices have gradually developed through the selective activities of the industry (hypothesis 2a) and academia (hypothesis 2b). Evidence discussed in section 4.4 supports these claims. Background interviews and other primary sources show that industrial funders are able to select topics and researchers based on their commercial interests. Researchers who do not use these topics and methods, or who might not share the same values as them, will therefore have a harder time gathering funding and publishing articles. Regarding academic selection, evidence suggests that universities' (nutrition) research departments indeed recruit and promote researchers based on their industrial connections and external funding. They therefore (indirectly) select for researchers that hold values and value-embedded concepts that are

functional towards the industry.

Despite this evidence, there are also signs that selection might be more complex than the selection hypothesis suggests. First, it appears that governmental research funding agencies can be seen as an additional structure that exerts selective pressure on the research community. Since these agencies play a large role in determining the themes and projects of private-public research, their selection of research proposals will definitely leave a mark on the values and practices of the nutrition research community. How they select and what effect this has on the nutrition science community is yet to be researched. Second, the interview with interviewee C shows that the selection of pro-industry topics and practices also occurs at an individual level. They described that when proposing a research project, they themselves select a topic based on how it fits with the industry's interests. It therefore appears that researchers are able to anticipate on industrial selection by internalizing the industrial interests and values, and already select value-embedded topics, methods and concepts in advance. This process can reinforce the industry's own selection process, and could benefit from further research: when does this occur and why?

Lastly, although the evidence suggests that the functional values in dairy science can be explained through selection, I want to point out that this explanation has much room for further support.[279] Due to the limited scope of this thesis, the case study only briefly investigates the historical dimension of values and selective processes. To recall, the historical dimension is needed in the structural selectionist method to distinguish functional elements that have developed through selection, from elements that are historical vestiges or that incidentally correlate with the selective practices. In order to establish causation between the values and selective practices, future research should test whether their connection is historically stable. Following the interventionist approach, the causal relation could also be tested by disabling or manipulating the selective practices that act upon the research community.

In sum, I suggest that this case study can best be seen as an exploratory one. Nevertheless, it demonstrates well that a selectionist explanation of values in nutrition science is not only possible but also plausible. In the next section I compare the selectionist account to the most popular alternative explanation: unconscious bias.

The selection hypothesis versus unconscious bias

The most popular way to explain why knowledge produced by current day nutrition science serves the industry's interests, is by referring to unconscious bias.[280] This bias can emerge when researchers have an interest in reaching a specific research outcome, or when industrial funding and gifts induce the unconscious tendency to reciprocate. Although unconscious bias itself is supported by several psychological experiments, its role in steering scientific studies and results has not yet been tested, leaving its empirical support fairly weak. The support for

[279] There are two additional aspects of the selectionist hypotheses that could benefit from more support. The first is whether positive findings for industrial funders is correlated with continued funding and a higher chance of increasing one's academic position. Future research could address this question using quantitative methods. The second is the transmission of functional values and practices to newer generations of researchers.

[280] Please see section 2.2

the selection hypothesis, however, consists primarily of the case study described in the previous chapter. Since the level of empirical support for both explanations is similar, we arrive at an impasse.

Fortunately, because we adopted the interventionist account of explanation in section 3.6, we can compare the explanatory power of these two explanations by analysing the explanatory standards they serve. When doing so, it appears that the selectionist explanation is better in serving the standard of precision: it is causally dependent on the existence of specific values, beliefs and value-embedded practices as well as selective processes that take place in multiple institutions. In short, it is very detailed. Unconscious bias, on the other hand, only needs industrial research funding, gifts, or researchers with interests in certain research outcomes to develop an explanation. Since the latter requirements are fairly common and unspecific, the selection hypothesis offers more opportunity for asking counterfactual questions. Even though one could argue that most of these counterfactual questions haven't been fully answered yet, one could at least say that the selectionist account has more potential explanatory power. Furthermore, the context of the problem and research question both require a precise explanation. In order to choose between one of the many proposed management strategies to prevent or solve the current day issues in nutrition science, we need a precise explanation of how these issues arise, and what mechanisms are involved.[281] The selection hypothesis can offer us such a precise explanation.

Regarding the explanatory standard of idealization, both accounts appear to use similar levels of abstraction and generalization. Unconscious bias for example does not specify how gifts can lead to reciprocation, or when researchers' interests in certain outcomes actually steer the research and when not. The selection hypothesis, on the other hand, generalizes that the industry picks their researchers and topics in an ideal manner, and that researchers with less funding actually leave academia faster. However, there is one other explanatory standard that favours the selection hypothesis: the standard of integration.[282] This standard values explanations that are able to integrate with existing knowledge or theoretical frameworks. Since the selection hypothesis is well-embedded in the literature on values in science, and coincides with models and theory from cultural evolution, it has more explanatory power than the account of unconscious bias.[283]

Assessing structural selectionism

After affirming the first research question, it is now also possible to discuss the second one. In short, evidence shows that the integrated method of structural selectionism can indeed offer valid and powerful explanations on cultural development. It is able to uncover functional values and practices, and then link them with selective pressures and historical events that serve as their explananda. Nevertheless, there are still several improvements to be made. First, for uncovering the values of a community, it might prove useful to replace or combine Merton's

[281] See also the last subsection of chapter 5.
[282] Ylikoski & Kuorikoski (2010). Dissecting explanatory power.
[283] It must be remarked that future research might discover that the two explanations are compatible. It could be that unconscious bias shapes the values of researchers, and steers them towards using value-embedded practices that will form the material for selection to act upon.

focussed interview method with textual analysis or observational work. Although the focussed interview can shed light on certain structures, processes and the functions of some elements, it is hard to use it for uncovering values-attitudes.

Next, when one uses the structural selectionist method to study an element, the method forces the researcher to take into account multiple structural sources of selection. In doing so, the scope of the study quickly becomes very wide, and might overload the researcher. Future research should aim to narrow down on one or two structures, or perhaps study the development of one single element. The problem is worsened when the historical dimension is added to the mix. Although important for confirming the historical relation between functional elements and their selective origins, it complicates the research process by adding much extra work. Future structural selectionist work should focus on cultural elements that are easily to link to historical selective processes, and could make use of methods from the digital humanities.

The potential future applications for structural selectionism are numerous. It could for example be used to further study the selection hypothesis on values in nutrition science, or expand to other disciplines that deal with similar issues like the pharmaceutical sciences. However, it can also be used to study other forms of cultural norms, practices, traditions or values – especially when the research question aims to uncover their spread and their relation with other cultural elements or structures. Furthermore, the method will be the perfect candidate for explaining cultural phenomena that exhibit intelligent designed functions without having a clear designer, like conspiracy theories and misinformation.[284]

Lastly, structural selectionism might also serve as a heuristic framework by informing other forms of social research like journalism. To illustrate, many news articles that discuss the current day issues in nutrition science tend to sketch an image of greedy researchers that intentionally manipulate the research process for their own interests, or of immoral food companies that corrupt researchers. Although these headlines might incite our moral faculty and draw a lot of attention, the reality might be more complex and involve not only intentional actions and agents, but also dysfunctional cultural elements and conflicting structures. By emphasizing the structural aspects of societal problems, social researchers and journalists can produce an understanding that is truer to reality, prevent societal polarization and invent sustainable solutions to these problems.

Managing commercial values in nutrition science

The public and scholarly debate on how to solve the current day issues in nutrition science have resulted in a myriad of possible suggestions. However, when we accept the selection hypothesis, most of them will turn out to be insufficient, and some even counterproductive. To start off, some science scholars and public-sided nutrition researchers have called for increased education and awareness on scientific integrity. They argue that by launching educational programs and drawing up codes and principles that prescribe how researchers should deal with

[284] See for example this interesting study on the cultural evolution of witchcraft: Hofhuis, S., & Boudry, M. (2019). 'Viral'hunts? A cultural Darwinian analysis of witch persecutions. *Cultural Science Journal*, *11*(1), 13-29.

industrial funding, they can the raise the norms and integrity of nutrition scientists.[285] According to the selection hypothesis, these measures might help but are not sufficient. An obedient PhD student who complies with the new guidelines and codes will have a lower chance of gaining repeated industrial research funding than a PhD student who is eager to accept the input and advice of his industrial partner. Therefore, as long as the industry and academia keep selecting and rewarding nutrition scientists for holding values and practices that lead to beneficial results for the industry, they will select against researchers who hold these new norms.[286]

Another often suggested solution is increasing the transparency of research. These suggestions include measures like declaring conflict of interests, pre-registering studies in public registries, and obliging researchers to disclose their funding sources and ancillary activities. It has been recorded that these measures have some positive effects, and many public experts and civil society organisations like Foodwatch support this approach because it can help understand the issues and make researchers more accountable.[287] However, industry-funded researchers themselves also regularly argue for more transparency, often with the explicit aim of restoring peoples trust in nutrition science.[288] The catch is that most forms of transparency do not prevent research from serving the industry's interests.[289] Research that benefits the industry does not cede to be beneficial when it becomes transparent, and since values guide research in very subtle ways, most people will not be able to detect how the research is steered towards the industry's interests. Even worse, if it creates more public trust without increasing the public relevance of nutrition science, it might defuse the public awareness of this societal problem and hinder forms of truly effective change.

Instead, the selection hypothesis suggests that attention should be paid to the incentive structure of science. Only when governments and academia start rewarding researchers for contributing to academic or public goals, the values and value-embedded practices of researchers might gradually start to change. For the government, this would mean decreasing the high percentage of public-private research, and instead start funding research projects and themes selected for their potential contributions to the public interest. This could for example be done by devising funding criteria based on questions about what a project can bring to long term public welfare and wellbeing. In a similar fashion, academia should start including the public interest within its definition of academic excellence. Instead of rewarding industrial connections and funding, universities can hire and promote researchers for their contributions to the public or their field.

These suggestions are of course easier said than implemented, and it could have negative consequences for certain other structures. The Netherlands and its dairy industry might for

[285] Marlon Nestle holds this view. For the Dutch case, see: Versprille, H. (2016, October 1). Voedingswetenschap kan niet zonder geld van het bedrijfsleven. *Parool*.
[286] This argument also applies to the suggestion to manage by industrial values by creating fora where the researchers can engage with the public and civil society organisations, as suggested by Kevin Elliot. See section 2.4.
[287] This is paraphrased from a conversation with the campaign leader of Foodwatch Netherlands, Frank Lindner.
[288] When interviewee C accepted my interview request, they said they did so because they found that their university was not transparent enough about industrial funding.
[289] Hobma, M. (2023). Keeping bias out of industry-funded research requires more than just transparency. *A Blog of Trial & Error*. (forthcoming)

example lose its superior economic position and there might be less money available for academic research due to the withdrawal of industrial funding. Perhaps the only way to prevent the former problem is to orchestrate the above mentioned changes on a global or maybe European level. The latter problem could be solved by increasing public research funding and taxation.

Drawing in to a close, academia should also start reflecting on its concept of scientific integrity. The current definition of scientific integrity that emphasizes the importance of empirical accuracy and robust methods can actually obscure the influence of industrial values on nutrition research. By explicitly including the public interest as part of scientific integrity - and combining this with the aforementioned reform of the incentive structure of science - nutrition researchers might finally start producing results that are truly beneficial to the public.

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