TEXT ANALYSES FOR IDENTIFYING AND MITIGATING MORAL POLARIZATION ABOUT GENETICALLY ENGINEERED FOOD CROPS

Universität Hamburg

Fakultät für Wirtschafts- und Sozialwissenschaften

kumulative Dissertation

Zur Erlangung der Würde der Doktorin der Wirtschafts- und Sozialwissenschaften

doctor rerum politicarum

(gemäß der Promotionsordnung vom 18. Januar 2017)

vorgelegt von

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geboren in Halle (Saale)

Hamburg, den 31. Januar 2023

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Datum der Disputation: 04. Dezember 2023

Danksagung

Zuallererst möchte ich gegenüber Prof. Dr. Ulrich Fritsche meine größte Dankbarkeit ausdrücken, da dieses Projekt nur mit seiner großen Unterstützung, seinen zahlreichen Ratschlägen und seiner unerschütterlichen Geduld gelingen konnte. Durch seinen enormen Wissensschatz und der daraus resultierenden Weitsicht hat er mir entscheidend geholfen, mich methodisch und im größeren wissenschaftlichen Kontext zu orientieren und zu positionieren. Auch ist seine unerschöpfliche Neugier auf mehr Wissen für mich inspirierend.
Weiterhin danke ich Prof. Yoel Inbar, PhD, dafür, dass ich von ihm lernen konnte, wie man nach wissenschaftlich höchsten Standards Antworten auf die richtigen Fragen sucht. Und dabei viel Freude hat. Bedanken möchte ich mich auch bei Prof. Dr. Jörg Döpke, welcher meine Entwicklung als Wissenschaftlerin schon lange mit äußerster Geduld und Zuversicht begleitet, und mich dabei sowohl fachlich als auch als Mentor immer wieder entscheidend unterstützt. Auch Prof. Dr. Matthias Uhl ist für mich ein wichtiger Mentor geworden. Seine große fachliche Expertise bereichert mein wissenschaftliches Arbeiten immer sehr. Dafür möchte ich mich bedanken. Mein Dank gilt auch Prof. Dr. Ingo Pies, da ich durch ihn viel Übung im theoretischen und konzeptionellen Denken erhalten habe, und mich das von ihm vermittelte Wissen zur Gesellschaftstheorie zuverlässig bei jeder Problemanalyse begleitet.
Dem Leibniz WissenschaftsCampus Halle – Pflanzenbasierte Bioökonomie (WCH) danke ich, da diese Dissertation nur durch dessen finanzielle Unterstützung möglich geworden ist.
Auch der Edmund Rehwinkel-Stiftung und dem Europäischen Fonds für regionale Entwicklung (EFRE) danke ich für die finanzielle Unterstützung. Herzlich danken möchte ich dem Leibniz-Institut für Agrarentwicklung in Transformationsökonomien (IAMO), da vor allem dessen administrative und infrastrukturelle Unterstützung essentiell war, um das vorliegende Dissertationsprojekt nach höchstem wissenschaftlichen Standard durchführen zu können. Herzlich danken möchte ich dabei auch Prof. Dr. Alfons Balmann, welcher meine Forschungsideen immer unterstützt hat und mir so alle Wege eröffnet hat, mich als Wissenschaftlerin zu entwickeln. Auch das Promotionskolleg Agrarökonomik hat entscheidend zu meiner wissenschaftlichen Entwicklung beigetragen. Hier möchte ich vor allem die Unterstützung durch Dr. Franziska Schaft hervorheben.
Besonders meinen Eltern bin ich zutiefst dankbar, weil sie mir – schon immer – geholfen haben, meine Pläne umzusetzen – selbst in den Fällen, in denen sie mir vorher zu einem anderen Weg geraten hatten. Mein größter Dank gilt auch M.C. Crown, weil er diese Dissertation nicht nur inhaltlich unterstützt hat, sondern sein Rückhalt, sein Verständnis und zahlreiche Entlastungen mir die Energie gegeben haben, dieses Projekt abzuschließen. Und mir nebenbei immer wieder gezeigt hat, wieviel Spaß das Leben macht. Aber auch meinen Großeltern, Uli, Lisa, Mariam, Tina Spatz, Alex, Rosi, Betti, Clara und Limbo bin ich dankbar, da sie meine Promotionszeit leichter, und schöner gemacht haben.

Widmung

Ich widme diese Dissertation meinen Eltern, die mir beigebracht haben, meine Träume zu verfolgen, und zu verwirklichen.

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Kurzfassung

Die wirtschaftswissenschaftliche Disziplin erhebt den Anspruch, ihre theoretische Weiterentwicklung dem Wohle der Menschheit in den Dienst zu stellen. So ist laut Erlei et al. (2007) nicht nur die positive Analyse Aufgabe der Wirtschaftswissenschaften, sondern auch darauf aufbauende normative Theorie zur Überwindung von Knappheitsproblemen. Daraus folgt, dass die Theoriebildung in den Wirtschaftswissenschaften mit der Anwendbarkeit der Disziplin auf aktuelle dringliche Probleme der Gesellschaft Hand in Hand gehen muss.

Die vorliegende Arbeit macht sich diese Aufgabenstellung zu eigen, indem sie mit der deutschen Debatte um die Grüne Gentechnik, d.h. um gentechnische Veränderungen von Nahrungspflanzen, ein gesellschaftlich hoch brisantes Thema untersucht, dessen weiterer Verlauf nicht nur national, sondern auch international große Auswirkungen auf die Entwicklung der Landwirtschaft, der Technologie, der Lebensmittelproduktion und des Handels hat.

Die langandauernde Gentechnikdebatte zeichnet sich besonders dadurch aus, dass, im Gegensatz zur öffentlichen Meinung, unter den wissenschaftlichen Akademien nahezu Konsens besteht, die Technologie sei an sich nicht riskanter als konventionelle Züchtungsverfahren (National Academies of Sciences, Engineering, and Medicine, 2016; German National Academy of Sciences Leopoldina [Leopoldina] et al., 2019; Leopoldina et al., 2015). Trotz zahlreicher Kommunikationsversuche ist es der Wissenschaft bisher allerdings nicht gelungen, sichtbar zu einer Aufklärung der öffentlichen Debatte beizutragen.

Die vorliegende Arbeit geht daher den Fragestellungen nach, warum die Debatte so lange ohne Einigung geblieben ist, und wieso die Informationen aus der Wissenschaft keine Wirksamkeit zu haben scheinen.

Dabei konzentriert sich die Arbeit besonderes auf die moralischen Intuitionen, die latent in den Argumenten der Gentechnikdebatte erkennbar sind. Dies wird im ersten Kapitel dargelegt, indem, ausgehend vom Paradigma der Neuen Institutionenökonomik, moralische Intuitionen als informelle Institutionen verstanden werden, die das gesellschaftliche Zusammenleben koordinieren, um Transaktionskosten zu senken. Nun legt die Arbeit besonderes Augenmerk auf die Fälle, in denen die moralischen Intuitionen zu adversen Effekten führen. Diese können zum Beispiel moralische Konflikte sein, die Diskurse behindern und so gesellschaftliche Entscheidungsfindungsprozesse erschweren. Im Falle der Debatte um Grüne Gentechnik vermutet die vorliegende Arbeit solche moralischen Konflikte.

Da sich für die Untersuchung möglicher moralischer Konflikte Textanalysen besonders eignen, entwickelt das zweite Kapitel der Arbeit einen textanalytischen Ansatz, mit dem latente moralische Intuitionen in Argumenten identifiziert werden können. Dieser theoretische Ansatz argumentiert, dass moralische Intuitionen, verstanden als die Moral Foundations der Moral Foundations Theory (Haidt, 2012), eine spezifische strukturelle Funktion für den Gruppenzusammenhalt erfüllen. In ersten Ergebnissen weist das Kapitel nach, dass sich die Foundations über die jeweilige strukturelle Funktion verlässlicher im Text identifizieren lassen als mit vergleichbaren Vorgehensweisen. Daraus ergeben sich nicht nur methodische Weiterentwicklungen, sondern auch theoretische Beiträge zur zugrunde gelegten Theorie.

Im dritten Kapitel stellt die Arbeit eine moralische Polarisierung in der Debatte fest. Dies geht aus einer Inhaltsanalyse offizieller Stellungnahmen der prominentesten Debattenakteure hervor. Dafür werden die Argumente der Gentechnikdebatte induktiv herausgearbeitet. Außerdem wendet das dritte Kapitel den im zweiten Kapitel entwickelten strukturellen Ansatz an, um deduktiv die latenten Moral Foundations der Argumente zu identifizieren. Dabei wird an mehreren Stellen Potenzial für moralische Konflikte festgestellt. Während die Gentechnikbefürwortenden der technischen Entwicklung und dem wissenschaftlichen Fortschritt optimistisch gegenüberstehen, sind die Gentechnikablehnenden skeptisch und besorgt über den technischen Fortschritt und die Moderne, verbunden mit der Sorge um eine zunehmende Entfremdung.
Im vierten Kapitel stellt die Arbeit das Potenzial für moralische Konflikte auch in der breiten Öffentlichkeit Deutschlands fest. In einer repräsentativen Befragungsstudie werden die Narrative abgefragt, die die Probanden zu ihrer Gentechnikeinstellung bewegen. Außerdem bietet die Studie Einblick in die mentalen Modelle, die zur Gentechnik in Deutschland vorherrschen, sowieso in den Einfluss von Emotionen und sozioökonomischen Faktoren auf die Einstellung. Dazugehörige Freitextantworten werden mit einer Inhaltsanalyse untersucht und mithilfe des strukturellen Ansatzes aus dem zweiten Kapitel den latenten Moral Foundations zugeordnet. Die Ergebnisse deuten darauf hin, dass die Öffentlichkeit sich bei ihrer Meinungsbildung auf unterschiedliche Moral Foundations konzentriert. Während Gentechnikablehnende häufiger Narrative zu Gesundheitsrisiken (Care Foundation) nennen, erwähnen Befürwortende häufiger Narrative zur allgemeinen Wohlfahrt (Loyalty Foundation). Ergebnisse einer linearen Regression zeigen, dass diese Ergebnisse signifikant sind. Interessanterweise deutet die Analyse der mentalen Modelle daraufhin, dass sowohl Gentechnikablehnende als auch -befürwortende die Technologie als etwas unnatürliches, unnormales sehen. Nur scheint dies bei den Befürwortenden nicht ausschlaggebend für die Einstellung zu sein.
Das fünfte Kapitel stellt eine moralische Polarisierung in der breiten Öffentlichkeit Deutschlands fest. Dabei zeigen Gentechnikablehnende besonders extreme moralische Überzeugungen auf. Ausgehend von einem wirtschaftsethischen Lösungsansatz wird im fünften Kapitel ein repräsentatives Survey Experiment durchgeführt, in dem die Flexibilität der moralischen Überzeugungen getestet wird. Obwohl die moralischen Überzeugungen zur Gentechnik stabil sind, zeigen die Ergebnisse Potenziale zur Überwindung des Konfliktes auf.
Das sechste Kapitel diskutiert, interpretiert und evaluiert die Ergebnisse der Arbeit. Ausgehend vom Paradigma der Neuen Institutionenökonomik und einer daraus hervorgehenden funktionalen Wirtschaftsethik diagnostiziert die Arbeit eine Blockade der Debatte durch moralische Polarisierung. Zudem führt der Fokus auf unterschiedliche Moral Foundations zu Wertekonflikten. So stellt die Arbeit fest, dass Moral im Fall der Gentechnikdebatte teilweise einen konstruktiven Diskurs behindert, deshalb soziale Lernprozesse hemmt und zu inferioren politischen Entscheidungen führt, die nicht mit dem wissenschaftlichen Erkenntnisstand kongruent sind.
Aufbauend auf den daraus gewonnenen Erkenntnissen beschreibt das sechste Kapitel einen wirtschaftsethischen Lösungsansatz zur Überwindung dieser moralischen Polarisierung: Eine Fokusverschiebung auf gemeinsame, übergeordnete moralische Werte kann die moralische

Polarisierung abschwächen und einen konstruktiven Diskurs ermöglichen. Dieser Ansatz wird im fünften Kapitel auch mit ersten erfolgversprechenden Ergebnissen getestet. Aus den Erkenntnissen werden im sechsten Kapitel Handlungsempfehlungen abgeleitet.
Die Ergebnisse der vorliegenden Arbeit entwickeln die Subdisziplinen Neue Institutionenökonomik, Wirtschaftsethik und Narrativökonomik methodisch und theoretisch weiter und regen an, die Moral als informelle Institutionen verstärkt zum Gegenstand wirtschaftswissenschaftlicher Untersuchungen zu machen. Die aufgezeigten Handlungsempfehlungen bezeugen, dass die Wirtschaftswissenschaften mit ihren methodischen und theoretischen Werkzeugen einen Beitrag zur Lösung aktueller Probleme leisten können.

Stichwörter: Latente Inhaltsanalyse, Text als Daten, Moral als informelle Institution, Gentechnikdebatte, moralische Polarisierung, Moral Foundations Theory

Summary

The discipline of economics claims to put its theoretical development at the service of human welfare. Thus, according to Erlei et al. (2007), not only positive analysis is the task of economics, but also resulting normative theory to overcome scarcity problems. It follows that theory building in economics must go hand in hand with the applicability of the discipline to current pressing problems in society.

This thesis embraces this task by examining the German debate on the genetic engineering of crops for human consumption, a socially highly charged issue whose further course has major implications, not only nationally but also internationally, for the development of agriculture, technology, food production, and trade.

A particular feature of the long-lasting debate on genetic engineering is that, contrary to public opinion, there is a near consensus among the scientific academies that the technology does not in itself pose any greater risks than conventional breeding methods (National Academies of Sciences, Engineering, and Medicine, 2016; German National Academy of Sciences Leopoldina [Leopoldina] et al., 2019; Leopoldina et al., 2015). However, despite numerous attempts at communication, science has not yet succeeded in visibly contributing to clarifying the public debate.

The present work therefore addresses the questions of why the debate has been remaining without agreement for so long, and why the information provided by the scientific community does not seem to have any effectiveness.

In doing so, this thesis places a special emphasis on the moral intuitions that are latent in the arguments of the genetic engineering debate. Therefore, based on the paradigm of New Institutional Economics, the first chapter describes moral intuitions as informal institutions that coordinate social coexistence in order to reduce transaction costs. Now, the thesis pays special attention to the cases in which moral intuitions lead to adverse effects. These can be, for example, moral conflicts that obstruct discourses and thus hinder social decision-making processes. In the case of the genetic engineering debate, this thesis suspects such moral conflicts.

Since text analyses are particularly suitable for investigating possible moral conflicts, the second chapter of the thesis develops a text analytic approach that can be used to identify latent moral intuitions in arguments. This theoretical approach argues that moral intuitions, understood as the moral foundations of Moral Foundations Theory (Haidt, 2012), serve a specific structural function for group cohesion. In initial results, the chapter demonstrates that the foundations can be identified more reliably in the text via their respective structural function. This results not only in methodological advancements, but also in theoretical contributions to the underlying theory.

In the third chapter, the thesis identifies a moral polarization in the debate. This emerges from a content analysis of official statements of the most prominently debating actors. For this purpose, the arguments of the genetic engineering debate are inductively carved out. Furthermore, the third chapter applies the structural approach developed in the second chapter to deductively identify the latent moral foundations of the arguments. In doing so, potential for moral conflict is identified at several points. While those in favor of genetic engineering are

optimistic about technological development and scientific progress, those opposed to genetic engineering are skeptical and concerned about technological progress and modernity, coupled with concerns about increasing alienation.
In the fourth chapter, the thesis establishes the potential for moral conflict among the general public in Germany as well. In a representative survey study, the narratives that motivate the subjects' attitudes toward genetic engineering are identified. In addition, the study offers insight into the mental models that prevail on genetic engineering in Germany, as well as into the influence of emotions and socio-economic factors on attitudes. Corresponding free text answers are examined with a content analysis and assigned to the latent moral foundations using the structural approach from the second chapter. The results indicate that the public focuses on differing Moral Foundations when forming their opinions. While opponents of genetic engineering more often mention narratives on health risks (Care foundation), supporters more often mention narratives on general welfare (Loyalty foundation). Results of a linear regression show that these results are significant. Interestingly, the analysis of mental models suggests that both opponents and supporters of genetic engineering see the technology as something unnatural, abnormal. Only this does not seem to be a determining factor for attitudes among supporters.
The fifth chapter identifies a moral polarization among the general public in Germany. Those who reject genetic engineering show particularly extreme moral convictions. Based on an economic ethics approach, a representative survey experiment is conducted in the fifth chapter to test the flexibility of those moral beliefs. Although moral beliefs about genetic engineering are stable, the results show potential for overcoming the conflict.
The sixth chapter discusses, interprets, and evaluates the results of the thesis. Based on the paradigm of new institutional economics and a functional economic ethics emerging from it, the thesis diagnoses a blockage of the debate by moral polarization. Furthermore, the focus on different moral foundations leads to value conflicts. Thus, in the case of the genetic engineering debate, the thesis finds that morality partly hinders constructive discourse, therefore inhibits social learning processes, and leads to inferior political decisions that are not congruent with scientific knowledge.
Building on the insights gained, the sixth chapter describes an economic ethics approach to overcoming this moral polarization: a shift in focus to shared, overarching moral values can mitigate moral polarization and enable constructive discourse. This approach is also tested in the fifth chapter with first promising results. From these findings, recommendations for action are derived in the sixth chapter.
The results of this thesis further develop the subdisciplines of New Institutional Economics, Economic Ethics and Narrative Economics both methodologically and theoretically, and suggest that morality as informal institutions should increasingly be made a subject of economic studies. The recommendations for action outlined testify to the fact that economics, with its methodological and theoretical tools, can make a contribution to solving current problems.

Keywords: latent content analysis, text as data, morality as an informal institution, genetic engineering (GMO) debate, moral polarization, Moral Foundations Theory.

Chapter 1 –
General Introduction[1]

Currently, society faces numerous challenges, of which climate change and food insecurity are prominent ones. For example, climate change has already started to cause more extreme weather phenomena, such as droughts or floods (Ali et al., 2020; Woodward & Samet, 2018). These lead to an increased number of crop failures and adverse conditions for crop cultivation. These developments put pressure on food security (Murray-Tortarolo & Jaramillo, 2019; Verschuur et al., 2021). At the same time, the world population continues to grow and thus requires ever more nutrition (Kc et al., 2018).

In order to ensure food security, economic policymakers need to appropriately react to these developments. One way to do so is through the development and implementation of new technology and innovation that is better adapted to the adverse agricultural conditions (Deutsch, 2011; Lomborg, 2021; McAfee, 2020). However, making agriculture more sustainable, i.e., more environment-friendly and better adapted to climatic conditions, requires a large structural transformation of the agriculture system (Frank et al., 2018). Such disruptive changes can lead to conflict. One prominent example is the cultivation of genetically engineered crops for human consumption[2] (GE) in Germany. The supporting side mainly consists of scientists involved in this biotechnology. They virtually unanimously agree that GE should be widely integrated into modern agriculture (Leopoldina et al., 2019). The opposing side mainly consists of non-governmental organizations (NGOs) who campaign for a ban of GE from agricultural production (Kampagne Meine Landwirtschaft, 2022). A third large group is the German public, in which rejection remains strong: research finds rejection rates between 66% and 83% of the German public (Scott et al., 2019; Jauernig et al., 2021).

The German debate about GE has been fierce for roughly thirty years, without signs of agreement. To date, the divergence of attitudes towards GE seems irreconcilable. Such impeded public political debates can have immense costs on society (North, 1992). One likely reason for this is that if the policy-making process cannot move forward, the result can be adverse policies, or no policies at all. This hinders efficient markets (North, 1992).

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[1] This entire dissertation is formatted according to the guidelines of the American Psychological Association. (2020). *Publication manual of the American Psychological Association 2020: the official guide to APA style* (7th ed.). American Psychological Association.

[2] Rather than using the terms "genetical modification" or "genetically modified organisms" which are more common in popular media, the present work uses the term "genetic engineering" throughout all manuscripts. This is because "genetically engineered" more precisely describes the biotechnology in question. According to the National Academies of Sciences, Engineering, and Medicine [NASEM] (2016, p. 58), the term "genetically modified" is broader, referring to any type of genetic modification. Therefore, "genetically modified" can even include conventional breeding.

On top of this, the case of the German GE debate is particularly peculiar, because of strong divergence between public opinion[3] in Germany, and the overwhelming scientific evidence provided by scientists involved in genetic engineering: assessments of hundreds of studies on safety and benefits of the technology conducted by national scientific academies and national scientific organizations repeatedly reach the conclusion that GE crops are as safe as conventional crops and that potential risks are not inherent in the technology (see for example Leopoldina et al., 2019; NASEM, 2016; BBAW, 2018; BMBF, 2014).
So far, it remains unclear why parties still could not reach agreement despite the provision of information by scientific organizations. Bearth and Siegrist (2016) conclude that attitudes towards this technology appear rather based on intuitions. Moreover, newer research points towards a moralization of the topic among GE opponents (Scott et al., 2016). Research on other topics has shown that such strong moralizations are very hard to mitigate or change, compared to evaluations based purely on cost-benefit analyses (Skitka et al., 2005; Skitka, 2010; Skitka et al., 2021).

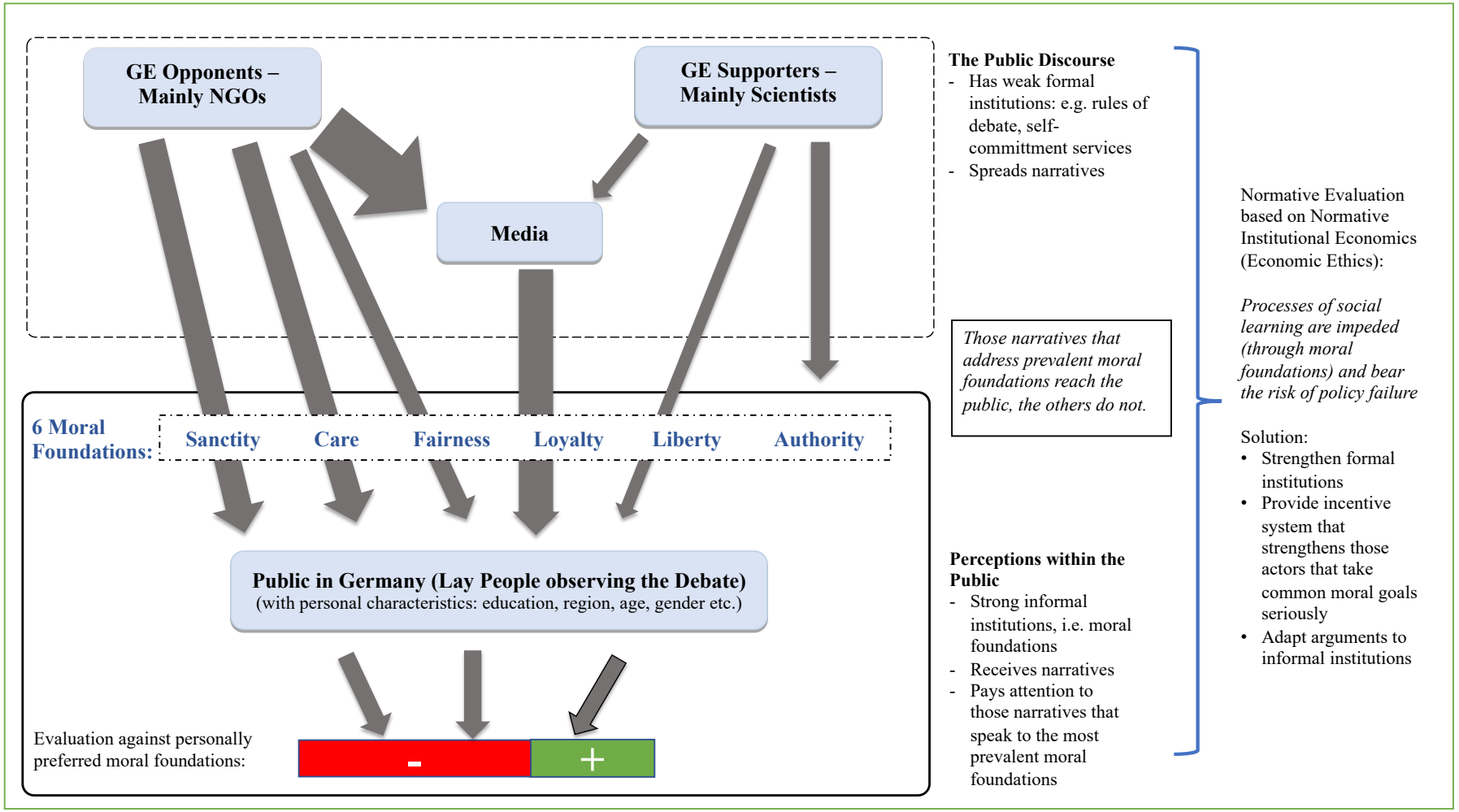
The Present Thesis

The present thesis frames this problem as an information problem, and assumes the current state of science to be the benchmark for assessing whether public debates suffer from misinformation or not. This makes the problem addressed in this thesis twofold: On the one hand, the debate generally does not seem to move forward, regardless of the information exchanged in the arguments. On the other hand, the popular public opinion about GE does not align with available scientific evidence.
Furthermore, the present thesis proposes to address this information problem within the framework of new institutional economics. Building on the framework of new institutional economics, the present work hypothesizes that the ongoing conflict about GE is rooted in diverging informal institutions, i.e. strong moral intuitions. Both sides, opponents and supporters, moralize the topic, and base their evaluation on distinct moral intuitions, which leads them to different moral conclusions.
Thus, the scientific problem addressed in this thesis is a potentially detrimental role of institutions, i.e. particularly moral intuitions, in societal conflicts. Taking the German debate about GE as an example, this work tests whether the debate is polarized through moralization, how strong this moral polarization is, which moral intuitions are relevant for which side, and how they may conflict. For this purpose, the project also aims to develop a methodological approach to identify latent moral intuitions through text analyses.
In a nutshell, the goal of this thesis is to contribute to explaining why
1) the German GE debate has been going on for so long without agreement,
2) and why scientific information does not seem to contribute to advancing the debate.
This endeavor shall also yield possible routes for mitigating a potential moral polarization.

[3] In this thesis, the used terms “public opinion”, or “the public”, generally refer to the aggregated perceptions and attitudes of a distribution across the (lay) people living in Germany, who observe the debate and form their view based on factors such as information, moral beliefs, or socioeconomic characteristics.

Figure 1.1

Moral Foundations as Informal Institutions that Guide Behavior and Decision-Making about Complex Topics such as Genetic Engineering



Theoretical Background

New Institutional Economics as Analytical Framework

This chapter approaches the problem from a perspective of new institutional economics and shows how the integration of insights from other fields (i.e. narrative economics, economic ethics, moral psychology, and consumer and acceptance research) helps to develop hypotheses to solve the problem. Figure 1.1 illustrates the reasoning of this approach.

Institutions Help to Reduce Transaction Costs

New institutional economics holds, just as does classical economic theory, that agents make individually beneficial decisions dependent on the restrictions they are facing under scarcity. Under perfect information and perfect rationality, such behavior leads to optimal outcomes and efficient markets. The present thesis understands public debates as markets as well, since they can essentially be described as a marketplace of ideas and interests (Mill, 1859).

However, and this distinguishes new institutional economics from neoclassical theory, transaction costs prevent perfect information and thus lead to inefficiencies (Coase, 1937, 1988). Due to this imperfect information and limited personal resources, Simon (1990) described economic agents as boundedly rational. He proposed that individuals do not maximize but *satisfice* their outcomes (Simon, 1956).

One way to lower transaction costs is through institutions that regulate a market (of ideas) (North, 1992). It shall be pointed out that the argument made in this thesis is *functional*: bounded rationality gives rise to the necessity of institutions. In this, institutions are seen as an adaptation to uncertainty, with the goal to coordinate (social) behavior and decision-making towards increased social welfare. Institutions can be formal and external, such as laws and constitutions; but also, informal and internal, such as culture and morality, e.g. moral values (Erlei, 1998; Erlei et al., 2007).

Morality as an Informal Institution

The importance of *informal institutions* as a factor of transaction costs was first pointed out by Douglass North. For North (1992, p. 9), "[i]nstitutions consist of formal rules, informal constraints (norms of behavior, conventions, and self-imposed codes of conduct), and the enforcement characteristics of both. In short, they consist of the structure that humans impose on their dealings with each other."

The present thesis focuses on such *informal* institutions, particularly on *morality* as informal institution.

Just as formal institutions, morality serves as a regulatory tool for human interaction, because it increases costs for some behavior and decreases costs for other behaviors (Leschke, 1996). For example, in Economic Ethics and Behavioral Economics, *trust* is long known to influence transaction costs and coordinate social behavior (see for example Gilbert, 2010; Fehr, 2009). Specifically, Gilbert (2007) pointed out that trust coordinates and enables cooperation. Due to imperfect information, trust is indispensable for economic transactions because it helps to reduce complexity and thus transaction costs (Gilbert, 2007).

Moreover, morality as an informal institution plays a decisive role in the judgment of economic agents (see for example Benabou et al., 2020; Kirchgässner, 2011; Mayer, 2001). For example,

Gilbert (2001) argues that stakeholders evaluate corporations not only according to economic output but also according to their compliance with moral responsibilities.

Morality as an Informal Institution is an Adaptation to an Uncertain Environment

The adaptive advantage of morality is to coordinate individual actions for the benefit of individuals because they enable socially desirable outcomes (Erlei et al., 2007). Interpreting morality as an adaptation to an uncertain environment is a functional approach to morality. This functional approach to morality as an adaptation is consistent with current understandings and evidence in moral, social, and evolutionary psychology, and evolutionary science more general (see for example Haidt, 2007; Gazzillo et al., 2020; Graham et al., 2013; Machery & Mallon, 2010).

Even less functional approaches, e.g. Gilbert (2007), point out that *trust* is neither purely calculated nor applied – after rational cost-benefit evaluation – whenever institutions or contracts do not suffice. Rather, trust depends much on affective-emotional intuition. This perspective is in line with findings on (moral) judgment and decision-making (see for example Kahneman, 2011; Haidt, 2001).

As mentioned above, the coordinating function of morality as an informal institution extends to public debates as well, since they can essentially be described as a marketplace of ideas and interests (Mill, 1859).

Informal Institutions Can be Miscalibrated

If these markets of political ideas are impeded, they can result in discourse failures. These can become detrimental to social welfare because they hinder the development of adequate policy-strategies (Blocher, 2007; Ingber, 1984; Pies, 2021). The result can be inferior or adverse policies, especially if a public debate is misguided by false alarms (for further information and examples see Lomborg, 2021). This means, the risk is collective self-damage through the individually (bounded) rational decision to reduce transaction costs through following quick moral intuitions that may be misguided.

Consequently, the present thesis argues that if morality coordinates public debates as an adaptation to reduce transaction costs, it might very well be the case that they are miscalibrated, leading to undesirable outcomes with adverse effects on economic outcomes and policymaking. Just as some formal institution might not be suitable for certain goals, morality might also be misleading. This may be particularly true if morality is an affective adaptation rather than a purely rational cost-benefit analysis.

Thus, the longstanding disagreement in the German GE debate, as well as the inefficacy of scientific information, might be rooted in *conflicting moral foundations*.

Moral Foundations Theory

Specifically, Jonathan Haidt and his colleagues developed the Moral Foundations Theory (MFT) that posits six innate moral foundations that constitute human morality (Haidt, 2012). These moral foundations are Care, Fairness, Loyalty, Authority, Liberty, and Sanctity. Based on ample scientific evidence in many countries of different cultures, the theory proposes that everyone is guided by these innate moral foundations, but people differ in which moral foundations are more important to them (Graham et al., 2013). These moral foundations are

affective and intuitive, triggered by moral emotions that help to evaluate whether a moral foundation is violated or catered to (Haidt, 2012). MFT is thoroughly explained in Chapter 2 of this thesis.
Referring back to the debate about GE, differing moral foundations might be the root of moral conflict: If different individuals find different moral foundations to be relevant for the evaluation of GE, they might conclude with different opinions about the technology.
The assumption that diverging moral intuitions, or moral foundations, lead to differing attitudes is consistent with findings on other (polarizing) topics, for example on political orientation, vaccine hesitancy, recommended policies, or gun laws (see for example Diaf et al., 2022; Amin et al., 2017, Graham et al., 2009; Graham et al., 2012; Cook, 2015).

Moral Foundations as Problem-relevant Restriction in the German GE Debate

Consequently, based on the research program of new institutional economics (Erlei et al., 2007), it is argued that moral foundations are a problem-relevant restriction influencing judgment and behavior. More specifically, through reviewing the literature on GE attitude, it is argued that moral foundations might be among the most relevant causes for the stability of the debate, as well as the inefficacy of scientific information. They thus deserve – and require – a deeper investigation in new institutional economics.

The relevant causes are:

1) (prohibitively) high transaction costs for information,
2) socioeconomic variables and personal characteristics,
3) adverse effects of incentives,
4) inefficient formal institutions (and their enforcement),
5) adverse effects of moral foundations.

In short, the argument is as follows:
For knowledge about GE and their potential impacts, transaction costs are extremely high, which makes it hard to develop appropriate policies. Thus ideally, experts in the GE debate objectively assess pros and cons of GE in order to develop socially beneficial policies. However, debating representatives do not have incentive to reach agreement, but to campaign fiercely for their own position in order to maximize their funding. This combination of high transaction costs and socially detrimental incentives require efficient institutions that enable a high-quality debate. However, formal institutions that regulate the debate are weak/virtually non-existent. Consequently, in the public, the importance of morality as an informal institution for orientation is maximized (see North, 1992). Thus, (conflicting) moral foundations likely have a large impact on the German GE debate. They may thus be decisive for explaining why the German GE debate has been going on for so long without agreement, and why information does not seem to contribute to advancing the debate.

Transaction Cost for Scientific Information is Extremely High

First, in the case of GE, the transaction cost for information can be regarded as extremely high. While much information is being shared in the debate, it is costly for the public to evaluate

whether this information is true. Valid impact assessments of GE require highly specialized knowledge from a large variety of fields. Such specialized knowledge is extremely costly to obtain and thus makes it necessary to resort to intuitive moral foundations in the evaluation of biotechnologies. North (1992) already pointed out that the higher transaction costs become, the more important become perceptions about morality, e.g. ideologies. The argument is that because information is so costly to attain, people resort to moral intuitions to make their choices. Moreover, the currently developing field of narratives in economics proposes that people make sense of such complex issues with narratives (Shiller, 2017). Such narratives are evaluated against an individual´s moral belief system, and thus result in judgments and subsequent (political) behavior (Roos & Reccius, 2021). Thus, according to this narrative understanding in economics, mere information does not suffice to impact judgment and behavior, because of the world´s complexity. Rather, the information needs to be transported within dominant narratives that fit a person's moral belief system. Narratives structure and evaluate arguments in public debates.

In line with that, research on GE acceptance has shown that information has little to no effect on GE attitude, particularly if recipients had prior beliefs on the technology (Huffman et al., 2007; Connor & Siegrist, 2010; Verdurme & Viaene, 2003). Rather, Scott et al. (2016) find that among GE opponents, about 80% reject the technology irrespective of potential consequences, meaning that – as stated by themselves – many explicitly disregard information when forming their attitude. This is typical for topics with a sacred (moral) value (see for example Baron & Leshner, 2000). Scott et al. (2016) thus suggest that GE attitudes are based on moral intuitions more than information.

Socioeconomic Variables and Personal Characteristics Cannot be the Whole Story

Second, Denzau and North (2000) describe that the effect of incentives and restrictions depends on how agents perceive them and their environment. These perceptions depend in part on personal characteristics. Consequently, they need to be taken into account when evaluating the effect of moral institutions on GE attitude. Research on drivers of GE attitude has indeed shown that some of the variance in attitudes can be explained through personal characteristics, e.g. gender (Zhang et al., 2016), or openness towards technologies (Zwick, 1998). For example, Chen (2011) found that women tend to reject GE more frequently than men. These effects are significant but small, i.e. with $r = 0.13$, they explain around 1.7% of the variance (Chen, 2011). Thus, they alone cannot explain why rejection of GE is so predominant in the German population.

Adverse Incentives Add to the Problem

Third, likely, the parties involved in the official debate have incentives to not deviate from their position (see for example Hielscher et al., 2016). In part, scientists involved in GE represent their own research in which they invested a lot of time and resources. If, for example, GE research would become prohibited in Germany, a transition to another field would be very costly for them. Moreover, they depend on funding which they receive only if their research is considered relevant and beneficial to solving societal problems. They thus have incentives to maintain a supportive position towards GE. Moreover, NGOs also depend on funding and donations, mainly by the public. NGOs thus have an incentive to heavily invest in their

marketing and campaigning to make the technology seem as threatening as possible in order to motivate the public to donate to their cause. This is because of negativity bias that makes people likely more attentive to negative news (see for example Rozin & Royzman, 2001; Vaish et al., 2008).

The media, who wants to sell their stories to as many people as possible, has an incentive to feed into that by spreading frightening images of GE as well as scary stories (Pinker, 2018).

Because of the high transaction costs, it is difficult for people in the public to judge who is right or wrong. So, it is argued here, that they tend to go with the opinion that is most appealing to their preferred moral foundations. Moreover, even if their moral intuition was wrong about GE, it would have virtually no tangible consequences: there are enough affordable alternatives to GE foods in Germany. Thus, the German public also has no incentive to invest time and money in acquiring the costly information to decide about GE purely based on a rational cost-benefit analysis. It is thus possible that the incentive structure increases the importance of moral foundations as informal institutions.

The fact that it has no tangible cost to be wrong about GE in Germany comes with another problem: it provides the incentive for people to, rather than caring about the right decision about GE, signal to their peers that they hold socially accepted and virtuous beliefs about new technologies (see for example Tosi & Warmke, 2020; Tosi & Warmke, 2016). Moreover, the low cost of being wrong about GE increases the incentive to resort to echo chambers with like-minded people who encourage beliefs based on moral gut-feelings rather than challenge it (see for example Cinelli et al., 2021).

Inefficient Formal Institutions

Fourth, the high transaction costs for knowledge about GE, as well as the adverse incentives by debating parties, require strong institutions that efficiently channel these costs and incentives (see for example Schotter, 1986). Ideally, their objective would be to enable a constructive debate that objectively assesses pros and cons of the technology and reaches consensus that benefits all. However, at the moment, institutions aiming at high quality debates are inefficient. While some self-commitment initiatives exist, such as Accountable Now (https://accountablenow.org/), their enforcement mechanisms still appear somewhat weak and ineffective. For example, measured by their number of followers on twitter, their impact and reach seem small compared to, e.g., the reach of Greenpeace. While Accountable Now (n.d.) has got less than 2000 followers, Greenpeace (n.d.) has got almost two million followers. This may be one reason why Greenpeace only loosely complies with the guidelines of the initiative, as can be inferred from evaluations of their annual reports (for more information, see https://accountablenow.org/). Thus, for people in the general public, it remains difficult to evaluate the quality and validity of the arguments made in the debate. Instead, the observer is left with mutual accusations of deception made from both sides (see for example Roberts, 2016; Johnston, 2016).

For North (1992), it is the *lack of efficient institutions* that enables an incentive system in which involved groups invest in rent-seeking activities rather than in mutually beneficial outcomes.

The Public Resorts to Informal Institutions

Fifth, taken together, points 1) to 4) suggest that since transaction costs are extremely high, formal institutions are weak, and create an adverse incentive system, the public needs to resort to informal institutions such as trust (see for example Hielscher et al., 2021).

This is in line with other research on GE attitudes, moralization, and sacred values. For example, GE attitude has been shown to depend on moral values such as trust in institutions, and fairness perceptions (Siegrist et al., 2012). Moreover, research on GE opposition found that the majority of opponents qualify as moral absolutists, i.e. they state to maintain their position regardless of its consequences (Scott et al., 2016).

Similar dynamics, in which a position on a topic is moralized, have been observed for example with vegetarianism, vaccination or climate change (see for example Feinberg et al., 2019; Skitka et al., 2005; Baron & Leshner, 2000; Tetlock et al., 2000).

Building on this literature review, the present thesis proposes to explain the stability of the debate, as well as the inefficacy of scientific information, with conflicting moral foundations: because supporters and opponents focus on distinct moral foundations, the debate becomes morally polarized. And because scientific arguments do not address the moral foundations that are most relevant in the narratives that shape public opinion, they lack effectiveness.

Moreover, the stark opposition towards GE has motivated much research, especially in the fields of consumer research and psychology (for an overview, see Scott et al., 2018). However, little to no research has investigated GE supporters. The present work thus also adds to previous research by including GE supporters in the research design.

Summing up, new institutional economics has the goal to describe the effect of institutions on economic behaviors and outcome. However, ultimately, the purpose is normative: to develop reform recommendations that improve current causal relationships between behavior and institutions.

Consistent with that, the present thesis evaluates and interprets the results with an approach to economic ethics that is based on new institutional economics (Homann & Blome-Drees, 1992; Erlei et al., 2007; Pies, 1993, 2004). The goal is to identify potentials to overcome moral hindrances to constructive policy debates about GE.

Limitations

While the present work is informed by research in other scientific fields, it positions the presented problem within the paradigm of new institutional economics. This functional approach to moral foundations also results in normative reform recommendations that are based on a functional economic ethics (Homann & Blome-Drees, 1992; Leschke, 1995, 1996; Pies, 1993, 2004). The decision for this paradigm comes with blind spots for research questions that are better addressed with other scientific fields or approaches.

Economic Approach of New Institutional Economics

The framework of moral foundations as institutions is heavily informed by insights from other scientific fields. While this demonstrates the advantages of interdisciplinary research in moving research in one field forward, there are many research questions that this institutional framework cannot address. For example, “What role does the social environment of an individual’s upbringing play in the development of preferences about GE?”, or “How does an

individual deal with conflicts of attitudes, personally?" – these would better be addressed within the framework of sociology or psychology, respectively (see for example Schnellenbach, 2019).

Economic Ethics Based on New Institutional Economics

The present work applies an approach to economic ethics that is based on the framework of new institutional economics (Homann & Blome-Drees, 1992). As an ethics of order, it identifies potentials for solutions, i.e. normative reform suggestions, on the level of institutions (Homann & Blome-Drees, 1992). Thus, it does not tackle the problem at an individual level. Inevitably, this approach to morality comes with blind spots.

For example, it virtually neglects the meaning of individual morality, specifically, the meaning of an individual's capability to actively decide for and develop moral behavior (Aßländer & Nutzinger, 2010). These are addressed in alternative approaches to ethics in economics, such as the Integrative Economic Ethics by Peter Ulrich (see for example Ulrich, 1986, 2000, 2001). However, in exactly this individual decision-making lies much potential for additional solutions to the longstanding GE debate. For example, Schormair and Gilbert (2021) propose a discursive value-sharing process to overcome value conflicts. This proposal attempts to tackle value conflicts on the individual level. Thus, potential solutions might be identified with further research applying individual approaches to ethics.

Generally, the selection of a theoretical approach depends on the decision which part of a problem should be dealt with. This means that no scientific field or approach is inherently superior to another, but, *depending on the research focus*, some approaches are more *appropriate* for some foci than others. Usually, there is no one-fits-all solution for a societal problem. For example, the problem of misinformation and polarization in public debates is unlikely to be solved only at the institutional level. However, it also is unlikely to be solved only at the individual level.

Ideally, the different approaches find a way to communicate with each other and merge their findings for the greater good.

Research Questions

The problem addressed in the present thesis can be theorized as follows: Generally, the purpose of moral foundations is adaptive, i.e. they reduce transaction costs since they enable and guide mutually beneficial cooperation (Gilbert, 2007, 2010; Leschke, 1995, 2011; Haidt, 2012). However, in the case of GE, moral foundations might actually *increase* transaction costs if they impede an open and constructive debate. The here proposed project wants to explore this possibility.

The resulting research question is „*Do conflicting moral foundations impede the German debate about genetic engineering?"*.

To answer this question, the proposed project aims to identify the predominant moral foundations among GE supporters and opponents, aims to search for conflict potentials and

aims to measure the extent of moralization.[4] Four subprojects aim to address the following more specific questions:
1) How can Moral Foundations Theory be operationalized for application in latent content analysis? (Chapter 2).
2) In the public debate about GE, which moral foundations are addressed by which party, i.e. by GE opponents or GE supporters? Which potentials for conflict can be identified here? (Chapter 3).
3) Do moral narratives drive attitudes? Which moral narratives drive GE attitude in the German public? Do supporters follow different moral narratives than do opponents? (Chapter 4).
4) Are beliefs about GE moralized, and, if so, how strong is this moralization? Is the public, and the public debate polarized? Is there potential to overcome a potential moral polarization? What, if anything, might change people's beliefs about GE crops? (Chapter 5).

Methodological Approach

Text Analyses for Latent Content Analysis

Text as Data – Narratives and Arguments

As explained above, the present work is interested in moral foundations as informal institutions that motivate positions about biotechnologies. The goal is to contribute to explaining why the German GE debate has been going on for so long without agreement, and why scientific information does not seem to contribute to advancing the debate. For this purpose, it is necessary to identify *what is being* said in the debate. Thus, the present work uses texts by official representatives as data in order to identify the arguments and their moral content.
Furthermore, an efficient way to investigate what the German public believes about GE is to collect and analyze the narratives that people hold about GE. This has a few advantages compared to other forms of data collection and analysis. First, addressing open text questions to a representative pool of participants provides inductive information on a) which beliefs and narratives are most relevant, and b) which may have been previously overlooked by research. Second, as people use stories to make sense of the world around them, they do not use a quantitative model to represent what motivates them to a certain position towards GE. Rather, they tell a story, a narrative, whose causal relationships are crucial to *understand why* a person chooses to be against or in favor of GE. And third, people do not usually and consciously quantify and qualify a moral evaluation of the narratives they hold. Rather, this moral content is *latent in meaning of the text*, which makes it necessary to collect textual information.
Thus, gathering new content, as well as new information about the moral evaluations of this content, is very difficult with quantifying methods, such as Likert scales. Similarly, classic econometric data about macroeconomic events does not yield insights into people's beliefs about a topic of macroeconomic relevance.
At the same time, these different forms of data collection and data analysis do *complement each other*. For example, for measuring the impact of people's beliefs about GE on macroeconomic events or policies, both types of data, narratives as text as well as quantitative indicators from

[4] This endeavor requires two restricting assumptions: First, the arguments of the official debate do indeed impact public opinion by addressing relevant moral foundations. Second, the narratives stated by lay people do indeed reflect their true moral reasoning for their position towards GE.

large panel data, are necessary. Moreover, for investigating what influences people's beliefs, e.g. in experimental settings, scales as well as experimental paradigms can be developed *based on* the findings from the text data.
Thus, to identify the moral content within narratives and arguments about GE, the present work uses text as data.

Content Analysis to Analyze Text as Data

For the present research purpose, an analysis of the text data needs to a) identify the arguments made within the narratives about GE and inductively develop a category system based on these, and b) deductively identify the latent moral foundations addressed within these narratives. According to Mayring (2015a), these two goals are best pursued with a *content analysis*. This is because of two main reasons that are inherent in narratives. First, following the approach of structural semantics (Mayring, 2015a), meaning can only be inferred from the relationship of several words between each other, and not through a single term. And second, similarly, people do not directly state the moral foundations they see as violated or catered to by GE. Rather, these are latent within the meaning of the text and need to be inferred based on the theory. Thus, for narrative research on GE, the causal relationships in text are particularly crucial because they provide information about how and why GE are evaluated a certain way by a person. For this reason, it would not suffice to, for example, only identify an addressed topic, since knowledge on the causal relationships and moral evaluations thereof are necessary to interpret the results.
For information about the procedure and rationale of the content analysis, please consult the Appendix of Chapter 3.
As mentioned above, while content analysis is not a classical economic type of analysis, it complements economic inquiry, through illuminating *how and why* narratives drive macroeconomic events and economic policymaking.

Moral Foundations Theory to Identify Latent Moral Content

In order to identify the latent moral evaluations about GE within the arguments and narratives, the present work builds on Moral Foundations Theory (Haidt, 2012; Graham et al., 2013). This is because MFT can be used as a template that structures the inductively identified content of the arguments and narratives. This allows to *deductively* identify the differences and conflicts in the use of moral foundations.
This is necessary because moral meaning in text is not delivered according to one specific model, but comes in all kinds of forms, structures, and words. Thus, the verbal intuition of a researcher usually does not suffice to understand the latent moral content of a narrative. Consequently, in order to make moral content measurable, it needs to be structured according to a theory of moral values.
For such a theory, there exist various useful approaches, most importantly the Moral Foundations Theory (Haidt, 2012; Graham et al., 2013), and the Theory of Basic Individual Values (Schwartz et al., 2012; Schwartz, 2012, 1992). These theories are based on extensive empirical tests and assume very similar moral drivers for human behavior. Generally speaking, they are simply different ways to structure moral content. Thus, the results of a content analysis applying either of these theories should yield similar results. However, the present work applied

Moral Foundations Theory, rather than Schwartz's theory. An important reason for this is that Schwartz's theory has almost exclusively been tested in highly developed western countries. Contrary to that, MFT is developed and tested based on findings in more communal societies, such as India. Thus, while MFT has not yet been tested and further developed based on every country, it better captures the variety of moral foundations in human cultures. Moreover, while MFT distinguishes six moral foundations, Schwartz's theory distinguishes nineteen. For pragmatic reasons, MFT seems more applicable for the present purpose. Another reason for this is that MFT appears to be generally more prominent, being frequently applied to topics in public debates, e.g. to polarizing topics such as politics or vaccinations (see for example Day et al., 2014; Amin et al., 2017).

Developing a Methodological Approach to Identify Latent Moral Foundations in Text

Moral Foundations Theory is based on the assumption that all foundations are overlapping systems (Graham et al., 2011; Graham et al. 2018). Thus, the difficulty to distinguish moral foundations in text is inherent in the theory.

Following, in order to identify latent moral foundations in the text data, a methodological approach is needed that distinguishes latent moral foundations validly and reliably. Chapter 2 discusses that while there exist suitable dictionary approaches to identify moral foundations in text, human coding approaches are more advantageous for this purpose. Furthermore, Chapter 2 develops a structural approach to MFT that inquires into *what distinguishes* the six moral foundations. This requires a novel perspective on the theoretical assumptions. Resulting, Chapter 2 finds that each moral foundation fulfills a distinct structural function within a group or society. This in itself is a novel theoretical contribution to MFT.

Moreover, from this contribution also follow further conceptual insights that further develop the theory of moral foundations. These conceptual contributions are discussed and described in Chapter 2.

Mixed-method Approach

While text analyses of arguments and narratives about GE, and more specifically, analyses of their content and latent moral content, constitute a major part of the analyses conducted in this thesis, quantitative analyses are also implemented here. This is because, as mentioned above, different methodological approaches are not mutually exclusive but *complement* each other in the inquiry of a topic. For the present research questions, a mixed-methods approach is particularly suitable because it allows to identify both, *how* GE opponents and supporters differ in their moral preferences, and *how intense* these differences are.

Specifically, Chapter 4 and Chapter 5 are built on representative surveys, qualitative content analyses, as well as quantitative analyses. This allows Chapter 4 to quantify the moral contents of narratives and identify their relative impact compared to socioeconomic variables in a regression. Moreover, this allows Chapter 5 to measure the magnitude of moralization of GE among the public, as well as the potential and respondents' requirements that they find necessary to mitigate this moralization.

Furthermore, the thesis contains both, a text analysis of position papers by official representatives in the debate, as well as a text analysis of open text responses from two representative surveys in Germany. Combining these two allows to interpret similarities and

differences about how the official debate is conducted, versus which moral narratives are actually important to people in the broader public. These insights also reveal potentials to advance the debate.

The Strength of Interdisciplinary and Transdisciplinary Research

While the present thesis uses the economic paradigms of institutional economics, it also strongly incorporates economic ethics, and narrative economics. Moreover, the thesis builds on moral psychology, as well as consumer and acceptance research.

Provided that often, in related fields, relevant findings are readily available, combining research helps to swiftly advance a field. One example is narrative economics that learns from, for example, political science in which narrative research is more established (Roos & Reccius, 2021). Another example is behavioral economics that heavily drew from insights from psychology before developing its own research agenda (Kahneman, 2011; Gigerenzer, 2018). A further success story is Game Theory, in which the combination of economics and mathematics yielded a new subfield with groundbreaking insights. This is because often, relevant research enquiries of different fields overlap, which means that superficially distinct fields can learn from each other. A prominent example is the Santa Fé Institute which combines physics, computation, biology and social sciences (https://santafe.edu/about/overview). Some research of this institute found a comparison between the mortality rate of plants and the mortality rate of companies, which both, in their world, have to compete with others for scarce resources. Specifically, businesses show constant lifespan patterns of about ten years, regardless of the type of business (Daepp et al., 2015).

In the same vein, economic principles are starting to inform moral psychology. For example, Sharot et al. (2022) propose that holding a specific (moral) belief depends on its expected utility, and changing this belief depends on a cost-benefit analysis.

Similarly, the present thesis shows that interdisciplinary research yields contributions that are relevant for institutional economics, economic ethics, narrative economics, moral psychology, consumer and acceptance research, as well as science communication.

Limitations

As described above, the methodological choices were made in an effort to use those methods that are most appropriate to address the stated research questions. However, each methodological choice also closes the path to other related findings. This is because each scientific method has different advantages for the inquiry into a topic.

Generally, there exists no universally superior method for research. Rather, some methods are more suitable for some research questions and approaches, while others are more suitable for other research questions and approaches. Thus naturally, there are other research questions related to polarized debates that are better addressed with methods other than (latent) moral content analysis.

For example, Graham et al. (2009) developed the Moral Foundations Questionnaire (MFQ) to quantitatively test which moral foundations are generally more prominent in a group compared to another group. This questionnaire has been widely applied to the political divide in the US, showing that conservatives have significantly different moral preferences than do liberals (Graham et al., 2009). Applying the MFQ to the polarization of the German GE debate would

be a sensible strategy to find out whether GE supporters and GE opponents systematically differ in their moral preferences. However, the MFQ does not provide information about which moral foundations are relevant for the evaluation of GE *specifically*. Thus, the MFQ is more suitable for research questions other than those addressed in the thesis.
Furthermore, other theories of moral values, such as Schwartz's Theory of Basic Individual Values (Schwartz, 1992; Schwartz et al., 2012), may yield slightly different results. For the reasons mentioned above, MFT was chosen instead of other moral theories. However, for future research, it may be worth inquiring how the results of the content analyses would differ if another moral theory was applied, and what this means for the validation of MFT for content analyses.
Similarly, if the structural approach to MFT was applied on a larger scale, and to a variety of topics other than GE, it would no longer be sensible to have all the data hand coded by one individual. Thus, it should be a future research inquiry to combine the structural approach with computer-assisted methods. This way, the approach could be tested, validated, further developed, and scaled. At the same time, the approach could also support the development of various computer-assisted methods, such as dictionary models, scaling, topic modeling, or classifications, e.g. wordfish or naive bayes approaches (Grimmer et al., 2022).
Thus, because of its research questions and the according methodological choices, the thesis has blind spots that extend its scope. At the same time, the present results inform other research questions that are beyond the present scope. For example, the structural approach to MFT can be scaled and validated by computer assisted approaches to text analysis. It can also inform the development of other text analytical tools, as well as analyses of other polarizing topics.
Thus, the present choice of method does not replace but complement other methodological approaches to polarizing policy issues in economics.

Overview of Thesis Chapters
In the following, the thesis chapters and their main are summarized.

A Structural Approach to Moral Foundations Theory
Chapter 2 argues that each of the six moral foundations according to Moral Foundations Theory contributes a unique structural function to the social well-being of a group. This novel approach provides theoretical contributions to the understanding of MFT. For example, equality of opportunity is a goal of Liberty, but a prerequisite of Fairness. Furthermore, equality of outcome is a goal of Loyalty, but a prerequisite of Care.
Additionally, the far-leftist dislike of capitalism is a topic of Loyalty, general efficiency can be organized to Loyalty, and concerns of nature and the environment are most sensibly allocated to Sanctity.
Moreover, an initial interrater reliability test indicates that the approach proposed here generates higher reliability compared to alternative approaches, while reducing the required training time for coders. Background, procedure, and results are discussed in Chapter 2.

A Latent Content Analysis of the Official Debate about GE in Germany
Chapter 3 applies the structural approach to MFT developed in Chapter 2 to a text analysis of the official debate about GE in Germany. More specifically, the chapter analyzes official

position papers made by the organizations that are most active in the debate according to their latent moral content. The methodological approach and procedure of this text analysis is extensively discussed in the Appendix accompanying the chapter. The analysis finds that, rather than addressing risks and benefits of the biotechnology, most arguments refer to involved actors, and address concerns of Loyalty. Moreover, debating parties differ in their focuses on moral foundations: while supporters focus more on Authority, Fairness, and Liberty, opponents focus more on Care and Sanctity. Most remarkably, these moral conflicts exhibit a clash of two opposing worldviews. While supporters convey optimism towards technological evolution and scientific progress, opponents convey skepticism and worry towards technological progress and modernity combined with concerns about an increasing alienation. These results are discussed in Chapter 3.

A Latent Content Analysis of the Narratives in the German Public about GE

Chapter 4 also applies the methodology developed in Chapter 2, and identifies the most relevant narratives that lay people use to reason about their position towards GE, as well as their underlying moral foundations. Congruent with the position papers analyzed in Chapter 3, GE opponents conveyed a skeptical and concerned outlook about the future and technological progress in their narratives. Correspondingly, supporters were congruent with the official position papers of supporting organizations, conveying a more optimistic outlook towards technological progress and the future.

Most interestingly, the results suggest that supporters find Loyalty narratives more relevant for their position towards GE, while opponents find Care and Sanctity narratives more relevant for their position. Potentially, supporters find benefits for the general welfare of humans (Loyalty) more decisive for their position towards GE, while opponents find health risks for their immediate surroundings (Care), as well as risks for their regional environment (Sanctity) more decisive for their position towards GE. The results of Chapter 4 thus suggest that among the German public, there is *no disagreement* about potential risks of GE, but *foci* on different moral foundations.

These results may provide a strong example for how moral foundations can lead to conflict, even though all involved attempt to make a "good" decision.

Even more so, the results show that the majority of the German public focuses on moral foundations that differ from those that scientific organizations predominantly address. This may be a reason why scientific information has not been effective for advancing the debate.

A Survey Experiment about the Flexibility of Moral Beliefs about GE in Germany

Chapter 5 finds that the German public is indeed morally polarized about GE. Specifically, both, supporters and opponents, consider their attitudes towards GE to be a moral conviction. Moreover, a large majority of opponents and a substantial minority of supporters are consequence-insensitive: They say that risks and benefits are irrelevant to their views. Thus, GE attitude qualifies as moral belief.

Moreover, Chapter 5 probed whether respondents would be open to abandon their moral belief about GE under specific circumstances. And indeed, the responses of consequence-insensitive participants to subsequent belief probes show substantial flexibility. These results indicate

promising potential for moving the German GE debate forward. Background, procedure, and results are discussed in Chapter 5.

Chapter 2 –
A Structural Approach to Moral Foundations Theory – for Theory Development and a More Reliable Application in Latent Content Analyses

Abstract

Identifying latent moral foundations in text has proven useful for understanding polarization (see for example Kalimeri et al., 2019; Araque et al., 2019). Particularly, recently developed crowd-based approaches provide promising tools for human content analysis (Hopp et al., 2021; Hopp & Weber, 2021; Hopp et al; 2020; Weber, 2018). The present research adds to these contributions by developing an understanding of Moral Foundations Theory (Haidt, 2012) that increases the discriminatory power between the foundations.

Specifically, inspired by Donald Black's Moral Sociology (Black, 2011), the present work argues that each foundation provides a unique structural contribution to a social group. This structural contribution makes it easier for human coders to identify a specific moral foundation in text.

An initial interrater reliability test indicates that the structural approach proposed here does indeed generate higher reliability while reducing the required training time for coders.

In addition, this novel approach also provides theoretical contributions to the understanding of Moral Foundations Theory. For example, equality of opportunity is a goal of Liberty, but a prerequisite of Fairness. Furthermore, equality of outcome is a goal of Loyalty, but a prerequisite of Care. Moreover, the far-leftist dislike of capitalism is a topic of Loyalty, general efficiency can be organized to Loyalty, and concerns of nature and the environment are most sensibly allocated to Sanctity. These theory contributions are explained and discussed.

Keywords: Moral Foundations Theory, Content Analysis, Latent Moral Content, Coding Procedure, Human Content Coding, A Structural Approach to Moral Foundations Theory

Introduction

Vaccine hesitancy, contact-reducing measures due to COVID-19, climate change, equality, immigration, genetically modified organisms, gun law, abortion… - the amount of current as well as enduring polarizing topics appears countless. Much recent research found that attitudes towards polarizing topics are often related to morality and moralization (see for example Feinberg et al., 2019; Jansma et al., 2019; Hofmann et al., 2014; Scott et al., 2016).

Moreover, differing attitudes can be explained through distinct moral intuitions. For example, Graham et al. (2009) find that in the United States of America (USA), liberals endorse the moral foundations Care and Fairness more than conservatives. Similarly, research on judgments about food finds that these can be moral and are often related to purity, naturalness, or disgust (Rozin et al., 2000; Rozin, 2006; Scott & Rozin, 2020).

Here, the theoretical concept of six moral foundations according to Haidt (2012) is further developed in order to increase reliability and validity in human content coding. Specifically, inspired by Donald Black's Moral Sociology (Black, 2011), the present research proposes that the distinction between the moral foundations of the Moral Foundations Theory (Haidt, 2012) is much less ambiguous when focusing on their respective structural contribution.

Thus, the present paper adds to current methodological developments to identify latent moral content in text (Hopp et al., 2021; Grimmer et al., 2022; Weber et al, 2018; Lind et al., 2017). At the same time, the contribution of this paper is also theoretical because it provides and explains deeper insights and interpretations of Moral Foundations Theory. These novel theoretical contributions that are discussed in this paper could be derived from the structural distinction proposed here.

Methodological and Theoretical Background

Moral Foundations Theory as Explanation for Polarization

In order to identify the moral content in texts related to polarizing issues, Moral Foundations Theory (MFT) has proven particularly useful. MFT, developed by Jonathan Haidt and his colleagues, aims to describe and explain why individuals and groups sometimes differ in what they perceive to be morally right or wrong (Koleva et al., 2017). The theory holds that the human moral landscape consists of six moral foundations: Care, Fairness, Loyalty, Authority, Liberty, and Sanctity (Haidt, 2012). These are not values per se but evolved psychological mechanisms with the function to provide moral intuitions and feelings about perceived social activities and thus guide judgments about right or wrong (Graham et al., 2018; Koleva et al., 2012; Graham et al., 2009; Haidt, 2001; Haidt & Kesebir, 2010).

MFT is framed within the proposition that moral systems are innate, but malleable and thus get edited through culture, development, experience, and socialization (Graham et al., 2018; Koleva et al., 2017). They form the initial basis for what will later evolve into moral practices, virtues, and vices (Haidt & Graham, 2007; Haidt & Joseph, 2004). People thus vary as to how much emphasis they put on a foundation (Haidt, 2007; Graham et al., 2012; Graham et al., 2009). Because of such cultural variability, „different societies, as well as cultural subgroups in the same society, can build their moral virtues, claims, and institutions to varying degrees on each moral foundation" (Koleva et al., 2017, para. 9).

MFT has proven to be a robust explanation for a variety of international data sets (Graham et al., 2011); and matches research findings of virtues from anthropology, psychology, evolutionary biology and philosophy across many cultures (Haidt & Joseph, 2004), such as research on collectivism (for example Triandis, 1995), or egalitarianism (Arts & Gelissen, 2001).

Distinguishing a broader range of six moral foundations extends previous accounts of morality, generally limited to helping or playing fair (Koleva et al., 2017; Graham et al., 2011). This is useful because empirical research suggests that people's moral concerns extend considerations of not harming others and playing fair (Graham et al., 2018; Graham et al., 2009). For example, some non-western cultures emphasize virtues that focus on the well-being of the group rather than the individual (Haidt, 2008a; Graham et al., 2009; Shweder et al., 1987; Shweder et al., 1997). Moreover, evidence shows that moral judgments about suicide are much better predicted by concerns of impurity (Graham et al., 2018; Rottman et al., 2014a, 2014b). With this, MFT provides a broader picture of human morality. Assuming moral pluralism has thus more explanatory power than assuming moral monism (see for example Graham et al., 2013).

This is particularly useful for identifying conflicts between moral concerns as can be observed in polarized topics. For example, Haidt and Graham (2017) found that in the US, political liberals rely their moral judgments more strongly on Care and Fairness, while political conservatives tend to also base their judgments on Loyalty, Authority, and Sanctity. Thus, prejudices of groups might in part be explained by diverging moral preferences between these groups (Graham et al., 2011). Similarly, Amin et al. (2017) show that the foundations Sanctity and Liberty are significantly predictive of vaccine hesitancy.

Moral Foundations Theory for Content Analysis with Dictionaries

Consequently, applying MFT in latent content analysis promises to yield similarly insightful findings. Thus, Graham et al. (2009) developed the Moral Foundations Dictionary (MFD), e.g., for keyword-based approaches of content analysis. Numerous studies have already applied the MFD (e.g., Wheeler et al., 2019; Long & Eveland, 2018; Garten et al., 2018; Brady et al., 2017). This dictionary was further developed by Frimer et al. (2019) into the MFD 2.0. Just recently, the MFD has been developed further by Hopp et al. (2021), resulting in the extended Moral Foundations Dictionary (eMFD).

Through the MFD and eMFD, results can be reliably replicated, and huge amounts of text segments can be analyzed in a comparably short time. However, since the moral foundations are only latent in the text, some problems with validity remain which a few points may illustrate. First, depending on the analyzed text type, a latent content analysis based on a dictionary may miss out moral judgments that are not described with a keyword. For example, the sentence "He did not follow the rules we agreed on in advance." would not be identified as a Fairness argument because it does not contain the respective keywords of the dictionaries, such as "unfair" (see for example Frimer et al., 2019). Second, keywords may lead to a wrong allocation of moral foundations. For example, the sentence "Their commander needed to be hospitalized after they hit him with the car." might be allocated to Authority because of the

keyword "commander", although the context points to a Care concern (see for example Hopp et al. 2022). This may be particularly relevant for metaphors or sayings.
Moreover, it might be difficult to determine the frequency of arguments made because, for example, several keywords might appear in one single argument and are thus counted several times. And lastly, depending on the research question, it might not suffice to identify the addressed moral foundations, but it may be important to identify the actual moral arguments made. For example, to find out which reasons parties provide for their position on a polarized issue, or to find out what exactly their moral concern is within a topic addressed.
Thus, results of keyword-based methods can only be meaningfully interpreted with background knowledge and deep understanding of the analyzed texts.
Instead, it is suggested here, to apply the approach of structural semantics for the identification of latent moral foundations in text. It assumes that meaning can only be identified from the relationship of several words between each other, and not only with one single term (Mayring, 2015a). A single term can have completely different meanings depending on the context or the other words close to it. This is why a single word may not suffice in determining whether a certain moral foundation has been violated, or catered to, respectively.

Moral Foundations Theory for Content Analysis with Human Coders

In line with that, van Atteveldt et al. (2021) find, in a recent comparison of methodological approaches to latent content analysis, that human coding still outperforms the validity of dictionary-based methods. Similarly, while other recent developments in automated computer-assisted techniques for content analyses, such as models based on word embeddings, have made great advances in recent years (see for example Grimmer et al., 2022; Grimmer & Stewart, 2013; Jacobi et al., 2016) these are still in development and, particularly for identifying latent content of text, also rely on extensive human coding, e.g. for training a new model (Lind et al., 2017).
Thus, depending on the research question, human coding is a useful and necessary approach, especially for identifying latent meaning of text (van Atteveldt et al., 2021; Arendt et al., 2017). For example, through human coding, Clifford and Jerit (2013) were able to extend the word lists of the MFD based on which words they found consonant with the dictionary words and relevant for their research topic.
Generally, MFT is already widely used for human coding of moral concerns in text. For example, Hahn et al. (2019) applied MFT in manual coding to identify moral motivations of terrorist groups. Similarly, Krcmar et al. (2016) applied MFT in human manual coding to identify moral reasoning in gaming decisions. For further uses of MFT in manual coding see for example Gehman et al. (2021) or Dempsey et al. (2020).

Moral Foundations are not so Easy to Identify in Text

In most cases, the moral content is not explicitly stated in the text but latent in its meaning. Thus, identifying moral foundations requires an interpretation of the meaning of the text. As a consequence, some moral arguments are not always interpreted in the same way, i.e. as pertaining to the same moral foundation. For example, while Dempsey et al. (2020) organize

themes related to honesty into the Fairness foundation, Hofmann et al. (2014) argue that honesty is its own additional moral foundation.
Furthermore, Mäkiniemi et al. (2013) see issues related to environment protection and organic food as pertaining to the Care foundation. Similarly, Dempsey et al. (2020) also allocate the topic environment to the Care foundation. However, Haidt (2012) sees nature and naturalness as pertaining to Sanctity.
It comes as little surprise that researchers themselves frequently conclude that a topic may be allocated to several foundations. For example, Mäkiniemi et al. (2013, p. 777) state that "some associations may reflect more than one moral foundation". Similarly, Ford et al. (2018) allocate some of their identified topics to two foundations. For example, in their analysis about morality at the workplace, they find that "lack of promotion and development opportunities" may pertain to Care as well as Fairness (Ford et al., 2018, p. 173). Similarly, they see "poor coworker performance" as pertaining both to Fairness and Loyalty (Ford et al., 2018, p. 173).
Concluding, in content analysis, there is significant uncertainty as to which moral foundation is addressed by which statement. This leads to varying results and thus impacts reliability and reproducibility of research conducted with MFT. In that vein, Weber et al. (2018) illustratively state that, in part, they were not even able to reproduce their own coding of moral foundations.

Crowdsourcing as Extension of Content Analysis with MFT

To some extent, these problems with interpretation are inherent in latent content analysis. Latent content analysis is based on interpretations that will necessarily rely – at least in part - on the personal experiences of the researcher who does the interpretation (Bryman, 2012). Confronting this problem, Weber et al. (2018) recently developed a crowdsourced approach to content analysis with MFT, called the Moral Narrative Analyzer (MoNA, https://mona.mnl.ucsb.edu/). They argue that a heterogeneous crowd better captures the modular nature of the moral foundations (Weber et al., 2018). This is because Aroyo and Welty (2015) and Hopp et al. (2021, p. 3) doubt the claim "[t]hat there is a ´ground truth` as to the moral nature of a particular word". Rather, they show that factors such as political orientation can be predictive of coding choices. Hopp et al. (2021) thus conclude that generating an aggregate of codings from a large number of coders increases the validity of identified moral foundations.
Generally, crowdsourced approaches are a recently developed method for content analysis, which make use of a large number of human coders, mainly recruited from crowd worker platforms such as Amazon MTurk, Crowdflower, or ProlificAmerican (Grimmer et al., 2022; Lind et al., 2017, Weber et al., 2018; Hopp et al., 2021). It has been argued that crowdsourced approaches benefit from an increased reproducibility (Lind et al., 2017; Benoit et al., 2016). Another advantage of crowdsourced approaches is that very labor intensive and time-consuming human coding is outsourced to a larger group of e.g., lay people (Lind et al., 2017) that, in the case of MFT coding, leads to "acceptable intercoder agreement" (Weber et al., 2018, p. 18).

Some Problems with Reliability and Validity Remain

However, researchers still see some downsides in crowdsourced approaches. Grimmer et al. (2022) argue that the reliability of crowdsourced codings may be lower than among a small group of researchers. Similarly, Lind et al. (2017) raise concerns about the reliability and validity of results produced through crowdsourcing approaches. There are a few potential reasons for this.

First, it is not feasible to train crowdworkers as intensely on a respective topic (Grimmer et al., 2022). For example, researcher-coders often take months in order to develop a categorization of codes in an iterative process. In this time, questionable cases can be discussed among other expert colleagues, the literature can be consulted, and coding can be thoroughly practiced (see for example, Mayring, 2015a, 2015b). For anonymous crowdsourcing, one hour of training already seems like a long time. E.g., research related to answering survey questions suggests that surveys should be a maximum of 15 minutes to ensure a reasonable attention span (see for example Menon & Muraleedharan, 2020).

Second, monitoring and controlling the quality of coding by crowdworkers is difficult (Lind et al., 2017). While many crowdworkers are intrinsically motivated to provide thorough coding results, there are also many who put in too little effort to produce meaningful results (Lind et al., 2017; Vuurens et al., 2011). E.g., if crowdworkers get paid per code, they have every incentive to go over the coding as superficially as possible. But even if they get paid per hour, it is difficult to monitor whether this hour was really spent on trying to determine which moral foundation has been addressed in a segment.

And third, crowdworkers cannot be expected to put the same effort into coding as researchers who aim to publish the results as their own work. They often get paid below minimum wage for completing the coding tasks (Grimmer et al., 2022), and often do the crowd work as a side job – e.g., on the train on their way home, between two other meetings, or with many other distractions.

Consequently, while recent methodological developments for applying MFT in latent content analysis, such as MoNA, promise to be quite powerful in solving problems related to latent content coding, some concerns related to validity and reliability remain. This present review of coding approaches suggests that these are all related to potential shortcomings in training, monitoring and understanding of the moral foundations. Tying in with this gap, the present work formulates the following argument:

Recent developments and discussions on how to identify moral foundations in text focused on (how to improve) different methodologies to *generate output* – e.g., through dictionaries, word embeddings, single human coders or crowd-based approaches. However, value can be added to these methodological discussions by focusing on the *input into the coding procedure*, namely on how to *conceptualize* the moral foundations for *application* in latent content analysis. This is the purpose of the present research.

The Present Research

Specifically, it is proposed here that reliability, validity, and reproducibility of moral content analysis can be further improved by re-conceptualizing MFT in a way that makes the theory applicable to human content coding. It is further argued that the potential for confusing moral

foundations in human coding originates in the focus on the *similarities*, i.e. in the concept of modularity and overlapping systems, on which MFT is built. In contrast to that, it is proposed here that conceptualizing MFT based on the *differences* between the foundations makes it more applicable to human content coding. This argument is elaborated in the following.

MFT is grounded in Overlaps between Foundations

The theoretical development of MFT has been purposefully based on the assumption that each moral foundation contains a variety of facets which are not fully separated from one another but rather may overlap (Graham et al. 2018; Graham et al., 2011). Specifically, in an attempt to provide an explanation of the human moral mind that is closer to reality, Haidt and his colleagues assume flexible and overlapping innate moral templates that are further shaped through experience, e.g., through culture, socialization, or upbringing (Gintis, 2018; Sperber, 2005; Haidt et al., 2009; Haidt, 2012; Graham et al., 2009). This flexible modularity allows judgments, perceptions, beliefs and emotional reactions to be more diverse, differentiated and thus more sophisticated (Haidt & Joseph, 2007). Accordingly, from a theoretical perspective, it is purposeful and useful to allow for much flexibility in the understanding of the moral foundations.

These Overlaps are Reflected in the Seminal Literature on MFT

These overlaps are apparent in the seminal literature describing MFT. For example, *anger* can be felt in relation to Care (Graham et al., 2013), Fairness (Trivers, 1971), and Sanctity (Haidt & Graham, 2007). More strikingly, disgust, which is generally described as the archetypical emotion related to Sanctity (Koleva et al., 2014; Rozin et al., 2008), can also be felt in relation to Fairness (Haidt & Graham, 2007). Similarly, Gladden and Cleator (2018), report that the emotion *guilt* can be felt in relation to Care, as well as in relation to Fairness.

More generally, the moral foundations are described in terms of how someone ought to behave towards other individuals or the group. From this follows the distinction between what is good or bad behavior. These descriptions allow for confusion. For example, in Haidt (2007), Loyalty is described as "anything that tells you who is a team player" (Haidt, 2012, p. 163), and in Haidt (2012, p. 274) Fairness is described as "a set of modules that evolved in response to the adaptive challenge of reaping the rewards of cooperation without getting exploited by free riders" (Haidt, 2012, p. 180). On first sight, both descriptions seem similar enough to lead to confusion as to where these two foundations differ.

Previous Conceptualizations of MFT are sensible from a perspective of theory-building

While not much information on coder training is available online, it appears the material provided to coders is usually very similar to how the theory is described in the seminal literature. For example, Mäkiniemi et al. (2013, p. 776) report that "[t]he analysis was theory-driven by nature and the aim was to follow the theoretical definitions and previously published empirical examples of the moral foundations as carefully as possible." Moreover, Hopp et al. (2021) provided the TED talk of Jonathan Haidt (Haidt, 2008) for training, which resembles a short version of the descriptions of the foundations in his book (Haidt, 2012).

Similarly, Hopp et al. (2021, Suppl. p. 15), describe the Authority foundation as "a social evolutionary adaptation" to enable "a mutual relationship that fosters group success". This, however, applies to *all* moral foundations and does therefore not help a coder to identify the Authority foundation in text.
Also, on p. 18., in Sanctity, Hopp et al. (2021) state the "human body […] should not be harmed", which may lead to a confusion with the Care foundation.
While these statements are all correct, they signal overlaps between these foundations and may lead to different coding outcomes and thus reduced reliability. Moreover, coders are asked to respond intuitively ("trust your gut.", Hopp et al., 2021. p. 20). While this is perfectly correct epistemologically, it can lead to confusion because, as explained above, the same emotions can be felt with different foundations.
Furthermore, McAdams et al. (2008, p. 986) describe Care as the wish "to reduce suffering" and Fairness as "connected to civil rights, gay and lesbian rights, equal rights for women, discrimination of all kinds". While this entails some of the typical keywords of their respective foundation (i.e., suffering and rights), they both point to some sort of suffering or prevention thereof: One can suffer greatly from discrimination. Also, reinforcing civil rights can alleviate this suffering. Both these examples, as they are described by McAdams et al. (2008), could be organized according to Fairness or Care and thus lead to potential confusions.

For Application in Content Analysis, the Conceptualization needs to be application-driven

Keeping the differences between the foundations somewhat vague and thus allowing for much flexibility of potential explanations is very sensible from a theoretical perspective, because conceptualizing the moral foundations as flexible and overlapping modules provides a more realistic theory of how the human mind processes (im)moral behavior. However, as demonstrated above, this may complicate the coding process since a text segment can be easily understood as pertaining to several foundations. Thus, results will be less reproducible and reliable. In line with that, Weber et al. (2018) argue that variability in coding comes from a) different emphases depending on coders' experiences and b) from actual overlaps between the foundations.
Thus, in order to apply MFT to latent content analysis, the conceptualization of the foundations has to be application-driven. This means that to a coder, the foundations should be described in a way that makes it as easy as possible for them to identify and distinguish specific foundations in text. What Lind et al., (2017, p. 195) state for general coding instructions also applies to coding moral foundations specifically: "To obtain annotations of high quality, instructions need to be simple, clear, and free from any ambiguity".
Thus, rather than comprehensive descriptions of the foundation, the explanations have to be functional and effective for latent content analysis (Grimmer et al., 2022).
For crowdsourced approaches, this is especially crucial for the reasons stated above, i.e., restrictions of time, money, and resources, limited monitoring options, and limited incentive for crowdworkers to respond perfectly thoroughly and sustain a high level of attention through the entire coding time (Lind et al., 2017). Moreover, a large number of crowdworkers will always be more heterogeneous in their previous experiences than a small number of highly

trained scientist-coders, which makes a distinguishable, non-ambiguous formulation of the target indispensable.
It is proposed here that the discriminatory power between the foundations can be maximized through identifying the distinguishing factor between the foundations.

Strategy to work out differences: how do moral foundations support the group structure?
For this purpose, this paper proceeds as follows: First, the seminal literature on each foundation is reviewed according to the questions *Why*?, *How*?, *Who*?, *What*?, *Where*?. From this review, the essential characteristics of each foundation are extracted. Second, inspired by Donald Black's Moral Sociology, a unique structural contribution for each foundation is identified. Building on this, a template is proposed that contains unique characteristics of each foundation. Third, the template is then tested by three coders with different levels of training and compared to codings by two coders who were not provided with the template. Fourth, the methodological contributions of the template are discussed in relation to current research in the field. And fifth, the theoretical contributions of the template to the development of MFT are discussed.

Materials and Methods

Transparency, Openness and Ethical Standards

Data and materials are available at https://doi.org/10.7910/DVN/YGNDP3[5]. Specifically, the repository file contains a literature list for the systematic review, a table with the text excerpts used for the systematic review, a table with the results of the systematic review, and a table that provides an overview of the resulting conceptualization of MFT. Furthermore, the repository file contains the data used for the interrater reliability test, as well as the codings of five raters.
Since the data collection did not involve the participation of human subjects, no ethical clearance is required.

Systematic Literature Review on MFT

Following concept-building approaches for qualitative content-analysis (for example Bryman, 2012; Mayring, 2015a, 2015b; Gioia et al., 2013; Corley & Gioia, 2011; Gioia & Pitre, 1990; Bengtsson, 2016), the seminal primary sources of theory behind MFT are reviewed according to the following information categories (see Mayring, 2015a, 2015b):

- Why? – What was the evolutionary advantage of the moral foundation?
- How? – What is the content of the moral foundation?
- Who? – Towards whom or what is the moral foundation directed?
- What? – Which emotions are felt when this moral foundation is violated or catered to?
- Where? – In which cultures, groups or circumstances is this foundation predominant?

[5] Waldhof, G. (2023). Supplemental Information for "A Structural Approach to Moral Foundations Theory - for Theory Development and a more reliable Application in Latent Content Analyses". *Harvard Dataverse, V3.* https://doi.org/10.7910/DVN/YGNDP3

This generates an organized overview over the content of the foundation, in order to more easily identify singularities.

Care

Why? The Care foundation is innate to all mammals since their offspring has a long development period in which it is vulnerable to predators and hence needs protection by caretakers (Graham et al., 2018). It concerns the protection of the vulnerable and weak and is linked to the attachment system (Graham et al., 2009). It promotes kindness and nurturance to others, and rejects cruelty and harm (Gladden & Cleator, 2018). Consequently, when we perceive cues (triggers) of suffering, neediness, or distress, the Care foundation motivates us to protect, care, and nurture (Graham et al., 2013).

How? Care guides us to approve of people that prevent harm or alleviate others from it (Koleva et al., 2017); and vice versa, Care guides us to disapprove of people who cause pain and suffering (Koleva et al., 2012).

Who? Care is the attachment foundation (Haidt, 2012). With that, it comes with a compassion for (innocent) victims, and often with anger towards perpetrators (Graham et al., 2013). This sensitivity to suffering is activated not only in relation to our own children, but extends to strangers, for example poor people, or people threatened by violence, even adults, and even animals (Graham et al., 2018).

What? Other emotions associated with Care are compassion, sympathy, (emotional) empathy, and guilt (Gladden & Cleator, 2018). Corresponding virtues are kindness and compassion, corresponding vices are cruelty and aggression (Haidt & Graham, 2007).

Where? In some cultures, these virtues are highly valued, e.g., in Buddhist cultures, in other cultures, such as classical Sparta or Nazi Germany, they are not (Graham et al., 2013).

Fairness

Why? The Fairness foundation has its evolutionary advantage in solving commitment problems, which made it easier to engage in cooperative relationships on the one hand and detect cheaters on the other hand (Graham et al., 2013).

Who? The Fairness foundation constitutes a sensitivity for cooperation or cheating in interactions between unrelated individuals on the same hierarchical level (Graham et al., 2013; Haidt, 2007), and is concerned with mutual respect for each other's rights (Gladden & Cleator, 2018).

How? It is consequently concerned with matters of reciprocity, proportionality, justice, and individual rights (Koleva et al., 2017; Haidt, 2012). Famous in this regard is the golden rule, which constitutes the basis of many religions (Haidt, 2008b).

What? Fairness is associated with emotions such as pleasure, liking, friendship, gratitude, when witnessing cooperation, and guilt, anger, contempt, and sometimes disgust if someone is cheating or taking advantage of somebody (Gladden & Cleator, 2018; Haidt, 2012; Haidt et al., 2007). Such emotions that motivate individuals to play tit-for-tat are usually experienced between interaction partners or when observing interactions of third parties (Graham et al., 2013).

Where? Fairness as a moral foundation can be found in all human cultures, and is developed in early childhood (Graham et al., 2018). There are differences however, as to how highly developed notions of individual rights or equality are, since especially traditional cultures have a proclivity toward hierarchy (Haidt et al., 2007).

Loyalty

Why? The Loyalty foundation has its origin in tribal ancestry, when it was advantageous to recognize members of the own group and collectively defend one's group against outsiders for survival, territory, and power over other groups (Graham et al., 2013; Haidt, 2012; Haidt, 2008b).

How? Loyalty is a coalitional foundation that helps bind individuals into stable social groups (Gladden & Cleator, 2018). It thus ensures group cohesion and is crucial for intergroup competition (Graham et al., 2013; Haidt, 2012). It motivates our attachment and obligation to the groups we identify with, e.g., family, country, church, or sports clubs (Koleva et al., 2017; Koleva et al., 2012). It also supports group favoritism toward ingroups (Gladden & Cleator, 2018). In this context, diversity is not a desirable goal, but focusing on rituals that strengthen group solidarity (Haidt et al., 2007).

Who? Loyalty leads us to approve of team players, or heroes that sacrifice for their group in order to contribute to the groups' well-being (Koleva et al., 2017; Koleva et al., 2012; Haidt et al., 2007). On the other hand, it guides us to reject traitors and exclude them from the group or even kill them (Graham et al., 2018, Gladden & Cleator, 2018). Consequently, virtues of this foundation are heroism, self-sacrifice, and patriotism, betrayal is a vice (Graham et al., 2009; Haidt et al. 2007).

What? The Loyalty foundation is activated through social emotions that help individuals to recognize, trust, and cooperate with members of their own group while being distrustful and cautious with regard to members of other groups (Haidt et al., 2007).

Where? Loyalty is triggered for example in relation to sports fandom, company branding or patriotism (Graham et al., 2013).

Authority

Why? Humans have an innate tendency to live in hierarchies of dominance and subordination, which can be observed in human political behavior (Graham et al., 2018, Koleva et al., 2017). This foundation is likely inherited from primates, and made groups with a respected and legitimate authority function better since a leader can fulfill functions such as protection or resolving conflicts (Graham et al., 2018; Haidt, 2012; Haidt et al., 2007; Graham et al., 2009).

How? Additionally, accepting a social order - and with that conforming to social traditions - keeps the group structured which may allow more efficiency since every member is aware of their role (Gladden & Cleator, 2018). This foundation is thus associated with a preference for stability instead of change (Koleva et al., 2012).

Who? The Authority foundation refers to socially beneficial leadership, and should not be confused with power and oppression (Haidt, 2012). It is about voluntary subordination below an authority which is perceived as legitimate because they fulfill the duties of their (social)

position (Graham et al., 2018; Koleva et al., 2012; Haidt et al., 2007). These can be for example religious leaders, police officers, or established scientists (Graham et al., 2013).
What? The foundation Authority is activated through feelings of respect and admiration (Haidt et al., 2007), and triggered by signals of lower or higher ranks (Haidt, 2012). Accordingly, virtues are obedience, deference, magnanimity, and wisdom (Graham et al., 2013; Haidt et al., 2007; Graham et al., 2009). Consequently, those who disrespect or do not live up to their duties, are disapproved, punished and even ostracized from the group (Graham et al., 2018; Koleva et al., 2017).
Where? The Authority foundation is generally relevant in modern institutions that require leadership or represent an authority, such as corporations, law courts, or police departments (Graham et al., 2013).

Liberty
Why? From an evolutionary perspective, the Liberty foundation might have served well for protecting one's own reproduction against overly controlling people (Gladden & Cleator, 2018).
How? With that, this foundation represents a sort of social detachment and preference for individualism and self-direction that is moralized into supporting liberty with autonomy being an end in itself (Gladden & Cleator, 2018; Iyer et al., 2012). There are two patterns for this foundation: Political transition/reverse dominance, and autonomy, i.e., a general rejection of dominance (Gladden & Cleator, 2018; Haidt, 2012). Generally, Liberty is related to personal rights and negative liberty (Iyer et al., 2012; Graham et al., 2011). With that, Liberty is in tension with the Authority foundation, because it concerns reverse dominance (Haidt, 2012).
What? Generally, libertarians are related to a stronger preference for cognitive reflection and pragmatism instead of emotionality (Iyer et al., 2012). People with a strong preference for this foundation (e.g., libertarians) exhibit lower emotionality with regards to the other moral foundations, because they appear to be of smaller importance for people with a high preference for Liberty (Iyer et al., 2012). However, this does not mean that libertarians are emotionless. They react quite strongly to signs of limits to personal freedom and interference in their autonomy (Gladden & Cleator, 2018; Iyer et al., 2012).
Who? Political reversion seeks equality and is therefore catered to victims and powerless; rejecting dominance in general motivates action against any control over one personally or their group (Haidt, 2012).
Where? People who endorse the Liberty foundation reject government involvement and prefer to be left alone to live their personal life. They also want to enjoy their economic life, e.g. spending their wealth, as they please (Iyer et al., 2012).

Sanctity
Why? Sanctity is closely related to the emotion disgust, which warns of biological contaminants (Koleva et al., 2012). This "behavioral immune system" (Schaller & Park, 2011, p. 99) has the adaptive advantage to detect signs of disease and foulness, which secures survival (Graham et al., 2018; Graham et al., 2013; Haidt et al., 2007; Haidt, 2012).

How? However, Sanctity is not only related to biological contaminants, but also to people that are associated with social contamination, and as such has a strong link to the spiritual and religious (Haidt, 2012; Haidt et al., 2007; Koleva et al., 2012). With that, Sanctity identifies the two extremes of the "untouchable": the polluted and the pure/sacred (Haidt, 2012).
Who and where? The first motivates to avoid proximity to anything and anyone with a potential threat of disease, such as feces, certain animals, people that are different, belong to stigmatized groups or occupations, or are deviant from the perceived norm in other ways, e.g., sexually (Haidt et al., 2007; Graham et al., 2013; Haidt, 2012). The second motivates people to protect (keep clean) the sacred and divine (Haidt, 2012). Sacred meaning can be ascribed to entities such as God or nature (Koleva et al., 2017). Thus, keeping the sacred pure from the polluted can refer to freeing nature of industrial capitalism, protecting the sacred practices of a group, or rejecting immigration from one's country (Haidt, 2012; Graham et al., 2013; Graham et al., 2018).
What? Sanctity signals a group's cultural boundaries (Gladden & Cleator, 2018; Graham et al., 2009). Consequently, within the Sanctity foundation, such people are seen as virtuous, who live according to a more spiritual mindset or treat their body in a noble way (Gladden & Cleator, 2018; Graham et al., 2009). This may refer to eating healthy, or to controlling one's animalistic impulses and carnal passions such as lust, selfishness or material greed (Haidt, 2012; Gladden & Cleator, 2018; Graham et al., 2009; Koleva et al., 2012; Koleva et al., 2017). Virtues are for example temperance and chastity (Graham et al, 2013).

Review Interpretation – Moral Foundations as Typology of Social Relationships
The systematic review of MFT according to the questions *Why*?, *How*?, *What*?, *Who*?, *Where*? illuminated that all moral foundations coordinate social relationships within a group.
Whether a moral foundation is violated or catered to depends on a static and a dynamic element. The static element describes *which* structure the relationship of two social entities has (e.g., hierarchical, vertical, close, distant). The dynamic element describes whether the *action* of an individual *conforms* with the structure of the relationship or violates it (e.g., respecting others' rights, disrespecting authority).
Consequently, the static element is the *positive description* of the structure that is anticipated by observing a social interaction. The dynamic element, however, describes the *normative evaluation* of an observed social interaction. The combination of both comes with a *normative expectation* that people act accordingly. If they do, the respective moral foundation is perceived as catered to and the affiliated emotions are positive; if they do not, the respective moral foundation is perceived as violated and the related emotions are negative.
Donald Black (2011) formulated the idea that social relationships can be described in terms of moral space. Black (2011) distinguishes three dimensions of moral space (see also Pies, 2018): A horizontal, a vertical, and a diagonal. The horizontal dimension describes relationships in degrees of intimacy. The vertical dimension provides group structure, described as a degree of stratification into hierarchical groups. And the diagonal dimension describes group boundaries as a degree of diversity versus homogeneity in a culture.
For Black (2011), these three dimensions help to explain the emergence of moral conflict: According to Black (2011), if a social relationship moves along a dimension, the previous order

is disturbed, and conflict occurs (see also Pies, 2018). For example, a group of friends can be described as situated on the lower end of a vertical dimension, with little to no stratification. If one of the friends starts to lie to the others or, for example, steals from them, they exploit the others for their own benefit. In this scenario, they try to increase the stratification by putting their personal benefit before the group's wellbeing. They try to move up the vertical dimension and thus cause moral conflict.

The present work adopts Black's idea that morality structures social relationships according to three dimensions. Building on this, the present work proposes that each of the six moral foundations adds a *distinctive contribution to the structure of a social group*. It is argued that every two of the moral foundations can be organized to one of the three dimensions; and that each two moral foundations can be distinctively organized to one of the extremes (close – distant) within each dimension. This structure is illustrated in Figure 2.1.

Moreover, the present work also proposes that conflict does not only occur through a movement along the dimensions, but by *any movement* that differs from the normative expectation towards the relationship. This also includes abandoning a dimension and moving into another one.

Importantly, the present paper argues that this is how *conflicts between moral foundations* can occur. For example, if somebody emphasizes the Loyalty foundation, and demands that this foundation was catered to; but another person values Fairness more, and acts according to the Fairness foundation, a moral conflict can be the result. Even though both parties behaved morally in their eyes, they are in conflict about *which foundation applies* in a situation.

Results – A Structural Approach to Moral Foundations Theory

In the following, the structural differences between the foundations are illustrated with a three-dimensional cube (see Figure 2.1). Since all foundations contribute to the structure of a group, Figure 2.2 illustrates their function within a group.

The Structure in Three Dimensions

Based on the literature review above as well as on Black's (2011) three dimensions of moral structure, the positions of the moral foundations in the cube are described in the following.

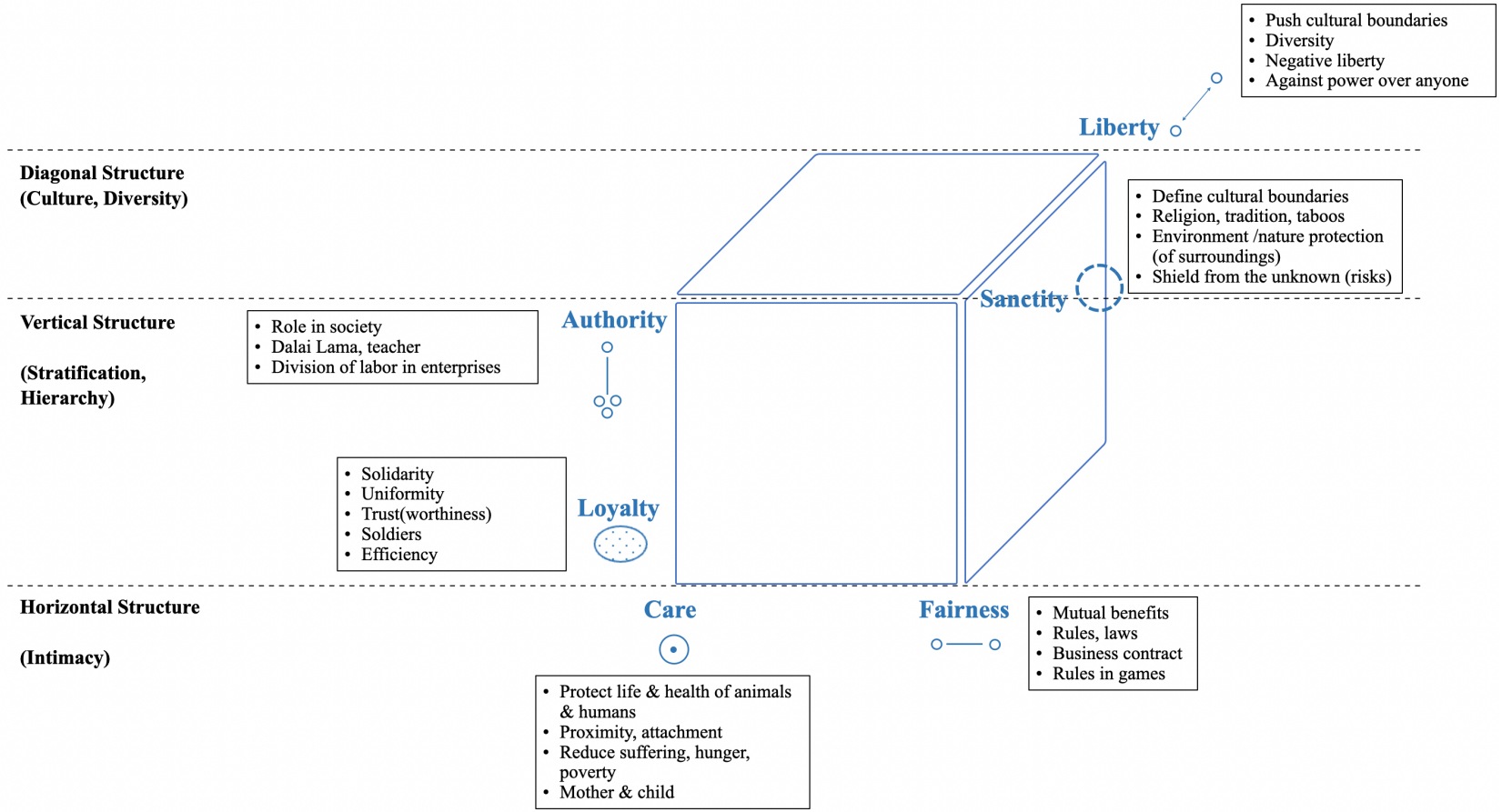
Horizontal Relationships (Degrees of Intimacy)

Care motivates to protect others' health and well-being. Structurally, it is *the* attachment foundation, enabling ultimate proximity. Accordingly, on a horizontal axis ranging from intimacy to distance, Care would be situated where intimacy is maximized. An archetypical example is that of a mother and her child.

Fairness motivates mutually beneficial cooperation. Structurally, it is thus characterized by a voluntary interaction between individuals on the same hierarchical level. Thus, Fairness would also be situated on the horizontal axis. Since Fairness is an individualist foundation, it is located to the right of Care, because of a greater distance between the individuals. Classic examples are a business contract between similar sized companies, traffic regulations, or rules of games.

Figure 2.1

The Structural Contribution of the Moral Foundations in Three Dimensions



Note. The three dimensions are adapted from Black (2011). The illustration of the dimensions is adapted from Pies (2018). The cube only serves as an illustration, and does not imply that inferences can be made about potential dependencies between foundations.

Vertical Relationships (Degrees of Hierarchy)

Loyalty is a binding foundation that motivates uniformity and solidarity, and focuses on subordination of each member below group cohesion. Loyalty encourages the group to be perceived as more important than the individual, and is thus situated at the lower end of a vertical axis, where stratification is minimized, and no individual is hierarchically situated above another. A classic example are soldiers.

Authority is a binding foundation that structures a group vertically, according to a hierarchy. Thus, it would also be situated on the vertical axis. Since Authority motivates voluntary subordination below an individual that is perceived as a legitimate leader, stratification is higher than in Loyalty. Classic examples are the Dalai Lama, respected teachers, or the division of labor in enterprises.

Diagonal Relationships (Degrees of Cultural Diversity)

Liberty motivates detachment and individualism. It thus contributes to a diagonal structure that organizes a group according to degrees of diversity. Since Liberty pushes the cultural boundaries of a group, it would be situated on the outer end of a diagonal axis describing a high degree of diversity. A classic example is the concept of laissez-faire.

Sanctity is a binding foundation that motivates self-control with regards to norms and traditions. Thus structurally, it defines a group's cultural boundaries. It would be located at the minimum end of the diagonal axis, where diversity is low. Classic examples are religious rules, protected values, conventions, or customs.

The Structural Contribution of the Moral Foundations in a Group Setting

Resulting from that, the six moral foundations can be described in terms of their structural contribution to a social system. This is illustrated in Figure 2.2 and described in the following, based on the above literature review.

Of the six moral foundations, *Care* contributes the structural component with the highest proximity. It keeps individuals very close. As attachment foundation, its focus lays on compassion and sympathizing with others. The motivating goal is to protect and nurture the weak and needy, particularly from harm to mental and physical health, well-being, or even life. It thus serves to prevent or seize suffering, also through medical care. The typical example for Care is the family, but it extends to other people in need, threatened by hunger, poverty, perpetrators, or general harm. Care also extends to (cute) animals.

Fairness helps to regulate social interactions on the same hierarchical level. A prerequisite of the Fairness foundation is equality of opportunity, because individuals enter voluntary cooperations that are perceived as mutually beneficial. It is thus an individualist foundation, in which individuals do not have a social obligation towards each other, aside from following the mutual rules or contracts they voluntarily agreed on. These rules, such as contracts or laws, are seen as mutually beneficial for both sides. Thus, Fairness motivates cooperation with win-win potential. As the Golden Rule describes, Fairness entails actions of reciprocity and proportionality, in which individuals give while expecting compensation in return.

Loyalty is a collectivist foundation that binds people into groups. It motivates group cohesion and uniformity, but discourages diversity. Group members identify with their group and signal

this to others. That way, group members can easily be recognized and distinguished from outsiders. Decisions about inclusion and exclusion are made around the judgment of whether someone contributes to a group's well-being. Team players that sacrifice (heroically) for their community are approved of. Acts that benefit the entire group are welcomed. Acts on behalf of self-interest that may even be detrimental for the group, or exploit a group's resources, on the other hand, are condemned. Such traitors are excluded from the group. Thus, expectations of solidarity are decisive within the Loyalty foundation. Loyalty serves as motivation to strive for equality of outcome. Matters regarding equality of outcome are the goal.

Authority motivates hierarchical structures among individuals that are beneficial for the entire group. Most importantly, this hierarchy does not develop due to oppression or an abuse of power, but because of a voluntary subordination under an authority. That means that other group members appreciate someone's expertise and leadership and perceive their hierarchical standing as legitimate. Within this foundation it is assumed that every hierarchy level is related to certain roles and duties. Thus, as long as a leader is perceived as fulfilling the duties of their social position responsibly, they are respected and encountered with respect. Their purpose is to set up and enforce rules and regulations that are beneficial for social welfare. Consequently, power-abusing despots are subverted.

Liberty pushes a group's (cultural) boundaries by motivating individuality, diversity, and tolerance. It is strongly related to social detachment and is thus an individualist foundation. It stands somewhat in tension with the Authority foundation because it mainly motivates negative liberty (i.e., freedom *from* something or someone) and the motivation to decide for oneself. Liberty promotes autonomy as a moralized end in itself.

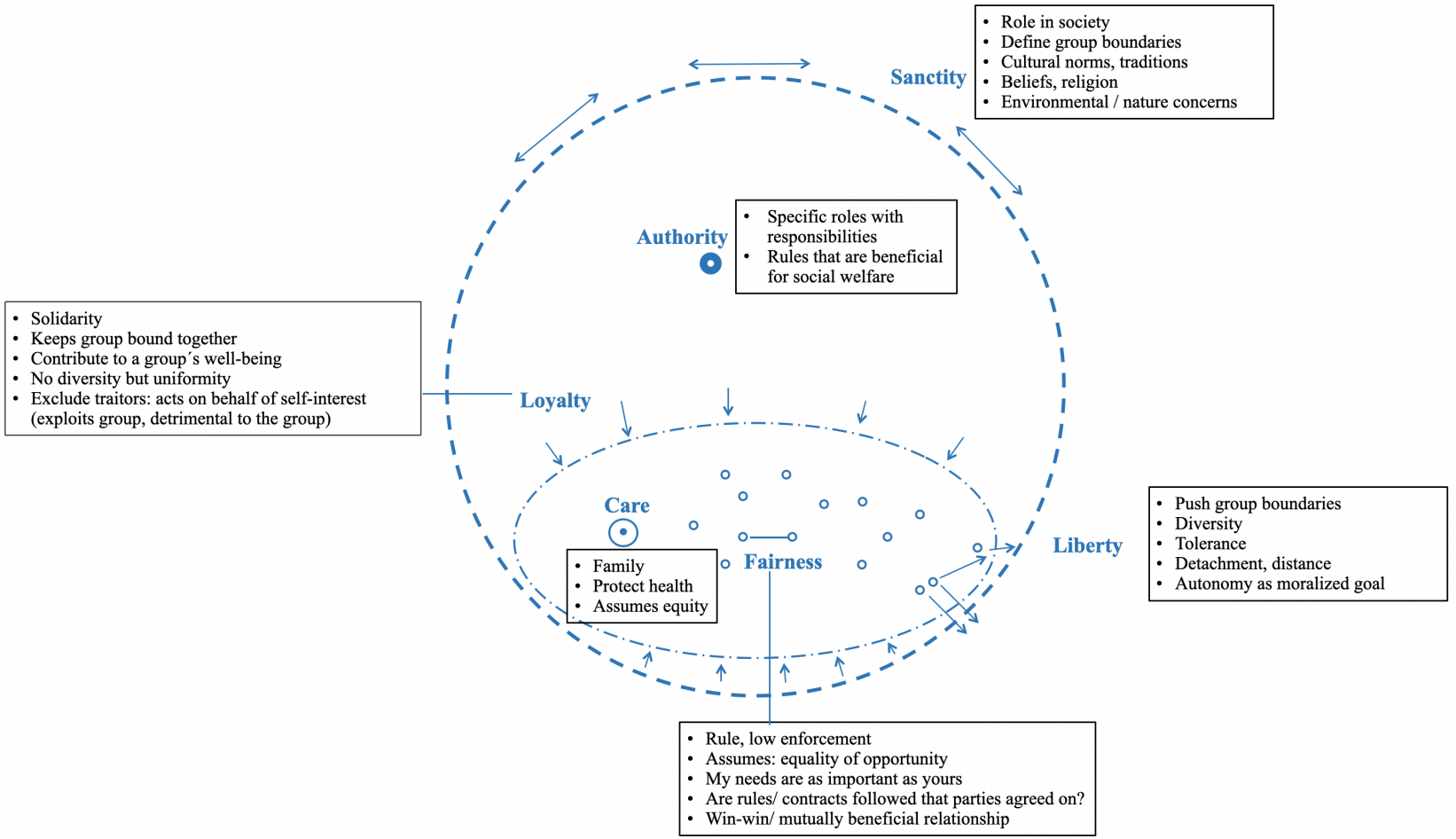
The goal of Liberty is equality of opportunity, and thus motivates to act against illegitimate constraints or control in general. Liberty motivates freedom of choice.

Sanctity is the third binding foundation, since it motivates self-control with regards to a group's cultural boundaries. These cultural boundaries are related to avoiding any potential threat of diseases, which does not only result in avoiding known threats, but also the unknown. They are manifested for example in religions, traditions, beliefs, cultural norms. The Sanctity foundation thus motivates to avoid deviation from any (perceived) norm. Such deviations, which are perceived as potential threats, do not only refer to unhealthy or unknown/new foods, but also to strangers or eccentric behavior or taboo-breaking practices. The aim to avoid proximity to such deviances goes so far as to protect the core ideals of a culture. These ideals are held sacred and thus are often protected at high costs. This protection extends to objects that symbolize the sacred, such as flags or books.

Put briefly, Sanctity motivates to keep our surroundings healthy, clean, and under control – spiritually (e.g., protect norms, traditions, religion), as well as worldly (e.g., protect the environment, prevent pollution or the spread of pathogens).

Figure 2.2

The Moral Foundations in a Group Setting



Note. Every moral foundation contributes a unique structural function to a group. Here, their functions are illustrated in a group-setting.

Testing the Template

In order to test whether the structural approach proposed here increases reliability between raters, interrater reliability tests (IRR) between five raters were conducted.

As explained above, only parts of training material from previous research was openly available online. These suggested a high similarity to the descriptions of the foundations in Haidt (2012). Thus, to test the template, these descriptions of the moral foundations provided by Haidt (2012) were used for the IRR.

The data used for the interrater reliability test, as well as the codings of five raters are available at https://doi.org/10.7910/DVN/YGNDP3[6].

Procedure

Raters 1 and 2 were provided with a TED talk by Jonathan Haidt explaining MFT (Haidt, 2008b). They were also provided with pages 200 to 282 of "The Righteous Mind" (Haidt, 2012). In both, Jonathan Haidt vividly explains the six moral foundations in detail, with many examples. This training took a few hours.

Raters 3 and 4 were provided with Figure 2.1 and Figure 2.2 from the present manuscript. The two figures were explained verbally by the author, once. This took a little less than 15 minutes. Raters 3 and 4 were not allowed to ask questions after the verbal explanation, but could use Figure 2.1 and Figure 2.2 as support during coding.

The fifth coder developed the structural distinction between the foundations (contributing author) and thus received no training.

Then, all five raters were provided with 60 statements in favor and against biotechnologies in general, and GMOs (genetically modified organisms) more specifically. The IRR was measured with Cohen's Kappa for two raters (McHugh, 2012).

Results

As shown in Table 2.1, the agreement differs greatly between the two treatments. Raters 1 and 2, who received a more conventional explanation of MFT, exhibit low interrater agreement among each other as well as with raters that worked with the structural approach of this manuscript (Rater 3 and 4) and the author (Rater 5). According to the classification proposed by Landis and Koch (1977), these results qualify as "slight" (and one "fair") agreement. Moreover, only two reliability scores with the conventional explanation were significant (between Rater 1 and Rater 3, and between Rater 1 and Rater 5).

On the other hand, those raters who received the new structural approach, exhibit very high interrater agreement among each other (Rater 3 and 4) as well as with the author (Rater 5). These results were all highly significant and qualify as *perfect* or *substantial* agreement (Landis & Koch, 1977).

[6] Waldhof, G. (2023). Supplemental Information for "A Structural Approach to Moral Foundations Theory - for Theory Development and a more reliable Application in Latent Content Analyses". *Harvard Dataverse, V3.* https://doi.org/10.7910/DVN/YGNDP3

Table 2.1
Interrater Reliability

	Rater 1	Rater 2	Rater 3	Rater 4	Rater 5
	(Conventional explanation)		(New structural approach)		(The author)
Rater 1	/	0.108	0.126*	0.0809	0.126*
Rater 2	/	/	0.359	0.114	0.0654
Rater 3	/	/	/	**0.705****	**0.878****
Rater 4	/	/	/	/	**0.782****
Rater 5	/	/	/	/	/

Note: * statistically significant ($p < 0.05$); **highly significant ($p < 0.005$).

General Discussion

Methodological Contributions to Human Latent Content Coding

In the present paper, a key proposition from Donald Black's Moral Sociology is used to develop a structural approach to Moral Foundations Theory. This resulted in the insight that each moral foundation provides a distinct structural contribution to a social group. An IRR suggests that using this structural categorization of moral foundations in latent moral content analysis greatly increases the reliability of human codings. This provides evidence that focusing also on the input into human coding procedures, and not only on the output, adds value to the methodological development of latent moral coding. This structural approach sharpens the understanding of Moral Foundations Theory, which leads to novel methodological contributions. Some of these are discussed in the following.

Training and Reliability

Particularly the limited training opportunities in crowd-sourced approaches led researchers to raise concerns about reliability (Grimmer et al., 2022; Lind et al., 2017). Hopp et al. (2021) and Weber et al. (2018) argue, that (close to) perfect reliability in latent content coding of moral foundations might be a questionable and unreachable goal because e.g., Weber et al. (2018) did not find that extensive training and expert knowledge increased reliability and validity of coding results.

The IRR above has shown that the structural approach proposed here makes the application of MFT in human content coding more reliable. From that, it is concluded that the concept provided to the coder is less ambiguous.

Moreover, the approach can be explained quickly, in about fifteen minutes, which makes the coding more time-efficient, and with that also cost-efficient. Thus, agreeing with Weber et al. (2018), extensity of training and providing in-depth expert knowledge may not be the key to reliability and validity. Rather, the results presented here suggest that clarity of concept and decreased ambiguity increase reliability and validity, while at the same time decreasing time and costs.

Ground Truth, Expert Knowledge, and Spontaneous Moral Intuitions

Hopp et al. (2021, p. 3) question the assumptions "(1) That there is a ´ground truth` as to the moral nature of a particular word, and (2) that ´experts` are somehow more reliable or accurate

in annotating textual data than are non-experts (Aroyo & Welty, 2015).” Rather, “moral intuitions follow largely a fast, spontaneous, subconscious cognitive process” (Weber et al., 2018, p. 17). Since humans evolved to intuitively and spontaneously detect moral concerns in information about a social interaction, there is no reason that experts would show more reliable intuitions than others.

However, a distinction needs to be made between practical intuitive skills and information about an underlying theoretical concept. While lay people are just as reliable in following their moral intuitions, they still need to become acquainted with the theoretical concept that they are supposed to use as an approach for annotation. People have a large variety of moral intuitions, and their categorization into six moral foundations is a theoretical proposal that is not innate. In order to reliably organize spontaneous moral intuitions according to a specific theory, this theory has to be explained with a maximum of conceptual clarity and unambiguity (see also Mohammad, 2016a, 2016b).

Even more specifically, moral intuitions are fine-tuned to detect *specific and diverse moral matrices* that vary much between cultures and people. The intuitions are *not fine-tuned to detect the six foundations* that these varying matrices are based on. As Haidt (2012, p. 211) points out: „Moral Foundations Theory says that there are (at least) six psychological systems that comprise the universal foundations of the world’s many moral matrices.“

Decreasing Ambiguity in Concept May Help to Separate Noise from Signal

Weber et al. (2018) found nonrandom differences in annotations, from which they infer that inconsistencies in coding might not be noise, but signal – showing interpersonal differences in moral perceptions of text. A person for whom the foundation Liberty is extremely important, might also identify this foundation more often in text than others. Thus, so goes the reasoning of Weber et al. (2018), depending on the respective salience for the coding individual, the same text may trigger different foundations. However, if the concept provided for coding is ambiguous, it is difficult to distinguish signal from noise because errors due to misunderstandings of the concept increase.

Thus, providing clear input to coders shall reduce noise and signal should become more obvious.

Limitations

While the structural approach to MFT promises to increase reliability in latent content analysis, some problems with coding remain. For example, short text sequences of a few words often do not provide enough information for the main message of the sequence to allow for a consistent interpretation across coders. Moreover, with every topic and text type, other difficulties arise. E.g., in the case of genetic engineering of plants, many arguments do not describe a social interaction between humans, but potential impacts of a technology on humans with moral relevance. Thus, it is still essential for the researcher to know the data well in order to be able to include potential pitfalls that are unique to the topic into the training (Grimmer et al., 2022). Moreover, the training could become even more user-friendly when provided with a short video clip. Subsequently, coders could receive a cheat sheet containing the two illustrations presented above. After a short training, coding could start.

Furthermore, raters should be advised to stick with just the information provided in the group of words and to not start a line of thought of all consequences that can result from provided information. For example, and argument in favor of growing genetically engineered plants is that farmers can greatly decrease their pesticide use (Klümper & Qaim, 2014). If coders were to identify the addressed moral foundation, they often start a line of thought about the deeper meaning of the argument from "minimizing pesticide usage is beneficial for the environment", to "environment protection is good to save natural resources", to "more efficient use of natural resources is beneficial for all humanity", to "if more people benefit, more people will stay healthy, if more people stay healthy, more people will survive". They could thus end up with a variety of different possible moral foundations.
And most importantly, the conceptualization of MFT for latent content coding presented here could strongly benefit from large-scale testing with a crowd-based approach such as MoNa.

Theoretical Contributions to Moral Foundations Theory
The present work demonstrated that the six moral foundations identified by Haidt and his colleagues can be clearly distinguished by their contribution to group structure. Care motivates proximity and attachment among individuals (e.g., family). Fairness motivates voluntary, mutually beneficial cooperation on the same hierarchical level (interaction among strangers, coordinating rules). Loyalty keeps the group together and motivates uniformity (e.g., team player, soldiers). Authority motivates a hierarchical structure of the group, in which different people take on different responsibilities and are seen as legitimate guides in their respective area of expertise (e.g., pedagogues, respected scientists). Sanctity defines the cultural boundaries of a group (e.g., norms, traditions). And Liberty pushes the cultural boundaries of a group (e.g., diversity, freedom of choice).
The insight that each foundation has their unique structural function in a social group, is theoretically important because novel conclusions about the content of the moral foundations can be drawn from it. These allow new theoretical perspectives on MFT, and also suggest solutions to past inconsistencies in coding. They may thus also increase validity in coding. A few of these novel conclusions are described in the following.

Equality of Opportunity
Equality of Opportunity is a Prerequisite of Fairness. It is argued here that in Fairness, equality of opportunity needs to be assumed as a prerequisite for this foundation to work. This is for several reasons. As described above, Fairness motivates mutually beneficial cooperation of individuals on the same hierarchical level. Fairness is seen as proportionality (Haidt, 2012), in which people get their share of a cooperation proportional to what they put in. Thus, there is no power imbalance assumed that could cause a party to receive more or less from an interaction than they put in. Similarly, for example, traffic regulations apply to every person in the same manner, regardless of income or influence.
If somebody gets more, or less, than they put in, or ignores traffic rules, this is met with outrage and perceived as unfair. Moreover, Gladden and Cleator (2018) describe that Fairness is concerned with mutual respect for each other's rights. Within the Fairness foundation, social interaction is measured and evaluated against the assumption that the same rules apply to everyone, and no one is entitled to more, or less, than they put in. Otherwise, they would not

have had the same opportunity from following the rules, which may make the rules obsolete. Thus, for the Fairness foundation to be catered to, equality of opportunity needs to already be implemented.

Equality of Opportunity is a Goal of Liberty. However, within the Liberty foundation, equality of opportunity is the goal. In this foundation, the cultural boundaries are pushed, diversity is desired, as is tolerance towards those who deviate from the norm. Thus, not Fairness, but Liberty is activated when political inequality is perceived (Haidt, 2012). In line with that, while Haidt (2012) initially organized some concerns of social justice into the Fairness foundation, he later corrected this allocation to Liberty after the foundation was discovered. Haidt (2012, p. 204): "[The Liberty foundation] leads liberals (but not others) to sacralize equality, which is then pursued by fighting for civil rights and human rights. […] Conservatives, in contrast, are more […] concerned about their groups […] don´t tread on me" […].

More specifically, concerns of social justice can broadly be organized into two groups: concerns of (in)equality and diversity, and (un)equal distribution of wealth. On the one hand, many aspects of social justice constitute a quest for equality of opportunity and thus belong to Liberty. For example, the abuse of power to exploit those at the bottom, or political inequality. On the other hand, aspects of social justice that concern the distribution of wealth belong to Loyalty, not Liberty, because they concern equality of outcome.

Equality of Outcome and the Principle of Solidarity

Equality of Outcome is a Goal of Loyalty. Mäkiniemi et al. (2013, p. 776) grouped an "equal or unequal distribution of food and welfare in the world" to Fairness. This example describes a demand for equality of outcome. In the following, it is argued that this might better be allocated to Loyalty, rather than Fairness.

Measured by standards of Fairness, equality of outcome would be considered unfair in a group in which some people put in most of the work and others less or none (Haidt, 2012). Contrary to that, equality of outcome leads everybody to having the same social status, uniformity being the goal. This concerns a reallocation of belongings and resources, even if the giving party does not immediately benefit from sharing. Such solidarity and sacrificing for the group are typical for the Loyalty foundation. One example would be social safety nets of industrial nations, through a redistribution of some taxes as a reimbursement in case of unemployment. These serve as personal risk insurance because they spread the risk of unemployment across the entire group as a collective safety net for everyone. In Germany, this policy is called *Principle of Solidarity*.

Concerns of Social Justice that Have Equality of Outcome as a Goal Belong to the Loyalty Foundation. Accordingly, those aspects of social justice that concern a redistribution of wealth from the rich to the poor, for example through higher taxes for the rich and higher social benefits for unemployed, also belong to the Loyalty foundation. Here, the present work argues differently than Haidt (2012), who organized them to the Liberty foundation. This is because a demand for redistribution connects to the principle of solidarity, in which those group members who have more, give to those group members who have less. This concerns equality of outcome, as Haidt (2012, p. 204) states himself: "Liberals sometimes go beyond equality of rights to

pursue equality of outcomes, which cannot be obtained in a capitalist system." And such pursuit of equality of outcomes is a main Loyalty concern.

Dislike of Capitalism by (far) Left Symbolizes a Wish for Solidarity. Consequently, many people, especially from the (far) left, argue that the capitalist system is inherently undesirable. Haidt organizes this dislike of capitalism to the Liberty foundation. However, as the argument behind this anti-capitalism is a desire for equality of outcome, it does belong to the Loyalty foundation, too. Haidt (2012, p. 203) writes: „[...] one liberal reader explained to me, ´Capitalism is, in the end, predatory—a moral society will be socialist, i.e., people will help each other.`" This expectation of solidarity, that is not inherent in a capitalist system, testifies a quest for Loyalty.

Equality of Outcome is a Prerequisite of Care. Moreover, it is proposed here that equality of outcome is a prerequisite of Care. This foundation assumes such proximity and attachment, that the well-being of a vulnerable individual and their carer appear indivisible. Archetypically, just as the relationship of a mother and her newborn, according to the principle "if you suffer, I suffer; if you are happy, I am happy".

General Efficiency can be Organized to Loyalty

General efficiency, that does not only benefit single individuals but society in general, can be seen as a Loyalty concern. For example, through reducing air pollution in a city, the entire city benefits. Or, if a new technology allows the cheaper production of crops for human consumption, in principle everyone benefits from decreased prices. However of course, if efficiency is only to the advantage of a few, this does not cater to the Loyalty foundation.

Concerns About the Environment may Better be Organized to Sanctity, not Care

In some qualitative studies, concerns of the environment and nature have been allocated to Care (e.g. Dempsey et al., 2020). Here, it is argued that those concerns do not fall into the Care foundation, but into Sanctity, because they can be organized to the idea to keep our surroundings clean, healthy, and free from pollution.

To illustrate, take the following example: "Genetically modified plants contribute to environment protection through reducing pesticide use." Here, the act of environment protection is morally evaluated. Generally, there are only two morally relevant reasons to care about (or for) the environment: environment protection as a moral *end in itself*, or with the purpose to secure human survival. If it was the former, it could be thought that the motivation to "protect" is indicative of the Care foundation. In this case, the action to "protect", which is directed towards the environment, would be morally evaluated. However, moral foundations coordinate the *social interaction between human individuals*. Therefore, protecting the environment as an end in itself, which describes an interaction between humans and a non-human entity (i.e. the environment), is not covered by the Care foundation. Even if some people take this literally, and care e.g., for a tree as they would for an animal or a child, or see nature as "their temple", this feeling or motivation seems more spiritual or holistic, and is thus a typical candidate for Sanctity.

There is also the latter understanding, that environment protection eventually serves the protection of humanity. This also does *not* substantiate its allocation to Care, because the eventual support of human survival is the general evolutionary advantage of *all* moral

foundations. This feature often provides grounds for confusion of Care with other foundations. The often-used phrase "to care about the environment" adds to that potential for confusion.
It becomes clear that in both cases, environment protection is best interpreted as a cultural norm that serves human survival. This is because for the majority, environment protection may best be understood as the motivation to keep our surroundings healthy and clean from pollution. In line with that, Sanctity relates to the "behavioral immune system" (Schaller & Park, 2011, p. 99) that helps to prevent threats from diseases (Graham et al., 2018). Thus, the protection of nature in order to keep it pure from threats can be organized to the Sanctity foundation (Koleva et al., 2017).

Conclusion and Outlook

Here, a structural approach to Moral Foundations Theory is proposed. It distinguishes the six foundations according to their structural contribution to beneficial social interactions in groups. Evidence is provided that this approach increases reliability in latent moral content coding with only fifteen minutes of training. This shall be particularly helpful for research on moral polarization. The next step would be to test this conceptualization in a crowd-based approach such as MoNa (https://mona.mnl.ucsb.edu/).
The present research provides a pragmatic approach to increase the discriminatory power between the moral foundations. From this follow new theoretical contributions to the understanding of the moral foundations. Building on these, a few suggestions to overcome typical confusions between the foundations are made.

Author Note

Data and materials are available at: Waldhof, G. (2023). Supplemental Information for "A Structural Approach to Moral Foundations Theory - for Theory Development and a more reliable Application in Latent Content Analyses". *Harvard Dataverse, V3.* https://doi.org/10.7910/DVN/YGNDP3. Specifically, the repository file contains a literature list for the systematic review, a table with the text excerpts used for the systematic review, a table with the results of the systematic review, and a table that provides an overview of the resulting conceptualization of MFT. Furthermore, the repository file contains the data used for the interrater reliability test, as well as the codings of five raters.

Since the data collection did not involve the participation of human subjects, and all used data were publicly available online, no ethical clearance is required.

For funding this project, I would like to thank ScienceCampus Halle - Plant-based Bioeconomy, EFRE funds, under Grant ZS/2016/06/79644. I would also like to thank the Leibniz Institute of Agricultural Development in Transition Economies (IAMO) for financial and infrastructural support of this project.

For valuable feedback during the development of this manuscript, I would like to thank Ingo Pies, Ulrich Fritsche, Matthias Uhl, and Alexander Reese. Furthermore, I would like to thank Rita Kopp and Anna Paulsen for excellent formatting assistance. I also would like to thank Sebastian Pfützner, Lisa Roch, Anna Paulsen and Christopher Krause for supporting the interrater reliability test.

The author has no competing interests to declare.

Chapter 3 – Opponents and Supporters of Genetically Engineered Foods Emphasize Distinct Moral Foundations and Exhibit a Clash of Two Diverging Worldviews[7]

Abstract

The German debate about genetically engineered crops for human consumption (GE) has been polarized for almost three decades. While attempts to overcome this polarization generally consist of the distribution of information, research has shown that information has little to no impact on GE attitude, particularly among most extreme positions (Fernbach et al., 2019; Connor & Siegrist, 2010; Verdurme & Viane, 2003; Huffman et al., 2007). Recent research suggests stable moral convictions as a driver of GE opposition (Scott et al., 2016). However, it is unknown whether opponents differ in their emphases on moral values underlying their attitudes from those held by GE supporters. For effective communication to overcome polarization, the potentials for conflict between moral foundations (Haidt, 2013; Graham et al., 2011) need to be identified. With a content analysis of the latent moral foundations addressed in the GE debate, it is shown here that, rather than addressing risks and benefits of the biotechnology, most arguments refer to the Loyalty foundation. Moreover, debating parties differ in their focuses on moral foundations: while GE supporters focus more on Authority, Fairness, and Liberty, GE opponents focus more on Care and Sanctity. Most remarkably, these moral conflicts exhibit a clash of two opposing worldviews: The arguments of GE supporters convey optimism towards technological evolution and scientific progress, combined with a perplexity in the face of a perceived growing skepticism towards scientists, their motives, and their communication. Conversely, the arguments of GE opponents convey a skepticism of modernity through concerns regarding technological risks, a fear of environmental contamination, and increasing power imbalances. In the face of growing societal challenges, such as climate change and food insecurity, the need for further technological innovation is anticipated. The present findings may thus provide an impulse to tackle this likely growing ideological divide through enabling societal acceptance of necessary sustainable developments without leaving large proportions of the population behind.

Keywords: Debate on Genetic Engineering, Moral Values, GMO Attitudes, Moral Foundations Theory, Latent Content Analysis

[7] This Chapter is currently under review at the journal *Science Communication.*

Introduction

Public debates are a crucial element of the democratic policymaking process (Habermas, 1983; Vanberg & Buchanan, 1989). Ideas about important societal issues are developed and discussed here, and eventually feed into policymaking. If public debates are impeded, the societal costs can be high, because they may result in inefficient or even adverse policies (Will & Pies, 2014). One example of such an impeded public debate is the debate about genetic engineering of crops for human consumption (GE). Particularly in Germany, this debate has been fierce, emotional, and long-lasting (Dürnberger, 2019; Freitag, 2013). Since its onset in the early 1990s, the publicly debating parties appear to not have been able to move towards consensus. Rather, their conclusions about GE are strongly polarized (Tosun & Schaub, 2017): Aside from few less prominent exceptions, the vast majority of main actors in the debate resorted to the two diametrically opposed camps in the debate (see for example Kockerols, 2021). While non-governmental organizations (NGOs), such as Greenpeace and Friends of the Earth, campaign for a complete ban of GE because the technology potentially bears high risks (e.g. Greenpeace, 2015), scientific representatives, such as the German National Academy of Sciences Leopoldina or the German Research Foundation, demand a revision of the current GE regulations because they would not coincide with the current state of science (German National Academy of Sciences Leopoldina, 2022).

Most peculiar about this debate is the stark divergence between the scientific academies´ assessment of GE and the public perception of the technology. For example, in two samples that were representative for residents in Germany, researchers found rejection rates to be as high as 76% (Jauernig et al., 2021), and 60% (Inbar & Waldhof, 2022). Likely, the arguments made by official representatives of GE opposition resonate more with the public sentiment about the technology. Also likely is that the arguments made by GE supporters are not convincing enough for the majority of the public to deviate from their known status quo towards introducing a technology with new consequences.

Recent research has shown that GE attitudes show many of the hallmarks of moral beliefs (Inbar & Waldhof, 2022; Scott et al., 2016). The moral content of the arguments made are thus likely to contribute to the positions people hold.

Thus, the present study contributes to explaining this divergence and the enduring polarization by identifying the underlying moral foundations that both, GE supporters and opponents, address.

Theoretical Background

Much information on the respective positions has been shared in the debate, being of no avail to a movement of the debate towards less polarized positions. Rather, many statements bear testimony to the gridlock in the German debate. For example, GE opponents are proud of 25 years of resistance and appeal to prevent the cultivation of GE (Gen-ethisches Netzwerk e.V., 2015). GE supporters, in turn, speak of a victory of dogmatism over reason (Bock & Szibor, 2015). And while Greenpeace (2015) describes research in GE as two decades of failure, Nellen (2018), assesses that researchers in Germany are mocked around until they are driven to despair. This situation suggests that involved parties do not expect the respective other side to be receptive to their arguments. Even more so, these highly emotional statements illuminate that involved parties accuse the respective other party of some sort of immoral behavior. This is in

line with Jansma et al. (2020), who demonstrate that in the public debate about GE, arguments addressing potential normative (de-)legitimation of GE were most frequent, and were often accompanied with emotionalized language.

These observed characteristics, i.e., strong polarization, the stability of positions in the debate, emotionality, and moral judgements, all suggest a potential moralization of the issue (see for example Ellemers et al., 2019; Feinberg et al., 2019; Skitka et al., 2005; Scott et al., 2016; Baron & Spranca, 1997; Tetlock et al., 2000; Ditto & Koleva, 2011; Feinberg & Willer, 2013; Matthes & Kohring, 2008).

Indeed, Inbar and Waldhof (2022) find that a large proportion of the German public moralize GE attitude. Even more so, the researchers find that while opponents moralize the issue more than supporters, a significant proportion of both, not only opponents but also supporters, state to maintain their position regardless of the consequences. Similarly, Scott et al. (2019), found that the majority of GE opponents in Germany, France and the US consider GE opposition to be a sacred value. These are strong indicators for a polarization not only within the public debate, but also within the German public.

In line with that, research on GE attitude in other countries showed that information on GE had little to no effect on opinion, particularly among those with most extreme positions (Fernbach et al., 2019; Connor & Siegrist, 2010; Verdurme & Viane, 2003; Huffman et al., 2007).

If moral concerns are so crucial for GE attitude, it seems worthwhile to investigate which moral concerns the public debate addresses, and who emphasizes which moral concern. This promises to shed light on why the polarization about GE is so enduring, and why most of the public diverge in their opinion from the assessment of scientific academies. For identifying the moral concerns addressed in the official German GE debate, Moral Foundations Theory shall be applied here.

Jonathan Haidt and his colleagues (see for example Haidt, 2012; Graham et al., 2011; Iyer et al., 2012) developed a theory of moral foundations. This theory proposes that moral intuitions are based on moral foundations that are innate, but malleable, modules. Thus, through factors such as socialization or personal dispositions, moral foundations differ in their salience among individuals, i.e., some moral foundations are more important to some individuals than others.

Specifically, Moral Foundations Theory (MFT) proposes the following six moral foundations: Care, Fairness, Loyalty, Authority, Liberty, and Sanctity (Haidt, 2012). These moral foundations guide moral judgments and social behavior. A more detailed description of the six moral foundations can be found in the section “Systematic Literature Review on MFT” pertaining to Chapter 2, as well as in the subsection “Moral Foundations Theory” of the Appendix.

MFT has been extensively studied and validated (Iyer et al., 2012; Graham et al., 2011). Previous research employing MFT suggests that diverging judgments can be associated with distinct moral foundations. For example, Graham et al. (2009) show that in the USA, liberals emphasize other moral values than do conservatives; Tamborini et al. (2012) find that evaluation of violence in media depends on distinct moral subcultures that can be predicted with the moral foundations Harm and Fairness; and Amin et al. (2017) show that vaccine hesitancy is associated with diverging emphases on Liberty and Sanctity. Thus, for the investigation of moral conflicts in polarized topics, MFT appears particularly useful.

The Present Research

Tying in with that, the present research identifies which moral foundations GE supporters and GE opponents emphasize and whether they exhibit potential value conflicts. For this purpose, more than 2,500 arguments are extracted from long position papers published by official representatives in the German GE debate, paraphrased, and allocated to one of the six moral foundations according to MFT.

Based on the assumption that official representatives address the moral concerns that are most relevant for their respective position, hypotheses about the results are based on previous research about GE attitudes in the public.

Specifically, Siegrist et al. (2012) found that GE attitude is associated with moral concerns related to honesty, fairness, confidence, health, and environment. Moreover, much research demonstrated that GE attitude depends on risk and benefit perceptions (see for example Ruth et al., 2017; Yue et al., 2015; Siegrist, 1999), with risk perceptions being much more impactful on, e.g., willingness-to-buy (Lee et al., 2018). Siegrist (2000) pointed out the importance of trust for risk and benefit perceptions of GE. Further research on trust in relevant institutions also confirmed trust to be a relevant factor (Siegrist, 2000; Gutteling et al., 2006; Kajale et al., 2015; Kimenju et al., 2008; Yue et al, 2015). Additionally, GE opposition has been related to concerns of purity, naturalness, and disgust (Scott et al., 2018; Hoogendoorn et al., 2021; Scott et al., 2016).

Based on previous research on GE attitude presented above, it is hypothesized here that

1) Care, Fairness, Loyalty, Authority, and Sanctity are all relevant in the debate.
2) Care is the most relevant foundation because it encloses arguments related to risks and benefits of GE.
3) Loyalty is very relevant because of the importance of trust in relevant institutions.
4) Care is more frequently addressed by GE opponents because of salience of risk concerns.
5) Sanctity is more frequently addressed by GE opponents.

The present research provides several theoretical contributions. First, previous research on GE attitude has largely focused on the impact of knowledge, as well as risk and benefit perceptions (see for example Ruth et al., 2017; Zhang et al., 2015; Yue et al., 2015; Siegrist, 1999). However, since the predominantly extreme attitudes towards GE have been shown to be moral (Scott et al., 2016), investigating the moral foundations underlying those extreme attitudes seems crucial for understanding the drivers of extremity. Second, reasons for GE support have rarely been investigated. Illuminating the moral arguments of both, GE supporters and GE opponents, contributes to understanding the role of moral conflicts in polarization. Third, applying MFT in a content analysis allows to systematically identify the extent of divergences in parties' emphases on distinct moral values.

Moreover, the present research provides a practical contribution. Identifying potential conflicts between moral foundations supports the development of efficient policies that may enable debating parties to reduce polarization. Even more so, identifying the most prevalent moral concerns may inform the policy debate about potential, and previously overlooked, issues that may inform an improved policymaking. Improved policies that include relevant moral concerns may ultimately reduce polarization.

Materials and Methods

Methodological Standards, Transparency, Openness and Ethical Standards

The present analysis was conducted in close accordance with the methodological principles of content analysis according to the guidelines of Philipp Mayring (2015). The Appendix consists of a detailed description of all steps involved in material selection and content analysis. Its reporting closely follows the "Qualitative Design Reporting Standards" according to JARS-Qual (Journal Article Reporting Standards of the American Psychological Association (APA), 2020, pp. 94-103). The "Results" section of this Appendix also contains Table 3.A.1 and Table 3.A.2 with the final code systems of all identified arguments, their frequencies, and addressed moral foundations.

All original data, the data used for the interrater reliability test, the code systems applied to the interrater reliability test, as well as the codes of two raters are available at https://doi.org/10.7910/DVN/K9LCB1[8].

No ethical clearance was necessary because all used sources were publicly available online.

In the following, a brief overview of materials and methods is provided.

Data Selection

Organizations that are most influential in the German GE debate, e.g. Greenpeace or German National Academy of Sciences Leopoldina (Leopoldina), regularly publish extensive position papers in which they explain their position by providing arguments and examples. The length of these position papers ranges from a few pages to about 60 pages.

In order to identify the most representative and comprehensive position papers[9], a list of organisations most active in the debate, compiled by Freitag (2013), was consulted. Moreover, the participant lists of events that are considered important for organisations active in the GE debate were consulted. For GE opponents, this is the event "Wir haben es satt!" [We are fed up!] (Kampagne meine Landwirtschaft, 2022; wir-haben-es-satt.de); and for GE supporters, these are the events "Internationale Grüne Woche" [International Green Week] (Messe Berlin, 2022, https://www.gruenewoche.de/) and "Global Forum for Food and Agriculture" (Federal Ministry of Food and Agriculture, 2022; https://www.gffa-berlin.de/en/). Furthermore, an online keyword search was conducted. The keywords were selected based on terms frequently used in the German debate, such as "genmanipulierte Lebensmittel" [gene-manipulated foods] for GE opposition, and "Grüne Gentechnik pro" [in favor of green genetic engineering] for GE

[8] Waldhof, G. (2023). Supplemental Information for "Opponents and supporters of genetically engineered foods emphasize distinct moral foundations and exhibit a clash of two diverging worldviews" *Harvard Dataverse, V1.* https://doi.org/10.7910/DVN/K9LCB1

[9] Motivated Reasoning and Incentives of Debating Parties: Official position papers do not necessarily reflect internally held moral convictions of debating parties. To a considerable extent, the declared positions will represent the business model of the respective organizations. For example, organizations such as Greenpeace rely on public funding, and will thus campaign for causes that likely generate most funding. Similarly, while scientists involved in biotechnology do have the mission to disseminate knowledge about their field of expertise, they at the same time have an incentive to represent their own field and research, in which they invested much time and effort. However, exactly because of this background it can be assumed here that involved parties use those moral arguments that they believe to make their respective position the strongest. These arguments can thus be seen as most representative for the respective position. Additionally, the endurance of the debate also allows to assume that arguments made relate to public sentiments. Particularly the considerable public support for the position of organizations, such as Greenpeace, shows that the moral arguments made appeal to a significant proportion of the German public.

support. And lastly, experts (i.e., scholars working on genetic engineering or the GE debate) were asked to recommend additional sources.

Official and comprehensive position papers published by these compiled actors were searched and included in the analysis, if they

- were published after 2010, in order to ensure similar topical focus,
- were published in German, in order to be relevant to the German debate,
- only address GE, in order to be relevant to the GE debate,
- exhibit a clear position against or in favor of GE.

In total, 30 position papers were included in the debate, 14 opposing, and 16 supporting GE. A full list of all position papers included in the analysis can be found in the Appendix under section "Final List of Position Papers Included in the Analysis". All 30 position papers are available at https://doi.org/10.7910/DVN/K9LCB1.

Coding Procedure

Each of the identified position papers consists of a plurality of arguments. These arguments were extracted from each position paper and coded. In order to identify all arguments made by official representatives in the debate, coding was conducted until no further arguments could be identified (saturation). In order to ensure maximum consistency between codes, the coding of arguments was conducted by one single coder (the author). For coding, the text analysis tool MaxQDA (version 2018) was used. The procedure mainly consisted of an inductive category development and a deductive content structuring. Here, the coding procedure is described briefly. A detailed description of the coding methodology, including examples, can be found in the Appendix section "Coding Procedure".

Inductive Category Development

In this inductive coding procedure, text segments that form an argument were identified and paraphrased into codes. Text sequences were understood as arguments if they contained a reason for the respective position towards GE. Usually, these reasons were accompanied by examples or further explanations. All these were coded as pertaining to the same argument. Since the position papers usually were long texts, a paragraph often stated several reasons at once. In these cases, each reason counted as a separate argument, leading to the text segment being coded several times into different paraphrases.

Coding was seized when arguments saturated, i.e. no new arguments could be identified, and when the total number of arguments counted was similar for both, GE supporters and opponents.

Deductive Content Structuring

Chapter 2 developed a methodology to identify latent moral foundations in text. This methodology is based on the seminal literature on MFT (for example Haidt, 2012; Graham et al., 2011; Iyer et al., 2012). Following the approach developed in Chapter 2, the paraphrased arguments were allocated to one of the six moral foundations. An argument was allocated to Care if it concerned general unspecified risks and benefits of GE, or specific risks and benefits to life or health of humans or animals. An argument was allocated to Fairness if it concerned the behavior of an involved actor in relation to rules, laws, and regulations, such as corruption,

cheating, law/rule breaking. Arguments were allocated to Loyalty if they concerned trust, or benefits and disadvantages for society as a whole. Here, society in general is understood as the reference group that potential loyalty would be directed towards. For example, whether GE or involved actors contribute to social welfare or try to enrich themselves at the costs of society.
Arguments were allocated to Authority if they appealed to a perceived authority, such as recited expert opinions. These could be for example scientists involved in GE, scientists assessing socioeconomic impacts of GE, or policymakers with a lot of experience. Here, it is important to note that an argument was allocated to Authority if a group or person was *perceived* as legitimate authority by the organization making the argument, irrespective of whether the group or person is an authority by some objective standards. Arguments were allocated to Liberty if they concerned civil liberties of affected people.
Related to the Sanctity foundation, it is important to note that Sanctity does not only include spiritual or religious concerns but also more general cultural boundaries and norms with an indirect effect on human wellbeing. While concerns pertaining to the other foundations usually have a direct impact on a human or a group of humans, e.g. physical harm or a deprivation of liberty, environment protection has more indirect effect on human wellbeing and can be seen a cultural norm. Arguments were therefore allocated to Sanctity if they concerned nature, contamination, environment protection, biodiversity, or sustainability.
Table 3.A.1 and 3.A.2 in the Appendix show all coded arguments with their frequencies and addressed moral foundations. Table 3.1 shows an overview of their content according to moral foundations.
Interrater Reliability of Coding Latent Moral Foundations. To check external validity, i.e. to test whether the coding decisions were systematic, consistent, and understandable for people not involved in the topic, the author's codings were compared to the codings of another person (interrater reliability test). Specifically, ten percent of all extracted text segments were randomly selected and coded a second time by a person that was unfamiliar with the topic but was provided the methodology of Chapter 2. Then, the agreement between both codings was calculated with Cohen´s Kappa (Cohen, 1960). According to the interpretation suggested by Cohen (1960), the agreement is "almost perfect" (Kappa = 0.851, p = 0). More detailed information on the procedure of the interrater reliability test and separate results for opposing and supporting position papers can be found in the Appendix section "Reliability: Interrater Reliability Check". The data used for the interrater reliability test, the code systems applied to the interrater reliability test, as well as the codes of two raters are available at https://doi.org/10.7910/DVN/K9LCB1

Rationale for Human Coding

While automated computer-assisted techniques for text analysis, such as dictionary-based methods, exist, a human coding approach was chosen for several reasons. First, while other recent developments in automated computer-assisted techniques for content analyses have made great advances in recent years (Grimmer et al., 2022; Jacobi et al., 2016), these are still in development and, particularly for identifying latent content of text, still rely on extensive human coding, e.g. for training a new model (Lind et al., 2017).

Second, similarly, while some automated computer-assisted techniques identify addressed topics, these can still only be interpreted with background knowledge of the analyzed texts. Thus, human coding is still indispensable to grasp the meaning of the identified topics.
And third, specifically for dictionary-based methods, van Atteveldt et al. (2021) find that human coding still outperforms their validity. This is particularly true for identifying the latent content of the official position papers analyzed here, since these rarely use typical keywords, e.g. fear or disgust, as contained in the Moral Foundations Dictionary (Frimer et al., 2017; Frimer, 2019), or the extended Moral Foundations Dictionary (Hopp et al., 2021), but describe their arguments in more formal language. This requires latent content to be identified through interpreting the content of text.

Results

From the 30 official position papers, a total of 2,583 arguments were extracted. Of those, 1,281 arguments were made by GE opponents, and 1,302 of GE supporters. By both groups, all moral foundations are addressed, generally to similar extents. Still, the differences of foundations addressed was highly significant between GE supporters and GE opponents ($\chi^2(5) = 101.82$, $p < 0.01$).
Figure 3.1 shows the distribution across the six moral foundations. Table 3.1 shows the frequencies of addressed moral foundations with paraphrased content of respective arguments. More detailed tables of the coded arguments, as well as coding examples for each moral foundation, can be found in the "Results" section of the Appendix.

Figure 3.1

Frequency Distribution of Moral Foundations Addressed by GE Supporters and Opponents

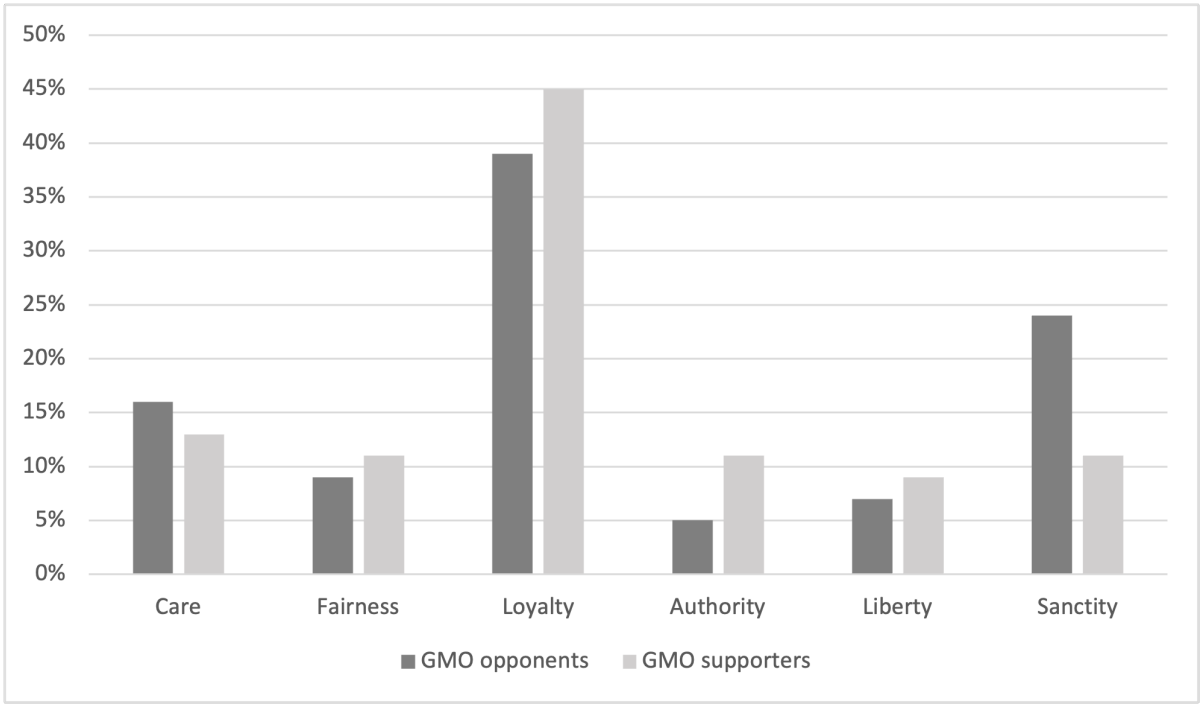


Table 3.1
Frequencies of Moral Foundations Addressed and Paraphrased Content

	GE Opponents		GE Supporters		
Moral Foundation	n	Paraphrased Content	n	Paraphrased Content	Total
Care	16% (210)	GE is a high-risk technology, risks for animals and human health.	13% (164)	GE is not a high-risk technology, benefits for animals and human health.	14% (374)
Fairness	9% (119)	Actors involved in GE do not comply with rules and regulations, are corrupt.	11% (147)	GE opponents behave unfairly in the debate, spread misleading information, smear campaigns against GE supporters, propaganda of frightening images.	10% (266)
Loyalty	39% (497)	GE and involved actors do not benefit society, but involved actors exploit common resources for their own advantage/profit.	45% (588)	GE and involved scientists and politicians contribute to society, are committed to social welfare.	42% (1085)
Authority	5% (66)	Experts oppose GE.	11% (141)	Experts/ scientists support GE, science should be the evaluating authority.	8% (207)
Liberty	7% (88)	GE leads to the oppression of civil liberties of consumers & small farmers.	9% (117)	GE opponents interfere with civil liberties of scientists, technological development, business, future generations.	8% (205)
Sanctity	24% (301)	GE contaminates nature and is a threat to sustainability and biodiversity.	11% (145)	Contamination is not a threat, GE supports sustainability and biodiversity.	17% (446)
Total	100% (1281)		100% (1302)		100% (2583)

Loyalty is by Far Most Frequently Addressed, Even More by GE Supporters

The foundation addressed most frequently by both is Loyalty, taking up 42% of all arguments made in the debate. While GE opponents address this foundation in 39% of their arguments, it is even more important for supporting arguments. GE supporters refer to Loyalty issues 45% of the time. Arguments made by GE opponents in this foundation generally claim that GE and actors involved in the technology do not contribute to social welfare, but rather exploit common resources for their own advantage. GE supporters, however, claim that the biotechnology does contribute to society, and that involved scientists and politicians are highly committed to social welfare.

GE Opponents Address Sanctity and Care More Frequently

With a total of 17% of all arguments, Sanctity is the second most prominent foundation in the debate. It is also the foundation with the largest difference in frequency. While it is addressed in 24% of the opposing arguments, it is addressed in 11% of supporting arguments. Within this foundation, GE opponents usually argue that GE contaminates nature uncontrollably and are a

threat to biodiversity and sustainability. GE supporters, however, hold that the spread of GE is not a threat, and that GE can support biodiversity and sustainability.
With a total of 14% of all arguments, Care is addressed less frequently by both – in 16% of opposing arguments and 13% of supporting arguments. It is thus more emphasized by GE opponents. GE opponents find that GE has unknown consequences and is thus a high-risk technology, which imposes risks for human health and animals. GE supporters argue that GE has shown to be safe and beneficial for animals and human health.

GE Supporters Address Authority, Fairness, and Liberty More Frequently

The second largest difference in frequency can be found in the foundation Authority. Authority is addressed in only 5% of opposing arguments, thus forming the smallest argument of GE opponents. Among GE supporters, however, with 11% of the arguments, Authority is addressed more than twice as often. GE supporters hold that scientists involved in GE support this technology and consider it to be safe. They also hold that science should be the evaluating authority because of reliable scientific methods for risk assessment. GE opponents argue however, that experts reject GE.
Fairness is addressed similarly frequently by both, but a bit more often by supporters. 11% of supporting arguments address this foundation, as do 9% of opposing arguments. In this foundation, GE supporters accuse opponents of behaving unfairly in the debate, e.g., through misleading information, smear campaigns against supporters and propaganda against GE with frightening images. GE opponents, however, claim that actors involved in the technology do not comply with rules and regulations, but corrupt politicians.
With a total of 8% of all arguments, Liberty has been addressed the least, though a bit more frequently among supporters. Nine percent of supporting arguments relate to Liberty, as do 7% of opposing arguments. Within this foundation, GE supporters accuse opponents of interfering with civil liberties of scientists, technology and business development, as well as with the free choice of future generations. Opponents, however, argue that GE leads to oppression and coercion of small farmers and consumers.

Notable Stylistic Choices

By their nature, official position papers are composed in more neutral language than for example colloquial language or marketing campaigns. Nonetheless, the content analysis revealed that supporting and opposing position papers differ in their use of stylistic devices. These suggest latent sentiments towards GE, which are positive for supporting position papers, and negative for opposing position papers. One example is the choice of language. On the one hand, opposing position papers sometimes contain pejorative terms such as “Genmanipulation” [gene-manipulation] (BUND, n.d., para. 7), or „gefährden“ [endanger] (IG Saatgut, 2020, p. 18). On the other hand, supporting position papers contain approbative terms such as “Grüne Gentechnik” [Green Genetic Engineering], „biosafety research“, „transparency“, or „scientific facts“ (Federal Ministry of Education and Research [BMBF], 2014, p. 9).
Likely, these stylistic devices support the experience of moral emotions while reading the official position papers. Moral emotions facilitate an assessment of whether a moral foundation has been violated or catered to (Haidt, 2012). More detailed descriptions of stylistic devices

including examples can be found in the Appendix section "Notable Characteristics of the Analyzed Official Position Papers".

General Discussion

The present research proposes that investigating who emphasizes which moral concern leads to novel insights about why the polarization about GE is so enduring, and why the majority of the public diverge in their opinion from scientific assessment. The content analysis of arguments in the debate revealed that while GE opponents focus more on Care and Sanctity, GE supporters focus more on Authority, Fairness and Liberty. In the following, referring back to the hypotheses proposed in the introduction, the different moral argumentations of both debating parties are discussed in more detail. It is also discussed how these may affect observers within the public in Germany.

All Moral Foundations are Relevant

In line with previous research, the present analysis confirms that a spread of moral concerns is addressed. Specifically, using MFT as a template allowed to systematically identify moral foundations addressed by GE opponents and GE supporters. Extending previous research, this revealed that not only Care, Fairness, Loyalty, Authority, and Sanctity, but also Liberty is relevant in the debate, albeit Liberty being addressed least frequently.

Likely, this spread across foundations can be explained by an attempt to diversify across potential moral concerns. Here, the goal of the debating parties would be to increase the chances to address a moral foundation that is relevant to a listener from the public.

Moreover, applying a content analysis allowed to identify differences in use of these moral foundations. These are discussed in the following.

The Prevalence of Loyalty

Loyalty is, with 42% of all arguments being made, by far the most frequently addressed foundation. This is surprising, given that previous research suggested risk and benefit perceptions to be most relevant for GE attitudes (see for example, Ruth et al., 2017; Yue et al., 2015; Siegrist, 1999; Lee et al., 2018). At the same time, previous research pointed out that trust in involved actors and institutions is a relevant factor of GE attitude (Siegrist, 1999; Siegrist, 2000; Gutteling et al., 2006; Kajale et al., 2015; Kimenju et al., 2008; Yue et al, 2015). Looking at the arguments made within the Loyalty foundation, these can generally be interpreted as pertaining to issues of trust. For example, Greenpeace (2015) titled their official position paper "Twenty years of failure – Why GM crops have failed to deliver on their promises". This suggests that the technology and involved actors cannot be trusted. Conversely, the Federal Ministry of Education and Research [BMBF] (2014), states that

> [t]o date, the BMBF has invested over 100 million euros in more than 300 projects relating to biological safety research. Of these, more than 140 projects concerned risk assessments of GM plants. Since 2000, three research programmes have been put out to tender that focus exclusively on GM plants. The projects selected for BMBF funding were chosen by independent, national and international experts. More than 60 universities and other research institutes took part in the research projects. (p. 11)

This extensive list suggests that involved actors do everything in their power to ensure the safety of GE and social welfare by using reliable methods and thus should be trusted.
The prominence of Loyalty provides two potential explanations for the small effect of information on GE attitude (see for example Fernbach et al., 2019; Connor & Siegrist, 2010; Verdurme & Viane, 2003; Huffman et al., 2007). On the one hand, much information is being shared in the debate in all kinds of forms. However, if there is a lack of trust in actors involved in the debate or in the technology, their information would not be trusted, and it remains unheard. On the other hand, specialized expert knowledge on GE is very costly to attain, and in the face of scarce time and resources prohibitively so. Thus, trust is the only means for actors of the debate to effectively reach the public with their communication.
However, the reciprocal accusations by both, supporters and opponents, might make it difficult for the public to assess whether, for example, NGOs are lying or involved scientists are corrupted by the industry. The public may thus just resort to the conclusion that appears least risky to them, which is to not introduce a new technology, if the status quo seems fine.
This also provides an explanation why justified trust in official representatives is so important, and why Loyalty arguments are thus so extensively used in the debate.
While the relevance of Loyalty in the German GE debate is in line with previous research on trust, it may previously have been overlooked just how important and prominent this foundation is for the communication about biotechnologies. Future research may further explore the role and relevance of Loyalty in public debates on polarized topics such as GE.
Since previous communication has been fairly unsuccessful in overcoming polarization, it may be a starting point for the development of credible science communication in order to regain public trust. For example, recent attempts of a more differentiated discussion about appropriate means for agricultural breeding seem promising (for example Eco-Progressive Network ÖkoProg, 2022, https://oekoprog.org/en/startseite-english/). Moreover, increased general science communication about scientific processes may increase understanding and trust.

Sanctity is Very Relevant for Opponents

Scott et al. (2016) suggested that concerns of nature and naturalness are one of the main drivers of GE opposition. This is also reflected in the results of the present content analysis. With 24% of all opposing arguments, it is the second most frequently addressed foundation by opponents. GE opponents address Sanctity more than twice as often as do supporters. With only 11% of supporting arguments, Sanctity is much less prevalent for GE supporters.
The majority of opposing arguments within the Sanctity foundation express disagreement with a general interference of GE technology with nature, often related to a concern about unintended, uncontrollable consequences for nature, such as hazardous mutations.
In line with that, Scott et al. (2018), point out that products such as GE foods, are associated with perceptions of unnaturalness because they are developed through human interfering. Similarly, Hoogendoorn et al. (2021) also report that GE are perceived as unnatural by many. These findings are building on work by Rozin (2005) who proposed that a product is considered (un-)natural not because of its characteristics but because of its process of creation.
The differences within the Sanctity foundation thus exhibit great potential for value conflicts, because if GE are rejected because human interfering is perceived as unnatural, this technology could per se not be implemented in agricultural production. If perceived naturalness is as crucial

for GE acceptance as previous research suggests, this may thus clearly indicate to the public that they should rather reject GE.

Care Matters Slightly More for Opponents, but is Generally Addressed Less Than Expected

Previous research pointed to the relevance of risk and benefit perceptions for GE attitude (Ruth et al., 2017; Yue et al., 2015; Siegrist, 1999; Lee et al., 2018), with risk and benefit perceptions being the most studied factor of GE attitude. Care was thus expected to be the most relevant foundation in the debate. Although with 14% of all arguments, Care is still important in the debate, it is much less relevant than expected. Possibly, since information on risks and benefits of GE have had little effect on the development of the debate, the debate has deviated towards other foundations. For example, as suggested above, the debate may have moved away from Care because of the likely trust issues that need solving.

Thus, measured by how relevant risk and benefit perceptions have been found to be for GE attitude, the debate puts quite little emphasis on this aspect. In the present study, most arguments that addressed risks and benefits remained rather broad, stating that GE is a high-risk technology, or, vice versa, that GE is as safe as conventional methods. Rather than being broad, future contributions to the debate could focus more on specific risks and benefits related to stakeholders, i.e. what is a benefit (or risk), and who could benefit from it (or not).

Authority is Much More Important for Supporters

Both groups also put different emphases on the Authority foundation. While GE opponents address this foundation in only 5% of their arguments, it is more than twice as prominent (11%) among supporting arguments. Here, a value conflict is also likely because the debating parties appear to have diverging understandings as to whether scientists involved in GE research or scientific risk assessments should function as an authority in the evaluation of GE. While the authority foundation is much less prominent among GE opposing arguments, GE supporters refer to the numerous studies conducted on GE, holding that scientific evaluations should be decisive in whether to implement GE in agricultural cultivation.

Referring back to the above-mentioned potential trust issues, further research may investigate why there appears to be such a widespread hesitation in following scientific assessments. Potentially, this is related to general mistrust in the system or a worry of corruption of scientists by large corporations.

What can be Learned from the Identified Value Conflicts?

Based on the results of the present study, it is argued here that the gridlock of the German GE debate represents a proxy for a much bigger problem. Specifically, it is argued that the content analysis of the debate reveals a likely growing clash of two opposing worldviews.

In the debate, GE opponents put more emphasis on the foundations Care and Sanctity, while GE supporters put more emphasis on Fairness, Authority, and Liberty. Loyalty is highly frequented by both, but a bit more by GE supporters.

Within Care, GE opponents argue that GE is a high-risk technology that may have unknown unintended consequences, e.g., for human health, which, once they are distributed, can no

longer be controlled. This can be understood as a general risk aversion in relation to GE technology, and a preference for the status quo to be left unaltered.

Similarly, within Sanctity, GE opponents worry about contamination and destruction of nature through GE. As mentioned above, GE technology appears to not conform with GE opponents' understanding of nature and naturalness. And within Loyalty, as well as within Fairness, GE opponents criticize the behavior of involved actors (e.g., politicians, biotech corporations, and scientists), signaling a lack of trust in the system and the establishment.

Thus, the arguments of GE opponents transport a skepticism towards technological progress and modernity combined with concerns about an increasing alienation.

Conversely, GE supporters use the Care and Sanctity foundations to disagree with opponents' worries and optimistically claim that GE have numerous benefits for humans and the environment. Their argumentations within Fairness, Loyalty, Authority, and Liberty all bear witness to the perplexity scientists feel towards the resistance they receive in relation to GE. Within Fairness, GE supporters assert that GE opponents behave unfairly with misleading information, smear campaigns and propaganda. This suggests that GE supporters feel treated unfairly, unheard, and misunderstood. This is also in line with their frequent argument within Liberty, according to which GE opponents and prohibitive regulations interfere with the civil liberties of scientists. Similarly, within Authority, GE supporters call for science to be the evaluating authority of GE's risks and benefits, suggesting scientists' irritation as to why their communication based on scientific principles appears not to come through in the debate. And similarly, within Loyalty, GE supporters campaign for being heard by reasserting that they can be trusted because of their high commitment to social welfare.

Thus, while GE supporters are optimistic towards technological evolution and scientific progress, they are perplexed in the face of the skepticism towards involved actors, especially scientists, their motives, and their communication.

Few previous studies have investigated the relationship of GE attitude and general world views. Zwick (1998) identified associations of GE attitude with different value orientations: He found GE opposition to be associated with establishment-distant and establishment-critical orientations, and GE support to be associated with orientations that are more aligned with the establishment and have been profiting from the economic system (Zwick, 1998).

Similarly, Siegrist (1999) related GE attitude to the two worldviews proposed by Buss and Craik (1983). Siegrist found a significant relationship between GE support and a worldview that emphasizes "a high-growth, high-technology, and centralized free society", and a significant relationship between GE opposition and a worldview that "is concerned about the social and environmental impacts of growth" (Siegrist, 1999, p. 2102).

These two precursors are in line with the interpretation of the findings presented here. They bear testimony to the importance of addressing these diverging world views because they provide a potential explanation for the stability of the gridlock: if GE supporters and GE opponents are divided by two fundamentally different approaches to growth, technology, the establishment, and modernity in general, consensus seems to be harder to find than if they were simply unsure whether GE can be beneficial for society or not.

The strong moralization of GE and the longstanding controversy around the technology may thus best be understood as moral piggybacking (Rozin, 1999), i.e., the seeming trade-off between modernity and alienation extends its moral weight to previously neutral topics which

then also become moralized. Accordingly, GE would just be a proxy for an underlying bigger moral issue. A prominent example of such moral piggybacking is vegetarianism, in relation to which the choice of food has become a moral issue (Feinberg et al., 2019; Rozin, 1999)
Considering the endurance of the controversy, the stability of the gridlock, and the enduring polarization, this problem does not seem trivial. Given the present dependence on growth and recent technological developments, the (perceived) alienation of significant proportions of the population will likely increase. It appears that there is no common understanding of what kind of society we want to live in. Future research and policy development could attempt to identify common ground for the direction which society ought to move towards.

Recommendations for Science Communication and Policymaking
Public opinion has a huge impact on food policymaking, particularly if potential policies are contested in the public debate. Interpreting the results of the present study, the polarized debate about GE may not help the public to navigate themselves within such a complex topic as GE and its impacts. Rather, the conclusions people may draw from the GE debate are that

- GE are contested, i.e. there are mixed signals and it remains ambiguous and uncertain to approve GE,
- it is not clear who they should trust,
- benefits, particularly for personal health but also for environment protection and climate protection, are not salient (enough),
- GE is a new technology, that means it is a deviation from the known status quo and thus comes with more perceived risk than maintaining the status quo, and
- GE could be related to power abuse by large corporations with negative impacts on developing countries.

This provides a potential explanation for why the majority of the German public opts for rejecting GE foods, even though scientific academies – over a long time, and repeatedly – come to the conclusion that GE foods are as safe as conventional breeds (see for example NASEM, 2016; or Leopoldina et al., 2015): The widespread GE rejection in Germany is a matter of opportunity. In Germany, food supply provides enough affordable alternatives which make it seem not worth the risk to deviate from the status quo and try a new technology.
Likely, many people in Germany do not perceive a necessity for GE, so they see no reason to test an unconventional food technology. Even if they trusted the scientific academies in the assessment that GE were safe, it just seems easier to maintain the status quo. This tendency to rather reject GE is likely supported by the higher impact of risk perception (Lee et al., 2018), a likely negativity bias of the media and its consumers (Pinker, 2018; Soroka et al., 2019; Demke & Höhler, 2020), as well as the likely more professional and higher funded communication strategies of NGOs, compared to those of scientists.
This leads to clear implications for an improved science communication and its regulation:
First, generally, it seems worthwhile for policymakers to invest much more in reputable science communication.
Second, science communicators should not only provide reasons why GE should not be rejected, but focus much more on its clear, tangible benefits, for personal health, socioeconomic outcomes, as well as for environment and climate protection. This should be accompanied with many illustrative examples that point out why GE should be applied *even though* it may be

perceived as unnatural. This is not to say that science communication has so far not addressed these aspects. But the present analysis revealed that they are currently greatly underrepresented.
Third, experts about GE cannot really speak to potential exploitative behavior of large corporations. Since these appear to be a concern for many, they should be addressed and assessed in a separate debate about such behaviors.
Fourth, science communication about new technologies should not only incorporate science communicators from the field of GE, but also from the social sciences and ethics. These communicators could provide tools and advice on detecting argumentative fallacies, or on how to distinguish reliable sources from unreliable sources, more generally. This way, listeners could navigate themselves more independently in highly specialized topics.
Fifth, it is important to convey that not only *changing* the status quo, but also *maintaining* it comes with risks that could ultimately lead to less wellbeing and regress (Deutsch, 2010). As a study by the European Commission (2021) found: "The use of [GE] raises ethical concerns, but so does missing opportunities as a result of not using them (...)".
In this vein, improved public debates could lead with the question „Which society do we want to live in?", and proceed from there with debating whether GE can be a helpful means for that, and under which conditions.

Limitations and Future Research

Generally, qualitative content analyses can be more prone to some degree of subjectivity than probabilistic computer-based analyses. However, applying, e.g., a topic model based on the Moral Foundations Dictionary (Frimer et al., 2017; Frimer, 2019) or the extended Moral Foundations Dictionary (Hopp et al., 2021) did not seem suitable for two reasons.
First, official position papers in the GE debate are not emotional, but neutral in their choice of words, i.e., they rarely use the keywords of the MFD. The moral content is delivered latently in the meaning of the sentence. For example, an argument in the debate allocated to Fairness would not say "biotech corporations *cheat*", it would say "biotech corporations do not follow the rules of market regulation". A few pilot rounds for the present study, applying a topic model confirmed this by identifying only a small set of relevant occurrences.
Second, even in the few occasions key words are used, they might be misleading. For example, an argument in the debate allocated to Care would say "A group of mothers reported they would not feed GE food to their children because of health concerns". In a keyword-based analysis, because of the words "group" and "mother", this argument would be allocated to Loyalty instead of Care.
A newer approach by Weber et al. (2018) suggests crowd-based coding as an alternative to one-person coding. In the future, the present research could be tested for validity by applying this crowd-based – currently, this Moral Narrative Analyzer (Media Neuroscience Lab, 2022) is not yet available.

Conclusion

Here, an extensive qualitative content analysis of more than 2500 arguments from position papers about GE was presented. Results show that, rather than addressing risks and benefits of the biotechnology, most arguments refer to the moral foundation Loyalty (according to Moral Foundation Theory, Haidt, 2012). Moreover, while debating parties address a spread of moral

foundations, these differ in their frequencies: while GE supporters focus more on Authority, Fairness, and Liberty, GE opponents focus more on Care and Sanctity.

Most remarkably, these moral conflicts exhibit a clash of two opposing worldviews: The arguments of GE supporters convey optimism towards technological evolution and scientific progress (within Care, Loyalty, Sanctity) combined with a perplexity in the face of a perceived growing skepticism towards scientists, their motives, and their communication (within Fairness, Authority, Liberty).

Conversely, the arguments of GE opponents convey a skepticism of modernity through concerns regarding technological risks (within Care), a fear of environmental contamination (within Sanctity), and increasing power imbalances (within Fairness, Loyalty, Liberty). However, in the face of growing societal challenges, such as climate change and food insecurity, the need for further technological innovation is anticipated. Thus, skepticism and perceived alienation may likely grow.

To a large extent, both debating groups provide arguments why they are more trustworthy than the respective other side (Loyalty). This seems unlikely to be a successful strategy for reaching agreement in the debate. Rather, the present findings may provide an impulse to tackle the likely growing ideological divide by turning the debate towards the question "In which society do we want to live in?". Once common ground on this question is created, suitable goals, e.g. sustainability or to fight hunger, can be identified. Building on these goals, the debate can assess whether GE is an appropriate means to reach some of these goals or not, and if so, under which circumstances.

Moreover, in order to enhance the dialogue, debating parties could reassess who they are trying to address with their arguments. For example, GE opponents could acknowledge that GE supporters put more emphasis on scientific studies and expert opinion (Authority). GE opponents could thus include more peer-reviewed, falsifiable scientific facts in their communication strategies than they already do. Vice versa, GE supporters could acknowledge that GE opponents put more emphasis on environment protection and GE as a process (Sanctity). GE supporters could thus explain more (and more understandably) why they think GE supports environment protection, and why they think the process of GE is consistent with naturalness concerns.

Author Note

All original data, the data used for the interrater reliability test, the code systems applied to the interrater reliability test, as well as the codes of two raters are available at: Waldhof, G. (2023). Supplemental Information for "Opponents and supporters of genetically engineered foods emphasize distinct moral foundations and exhibit a clash of two diverging worldviews" *Harvard Dataverse, V1*. https://doi.org/10.7910/DVN/K9LCB1.

The Appendix consists of a detailed description of all steps involved in material selection and content analysis. Its reporting closely follows the "Qualitative Design Reporting Standards" according to JARS-Qual (Journal Article Reporting Standards of the American Psychological Association (APA), 2020, pp. 94-103). Table 3.A.1 and Table 3.A.2 in the Appendix show the final code systems.

No ethical clearance was necessary because all used sources were publicly available online.

For funding this project, I would like to thank ScienceCampus Halle - Plant-based Bioeconomy, EFRE funds, under Grant ZS/2016/06/79644. I would also like to thank the Leibniz Institute of Agricultural Development in Transition Economies (IAMO) for financial and infrastructural support of this project.

For valuable feedback on this manuscript, I would like to thank Matthias Uhl and Ulrich Fritsche. I also would like to thank Rita Theresa Kopp for supporting the interrater reliability test.

The author has no competing interests to declare.

Appendix to Chapter 3 – Methodology for the Content Analysis

The following Appendix reports on the procedure of the content analysis of the German GE debate. The reporting closely follows the 'Qualitative Design Reporting Standards' according to JARS-Qual (Journal Article Reporting Standards of the American Psychological Association (APA), 2020, pp. 94-103).

The analysis presented here aims to systematically identify the moral arguments in the German debate about genetic engineering of plants for human consumption (GE). More specifically, the goal of the analysis is to identify the arguments in favor and against GE, as well as their latent moral content (according to Moral Foundations Theory as described in Haidt (2012), further explanation below). Consequently, three main research questions are addressed here:

RQ 1) Which arguments do GE supporters and opponents use in the debate?

RQ 2) Which latent moral foundations, according to Haidt (2012), are addressed in these arguments?

RQ 3) Which side emphasizes which arguments and which moral foundations?

These research questions follow two aims. First, the arguments of the GE debate shall be identified systematically but exploratory (i.e., without prior assumptions about the content). With that, a comprehensive overview of all arguments is generated, which allows to develop novel hypotheses about why the GE debate is gridlocked, and why opposing organizations seem to have been more successful than GE supporters. Second, applying Moral Foundations Theory (MFT) to the arguments provides a novel systematization that allows to develop new hypotheses about moral drivers of the debate and thus contributes to theory-building. These two aims, classification and hypotheses development, are typical applications of content analyses (Mayring, 2015, pp. 22-25). Therefore, the present analysis closely follows the methodological principles of content analysis according to Philipp Mayring (2015). Philipp Mayring is considered one of the founders of qualitative content analysis and is thus among the most renowned experts on this method. His book from 2015 is used here as a guidance, because it belongs to the most frequently applied guides for qualitative content analysis. This book also is a step-by-step guide for qualitative content analyses.

Specifically, according to Mayring (2015), three types of content analysis are sensible to answer the present research questions: inductive category development, content structuring, and a frequency analysis of the arguments as well as the moral foundations (Mayring, 2015, pp. 13-16, 21, 24, 29, 65, 68).

Contrary to, for example keyword-based approaches, the results of a qualitative content analysis more strongly depend on understanding the text material based on context, theoretical background and research questions (Mayring, 2015, pp. 32, 38). I.e., the development of paraphrases and their allocation to moral foundations is only possible through some form of interpretation of the material at hand. In the present study, for all analyses, the pragmatic theory

of meaning forms the basis (Mayring, 2015, p. 41). This means that extracted text segments are understood in close accordance with the contemporary linguistic use in Germany between 2009 and 2020, and not interpreted further. Furthermore, the text material is understood within the context it was created (Mayring, 2015, pp. 50f.). Consequently, the material, its context, and the identified categories are explicitly described below, as part of the analysis.

In a similar vein, the coder's background in training is described in order to provide additional context to the acquired results: the entire analysis, e.g. definition of research aim, material, type of analyses, coding, and interpretation, was conducted by the same researcher (the author). This researcher has a background in economics, philosophy, and behavioral science and held no prior position in relation to the German GE debate. Neither does the researcher hold a motivated interest in a particular outcome of the debate. However, since the researcher is German and lived large parts of their life in Germany, they are very aware of the development of the German GE debate, as well as of the large and stable opposition among the public. At the same time, the researcher is very familiar with the literature on Moral Foundations Theory (MFT), as well as on (moral) GE attitudes. Thus, the researcher had prior expectations as to which moral foundations and which moral arguments may be frequently addressed. These expectations are reported in the introductions of the research articles pertaining to the present Appendix.

The analysis is conducted in ten steps: First, material that is appropriate for answering the research questions is identified and described. Second, text segments are extracted that contain arguments in favor of or against GE. Third, the content of these text segments are paraphrased. Fourth, these paraphrased arguments are reorganized according to comparable groups of similar size. Fifth, Moral Foundations Theory (MFT) is operationalized for latent content analysis in order to have a clear guideline on how to identify these foundations in text. Sixth, the paraphrased arguments are allocated to the moral foundations. Seventh, the operationalization of MFT is refined to make the moral foundations applicable to the arguments of the GE debate specifically. Eighth, the paraphrased arguments are reorganized to be able to identify only one moral foundation per argument. Ninth, frequencies of arguments and addressed moral foundations are determined. And tenth, quality checks are run.

These steps are described in the following. A flow diagram of the entire coding procedure is provided in Figures 3.A.1 to 3.A.3.

Figure 3.A.1

Material Selection and Preparation

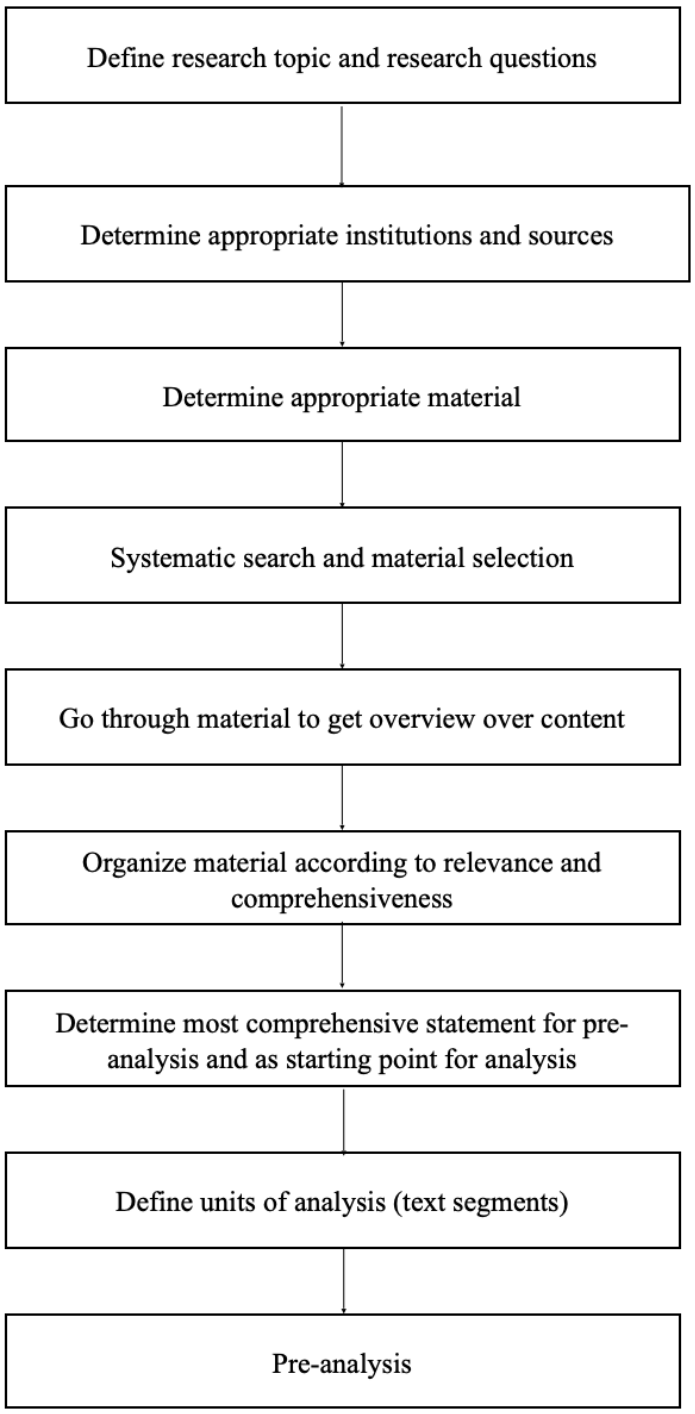


Figure 3.A.2

Inductive Coding Procedure: Inductive Category Development

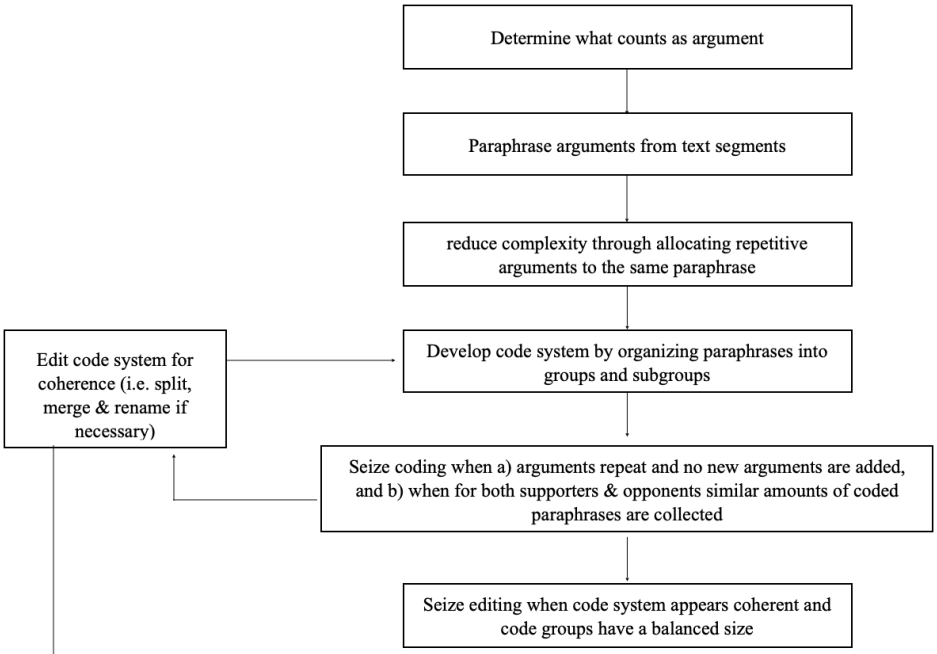
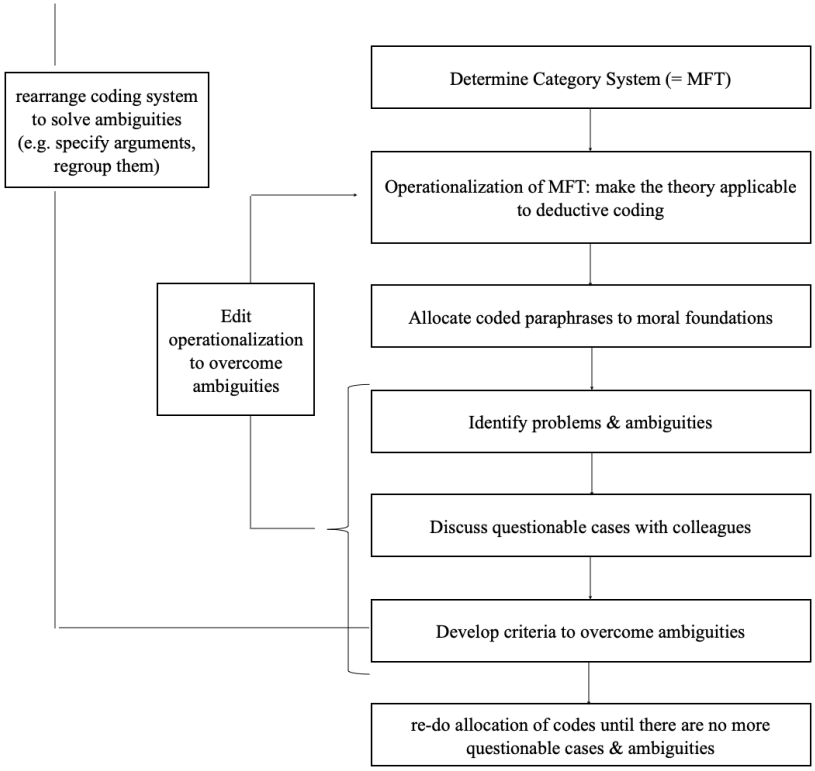


Figure 3.A.3

Deductive Category Application: Content Structuring



Material and Data Selection

In the following, it is described how the data was selected and why, what kind of material was used for analysis and which assumptions are made in support of the analysis.

Description of Representatives in the German GE Debate

In order to identify the arguments (and their moral content) used in the German GE debate, it appeared most sensible to determine the most active representatives of the debate since they likely advocate the most relevant arguments.

The parties most active in the public debate take clear positions in favor of or against GE. Non-governmental organizations (NGOs), such as Greenpeace, play a prominent role, many of them homogeneously rejecting GE (Freitag, 2013). Overall, GE opponents are very well networked and coherent (Tosun & Schaub, 2017) which is reflected in events organized by a variety of NGOs. The most prominent is the Wir haben es satt! [We are fed up!] (https://wir-haben-es-satt.de/) event in Berlin, with about 30,000 participants annually. They demonstrate against several issues, of which GE food is a prominent one (Kampagne Meine Landwirtschaft, 2022). Organic associations such as Demeter, and organic food producers such as Rapunzel Naturkost also reject GE (Demeter, 2018; Rapunzel Naturkost, 2022) and prominently represent this rejectionist stance in the public. For example, the initiative "Ich stehe auf Essen ohne Gentechnik" [I am not into food without genetic engineering] collected more than 100,000 signatures in 2018 and handed them over to the Bundesministerium für Umwelt, Naturschutz, nukleare Sicherheit und Verbraucherschutz [Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection, BMUV] (Rapunzel Naturkost, 2018, para. 1; Overmann, 2018, para. 3).

Tosun and Schaub (2017) find that in the European Union, the group of GE supporters consists of scientists, think tanks and corporations. However, supporters of GE are less prominent in bringing their position into the public debate: Political proponents have largely withdrawn their commitment (Nationale Akademie der Wissenschaften Leopoldina [Leopoldina], 2022). Also, although agricultural associations such as Deutscher Bauernverband [german farmers' association, DBV] or Deutsche Landwirtschafts-Gesellschaft [German Agricultural Society, DLG] position themselves in favor of genetic engineering (DBV, 2021; Lebensmittelverband Deutschland [Food Association Germany], 2009), they are not known to have any media campaigns or initiatives. The situation is similar for biotechnology companies such as Syngenta or Bayer: they support GE, but publicly available information is brief and rare (see for example Bayer, 2018). Although basic research on GE is still being conducted in Germany, industrial and applied research is increasingly migrating away (Bioökonomie.de, 2018). For example, the company BASF already moved its GE division to the US in 2012 (Zeit, 2012). One reason for this are prohibitively strict European regulations on GE crops, resulting in the approval of only two GE crops in the EU. In Germany, GE crops have not been commercially cultivated since 2012 (Presse- und Informationsamt der Bundesregierung [Press and Information Office of the Federal Government], 2022). Additionally, due to the high rejection rates of GE among the public, they are generally not offered in supermarkets (Presse- und Informationsamt der Bundesregierung [Press and Information Office of the Federal Government], 2022).

Thus, on the advocating side, scientists and science representatives are most active in the debate. These are for example the German National Academy of Sciences Leopoldina

(Leopoldina, 2022), and the Berlin-Brandenburg Academy of Sciences and Humanities (Berlin-Brandenburgische Akademie der Wissenschaften [BBAW], 2018).

Rationale for Using Official Position Papers in the Content Analysis

Official position papers of these institutions and organizations were used for the content analysis because they seemed most comprehensive in mirroring the arguments of the debate.

Official Position Papers are Assumed to Reflect the Most Relevant Arguments

Official position papers do not necessarily reflect internally held moral convictions of debating parties. To a considerable extent, the declared positions will represent the business model of the respective organizations. For example, organizations such as Greenpeace rely on public funding, and will thus tend to campaign for causes that likely generate most funding. Moreover, while scientists involved in biotechnology do have the mission to disseminate knowledge about their field of expertise, they at the same time have an incentive to represent their own field and research, in which they invested much time and effort.

However, exactly because of this background it can be assumed here that involved parties use those moral arguments that make their respective position the strongest. Additionally, the endurance of the debate also allows to assume that arguments made relate to public sentiments. Particularly the considerable public support for the position of organizations such as Greenpeace shows that the moral arguments made appeal to a significant proportion of the German public. The arguments can thus be seen as most representative for the respective position.

Arguments are Assumed to Carry Moral Valence

All arguments provided in the position papers carry some valence. I.e., based on each argument it could be concluded whether GE would be right or wrong. Thus, in the present analysis, the official position papers are generally understood as describing a form of moral reasoning (Richardson, 2018). For example, “GE bring health benefits” clearly indicates “GE are right / beneficial to society”. Similarly, “GE are unnatural” clearly indicates “GE are wrong”. Therefore, it is assumed here that each argument provided in the official position papers is a moral argument based on a moral foundation according to Haidt (2012).

Data Selection

The aim was to select the most representative and comprehensive official position papers about GE in the German debate. This search consisted of five steps. First, a list of organizations most active in the debate, compiled by Freitag (2013), was consulted. Second, organizations participating in the above-mentioned event Wir haben es satt! [We are fed up!] were added to the list, if they were not already included. Their websites were skimmed for further references to other potentially relevant organizations. The event Wir haben es satt! accompanies the Internationale Grüne Woche [International Green Week], a convention for food, agriculture and gardening industries (Messe Berlin, 2022). Thus third, the list of participants of this convention was also consulted. Moreover, the participant’s list of the Global Forum for Food and Agriculture, an international agrifood-policy conference pertaining to the Internationale Grüne Woche [International green week] (Bundesministerium für Ernährung und Landwirtschaft

[Federal Ministry of Food and Agriculture, BMEL], 2019) was also consulted to look for additional position papers. References and further information on the websites of these participants were also looked through. Fourth, an additional keyword search in the online search engine Google was conducted, to not miss any salient position papers. The keywords were selected based on terms frequently used in the German debate. These were "Gentechnik" [gene technology], "genmanipulierte Lebensmittel" [gene-manipulated foods], "GMO Kritik" [GMO criticism], "Grüne Gentechnik pro" [in favor of green genetic engineering], "genetisch modifizierte Organismen" [genetically modified organisms], and "Gentechnikdebatte" [GE debate].

Note here that to some extent, positions can already be determined by the term used to refer to genetic engineering. While opponents appear to mostly use the negatively connoted neologism "gene-manipulated", this term is not common among supporters. Supporters appear to most frequently use the positively connoted term "Green Genetic Engineering".

Additionally, experts (i.e., scholars working on genetic engineering or the GE debate) were asked to recommend additional sources. Fifth, official and comprehensive position papers made by these compiled actors were searched and included in the analysis, if they

- were published after 2010, in order to ensure similar topical focus,
- were published in German, in order to be relevant to the German debate,
- only address GE, in order to be relevant to the GE debate,
- exhibit a clear position against or in favor of GE.

For this, the texts were read.

Finally, the identified position papers were roughly organized according to relevance and comprehensiveness as was seen fit. For example, reading the position papers revealed that many NGOs cited the official position paper of Greenpeace (2015) called "Zwei Jahrzehnte des Versagens" [Two Decades of Failure]. This position paper appeared very rich in terms of diversity of arguments and was thus used as a starting point for the analysis.

Final Lists of Position Papers Included in the Analysis

In total, 14 opposing position papers and 16 supporting position papers were included. The amount of included position papers depended on the saturation of new arguments (this is explained below). All included position papers are available at https://doi.org/10.7910/DVN/K9LCB1. They are listed in the following.

Position papers by opponents:

1. Aktionsbündnis Gentechnikfreie Landwirtschaft in Baden-Württemberg [Action alliance for GMO-free agriculture in Baden-Württemberg]. (2018). *Positionen zur Agro-Gentechnik* [Positions on agro-genetic engineering]. Retrieved 19 Apr, 2018, from http://89.146.224.184/dbw-alt/gentechnik/pdf/gentechnik_positionen.pdf
2. BUND-Bund für Umwelt und Naturschutz Deutschland [Organization for environment and protection of nature]. (n.d.). *Risiken der Agro-Gentechnik – BUND Freunde der Erde* [Risks of agro-genetic engineering - BUND Friends of the Earth]. Retrieved 17 Apr, 2018, from https://www.bund.net/landwirtschaft/gentechnik/risiken/gesundheit/
3. Callenius, C., & Tanzmann, S. (2014). *Die Welternährung braucht keine Gentechnik* [Feeding the world does not need genetic engineering]. Brot für die Welt, Aktuell No. 37 [Bread for the World, Current No. 37]. Retrieved 16 Apr, 2018, from

https://www.brot-fuer-die-welt.de/fileadmin/mediapool/2_Downloads/Fachinformationen/Aktuell/Aktuell_37_Welternaehrung_braucht_keine_Gentechnik.pdf

4. Gen-ethisches Netzwerk e.V. [Network for gene ethics]. (2013). *Saatgut: Gentechnikfreiheit erhalten* [seeds: preserve freedom from GMOs]! Retrieved 22 Aug, 2018, from https://www.gen-ethisches-netzwerk.de/files/1301_gentechnikfreies_saatgut_flyer_www.pdf
5. Gen-ethisches Netzwerk e.V. [Network for gene ethics]. (2015). *25 Jahre Widerstand* [25 years of resistance]. Retrieved 29 Nov, 2018, from https://shop.gen-ethisches-netzwerk.de/faltblatt/26-25-jahre-widerstand.html
6. Gen-ethisches Netzwerk e.V. [Network for gene ethics]. (2017). *Gentech-Konzerne Macht euch vom Acker* [Genetic engineering companies get off the field]! Retrieved 22 Aug, 2018, from https://shop.gen-ethisches-netzwerk.de/faltblatt/1-gentech-konzerne-macht-euch-vom-acker.html
7. Greenpeace e.V. (2015). *Zwei Jahrzehnte des Versagens. Die gebrochenen Versprechen der Agro-Gentechnik* [Two decades of failure. The broken promises of agro-genetic engineering]. Retrieved 16 Mar, 2018, from https://www.greenpeace.de/publikationen/zwei-jahrzehnte-versagens
8. IG Saatgut - Interessengemeinschaft für gentechnikfreie Saatgutarbeit IG Saatgut - [Interest group for GMO-free seed work]. (2018). *Schöne Neue Gentechnik?! Anwendungen in der Landwirtschaft* [Nice new genetic engineering?! Applications in agriculture]. Retrieved 22 Aug, 2018, from https://www.ig-saatgut.de/media/ig_broschuere_2020-07-24_web_einzelseiten.pdf
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Description of the Material

Generally, the search for position papers supporting GE took longer than finding GE opposing position papers. Specifically, the positions and arguments of GE opposition are often prominently available on opponents' websites or through a short Google search. GE supporting position papers however, often required a longer and more specific search. Some exceptions were a few position papers by scientific organizations, such as the German National Academy of Sciences Leopoldina.

Position papers by corporations working with GE were particularly hard to find. Additionally, these are often very brief.

Generally, because these are official position papers, the language used is rather neutral, not emotional. For example, moral violations could rarely be identified based on keywords such as "unfair", "cruel", or "abusive", because due to the official nature of the position papers, clear emotional keywords containing a moral sentiment have rarely been used. Rather, moral sentiments need to be extracted from the meaning of entire text segments. For example, Volling (2018) writes

> Dabei stehen wir erst am Anfang dieser von vielen als ‚Revolution' angesehenen Techniken. Bislang verstehen noch nicht einmal die Forschenden selbst genau, wie sie im Detail funktionieren. Da es aber erste Hinweise gibt, dass die neuen Verfahren nicht so präzise arbeiten, wie behauptet wird, gilt es auch im Sinne des europäischen Vorsorgeprinzips - erst mal genau hinzuschauen – gerade auf die auch hier auftauchenden ungewollten Effekte" [Yet we are only at the beginning of these techniques, which many consider a "revolution". So far, not even the researchers themselves understand exactly how they work in detail. However, since there are initial indications that the new methods do not work as precisely as is claimed, it is important - also in the spirit of the European precautionary principle - to first take a close look - especially at the unintended effects that are also emerging here]. (para. 3)

While Volling (2018) does not use explicit keywords such as "risky", the meaning of this text segment can for example be paraphrased as "using GE is risky". Of course, other but similar paraphrases are also possible. Only carving out these meanings makes the arguments interpretable in terms of moral content. Thus, deriving the meaning from the descriptions in the material (Mayring, 2015, pp. 50f.) is even more important in the present material.

The descriptions in the position papers are sometimes longer, sometimes shorter, and often accompanied by examples. While many of the included position papers cover a variety of frequent arguments in the debate (for example Bundesamt für Verbraucherschutz und Lebensmittelsicherheit [Federal Office for Consumer Protection and Food Safety, BVL], 2010), other position papers focus on particular aspects such as safety (for example Bundesministerium für Bildung und Forschung [Federal Ministry of Education and Research, BMBF], 2014). While some position papers only consist of few pages (for example Bayer, 2018), others contain more than 50 pages (for example BMBF, 2014).

The arguments used on both sides of the debate are diverse and often contradictory. While opponents of GE fear health risks (Then & Bauer-Panskus, 2017), supporters praise health benefits of GE foods, for example through vitamin-enrichment (Rauner, 2017). While supporters are confident that GE will lead to higher yields and, thus, greater freedom and autonomy of agricultural workers (Nüsslein-Volhard, 2011), opponents believe that patented products based on GE will threaten the livelihoods of poor smallholders in developing countries (Callenius & Tanzmann, 2014).

Coding Procedure

Coding the official position papers according to moral foundations required four analyses. First, a pre-analysis with the aim to get an overview and rough understanding of the text material. Second, an inductive category development in which arguments are systematically extracted, paraphrased and organized into topical groups. Third, content structuring in which the paraphrased arguments are deductively allocated to the moral foundations. And fourth, a frequency analysis of the arguments as well as the moral foundations. The fourth analysis simply consists of counting the arguments made, as well as counting the arguments made per moral foundation. Thus, this very self-explanatory frequency analysis will not be explained further. The other three analyses are explained in the following.

These analyses are interdependent because qualitative coding of text content requires a iterative procedure in which coded information is revisited several times during the process (Mayring, 2015, pp. 29-32). Specifically, the coding rules can only be defined after the text material is read and a rough idea of which arguments are used exists. The inductive coding part is revisited and refined during the deductive coding, when the applied categories are clear. And the applied categories are revisited and refined with the help of the coded arguments, when it is clearer which content the categories need to capture. Even the selection of material, while mainly done before coding started, was dependent on the coding procedure, because the inclusion of new text material was seized when no new arguments were identified (saturation).This means that more material was included in the analysis as long as identified arguments did not yet appear repetitively. Once saturation was achieved, no additional material was included.

Technical Information – Coding with MaxQDA and GABEK

GABEK

The pre-analysis was coded with the software GABEK because it was available at the university for free. GABEK means “ganzheitliche Bewältigung von Komplexität” [holistic reduction of complexity, https://www.gabek.com/] and is a computer-based tool for text analysis developed by Josef Zelger (see GABEK, 2023 for more information).

In GABEK, text segments need to be separated manually before the coding process. The text segments then need to be paraphrased manually before the actual coding. This means that for each text segment, it must be defined where it begins and ends. Only then, coding can start. Coding, i.e. paraphrasing text segments is also done manually. This means for each text segment, a text (i.e. a paraphrase) has to be typed in a box with a small number of allowed characters. This means that if a text segment has the same content as a previous one, and would thus receive the same paraphrase, this paraphrase has to be typed in again in exactly the same way. Due to the layout of the interface, it is hard to find the code used previously, especially if a lot of codes (paraphrases) are used, as in the present case. If the coder makes a mistake, it is not possible to simply go back and erase and redo the coding. This means that in the end, for example, there are several paraphrases referring to the same content, but contain a typo and are thus counted separately. This makes it more complicated to count arguments after coding. Since the data set analyzed here is very large, and coding with this software is extremely tedious and time consuming, it was switched to MaxQDA for the actual analysis.

MaxQDA

MaxQDA is a more modern text analysis software with a user-friendly interface that gets frequently updated and further developed. It belongs to the most commonly used tools for modern qualitative content analyses (Mayring, 2015, p. 118). In the present analysis, the version of 2018 was used.

For coding, i.e. paraphrasing, text documents are uploaded into MaxQDA and then selected for coding. Text segments are marked and paraphrased. These paraphrases instantly appear on the left side of the interface, and grow into a coding system. If another text segment contains the same argument, it is dragged and dropped into a code from the code system on the left side of the screen. This procedure was followed through for the entire text material.

In MaxQDA, codes (i.e. paraphrases) in the code system can easily be renamed, reorganized, organized into subgroups, split up into more groups, or merged into a larger group. This was particularly helpful for the present extensive text analysis, because only through a more thorough word-by-word engagement with the text, a sensible code system is developed. For example, some codes appear so scarcely that it may be better to group them into one overarching paraphrase. Conversely, other codes are so frequent that it is better to split them up into several groups. Thus, many codes have to be edited after paraphrasing.

Pre-analysis – Precoding

All Texts Were Read

Initially, all texts were read. From this reading it was concluded that Greenpeace (2015) is the most comprehensive position paper because it addresses a great variety of topics. Although arguing entirely against GE, this position papers also includes many arguments in favor of GE in an attempt to debunk them.

Moreover, the initial reading illuminated that many position papers from smaller organizations cite Greenpeace (2015). Additionally, as mentioned above, several position papers focused on a particular topic rather than addressing all topics relevant in the debate.

Pre-analysis with GABEK

Thus, Greenpeace (2015) was used for pre-analysis, in order to systematically identify the majority of relevant topics. Specifically, the text first had to be transformed into a readable text document, i.e. word format, and figures had to be eliminated. Then, the text had to be portioned into text segments. Since the allowed number of characters is quite limited in GABEK, this was done at the sentence level. Then, sentences were paraphrased. Finally, the paraphrases were grouped into topics. These topics were used as a starting point for the second analysis, which is the inductive category development.

The identified topics were as follows.

1. Welternährung/Ernährungssicherheit/Hungerbekämpfung [World Food/Food Security/Hunger Relief]
2. Kaum Popularität – Bevölkerung will das nicht [Lack of popularity - population doesn't want it]
3. Gebrochene Versprechen/Erfolg [Broken promises/success]
4. Pflanzeneigenschaften (Klimaresistenz/Ertragssteigerung) [Plant traits (climate resilience/yield enhancement)]
5. Sicherheit für Mensch [Safety for humans]
    a. Gefahr [Danger]
    b. Unbekannte Risiken [Unknown risks]
    c. Schädliche Pestizide [Harmful pesticides]
6. Sicherheit für Umwelt [Safety for environment]
    a. Allgemein Umweltschutz [General environmental protection]
    b. Tierschutz [Animal welfare]
    c. Pflanzenschutz [crop protection]
7. Nachhaltigkeit/Biodiversität [Sustainability/Biodiversity]
8. Wirtschaftliche Rentabilität (Effektivität/Gewinne/Kosten) [Economic viability (effectiveness/profits/costs)]
    a. Für Bauern [For farmers]
    b. Allgemein/für Gesellschaft [General/for society]
    c. Für GT-Unternehmen [For GM companies]
9. Kontaminierung/Natürlichkeit [Contamination/Naturalness]
10. Innovationshindernis [Barrier to innovation]
11. Mangelnde wissenschaftliche Belege [Lack of scientific evidence]
    a. Zufällige unbeabsichtigte Folgen [Accidental unintended consequences]
    b. Mangelnde Erfahrung/Info zu Risiken [Lack of experience/info on risks]
12. Unterdrückung/ungleiche Machtverteilung [Oppression/equal distribution of power]
    a. Wirtschaftlicher Druck auf Bauern/Patente [Economic pressure on farmers/patents]
    b. Monopolstellung/Konzernmacht [Monopoly/corporate power]
    c. Staatsmacht/politische Macht (Wissenskonzentration oben) [State power/political power (knowledge concentration on top)]
13. Bessere Alternative, e.g. ökolog. Anbau (GMO & Glyphosat nicht ökologisch) [Better alternative, e.g. ecolog. cultivation (GMO & Glyphosate not ecological)]

Inductive Category Development

The goal of the inductive category development is to identify the arguments in favor of and against GE (RQ 1, RQ 3). It is not based on theory but data-driven (Mayring, 2015, p. 85). For this purpose, systematic coding rules have to be determined and applied (Mayring, 2015, p.29, 60). Specifically, it has to be determined a) What counts as an argument?, b) How are the arguments coded?, c) When is coding seized?, and d) How is the coding system edited?.

What Counts as an Argument?

In the official position papers, organizations state reasons for their position towards GE. Specifically, these reasons describe how an entity, society as whole, a rule or a norm are catered to, or violated, respectively, through GE. They thus label GE with a valence of "right" or "wrong". For example, Greenpeace (2015, p. 2) states "Die Gentechnik ist nicht dazu geeignet, die Probleme zu lösen, die Hunger und Mangelernährung begünstigen und aufrechterhalten" [Genetic engineering is not suited to solve the problems that promote and sustain hunger and malnutrition]. In this example, Greenpeace (2015) provides a reason that valences GE as "wrong". Often, these reasons were accompanied by examples.

Thus, a reason including its examples was counted as an argument.

How are the Arguments Coded?

The reason for extracting text segments that form one argument and paraphrasing those text segments is to reduce complexity (Mayring, 2015). The goal is to develop categories, i.e. paraphrases of addressed topics, from the text segments that make the data interpretable.

For this inductive category development, the documents were loaded into MaxQDA. They were then read by the author, starting from the beginning. Each time the author identified an argument for or against GE, it was marked. As mentioned above, these arguments were often accompanied by examples or further explanations. These were thus also marked as pertaining to the same argument.

Then, the author paraphrased the content of the segment. This so-created code, i.e. paraphrasis, is then added to the code system at the left of the screen. Basically, the code system is the list of all codes created in one project. This code system can be made more complex by creating subcodes. For illustrations, see for example MaxQDA (2023, https://www.maxqda.com/help-mx20/05-coding/how-to-code).

For example, one text segment read:

> Das am häufigsten verwendete Herbizid in GV-Kulturen ist Glyphosat. Es ist ein Totalherbizid: bei Anwendung sterben alle Pflanzen außer der gentechnisch veränderten Nutzpflanze ab. Besonders deutlich werden die Schäden dort, wo großflächig gentechnisch veränderte Pflanzen angebaut werden. So hat im mittleren Westen der USA der Anbau von herbizidtoleranten Mais- und Sojapflanzen zu einem starken Rückgang der Futterpflanzen des Schmetterlings Monarchfalter geführt. Die Folgen sind massiv: Von 1999 bis 2010 nahm die Schmetterlingspopulation um 81 % ab [The most commonly used herbicide in GM crops is glyphosate. It is a total herbicide: when applied, it kills all plants except the GM crop. Damage is particularly evident where large areas of genetically modified crops are cultivated on a large scale. In the midwestern United States, for example, the cultivation of herbicide-tolerant corn and

> soybean plants has led to a sharp decline in the forage plants of the monarch butterfly. The consequences have been massive: from 1999 to 2010, the butterfly population declined by 81%]. (Wirz et al., 2015, p. 32)

This was counted as one argument against GE by an opposing party and paraphrased as „risks and disadvantages for animals“. One example for a supporting argument made by a GE supporter read „Fachkräfte: Insbesondere im Bereich der grünen Gentechnologie muss das wissenschaftliche und personelle Know-how als Motor zukünftiger Innovationen langfristig in Deutschland gesichert werden” [Skilled workers: Particularly in the field of green genetic engineering, scientific and personnel expertise as a driver of future innovations must be secured in Germany for the long term] (BBAW, 2018, p. 14). This was counted as an argument in favor of GE and paraphrased as “GE research promotes innovation”.

Since the position papers usually were long complex texts rather than simple lists of arguments, a text segment often contained several distinct arguments. For example, due to how the sentences were structured by the respective authors, arguments were stated intertwined with each other, or connected with “and”, followed by examples. In these cases, the text segment was allocated to several fitting codes.

This way, the entire text document was worked through, and each argument was paraphrased. When one document was finished, the next document was opened in MaxQDA and coded (paraphrased) in the same manner from beginning to end.

After a while, arguments started to repeat and could thus be allocated to the same code per drag and drop. In these cases, the marked text segment was saved as pertaining to a specific code and the counted frequency of this particular code increased by one per added text segment.

When is Coding Seized? Saturation of Arguments

The goal of the coding was to capture all arguments in the GE debate and provide evidence of their relevance and moral content. Therefore, coding could be seized when no additional arguments were identified, and text segments were only added to already existing codes.

However, after no additional codes were identified, coding was continued for a few more position papers in order to achieve similar amounts of arguments between supporters and opponents. The rationale behind that was to be better able to compare which moral foundations are emphasized by supporters and opponents, given a similar amount of arguments made. Thus, since some supporting position papers were very brief, more supporting position papers (16) than opposing position papers (14) were included in the analysis while resulting in similar total amounts of arguments.

How is the Coding System Edited? Rearranging and Regrouping Arguments

The inductive development of a code system is usually an iterative process between adding new codes and rearranging and renaming existing ones. This is because through the coding process, the coder gains more insight into the material and is able to formulate more precise paraphrases. Moreover, only during the coding process it becomes evident which codes are more frequent than others. Consequently, if an argument appears much more frequent than others, e.g. in more than one hundred occasions, it is split up into several codes in order to maintain a similar level of depth between the codes. Similarly, if arguments are only addressed rarely, e.g. once or

twice, it made sense to merge them with others. The aim was to avoid an unpractically high number of paraphrases.
This process depends on the assessment of the coder. For example, some arguments appear extremely rarely but have such highly informative value that they are not merged with other codes.
Additionally, the codes were checked for coherence by colleagues not involved in the coding process. Questionable cases were discussed and amended where necessary.

Code System
The final code system with all paraphrases and their frequencies is reported in Table 3.A.1 and Table 3.A.1 of the "Results" section of this Appendix. In these tables, the codes are already allocated to the moral foundations. The subsection "Examples of Paraphrases and their Allocation to Moral Foundations" of this Appendix provides a coding example for each moral foundation.

Content Structuring (Deductive Category Application)
Content structuring is the third part of the content analysis. In this type of qualitative analysis, a category system is deductively applied to text segments. In most cases, this category system is derived from theory (Mayring, 2015, p. 85). Particularly, in the present analysis, Moral Foundations Theory was applied to the text segments previously paraphrased during the inductive category development.

Moral Foundations Theory
Specifically, RQ 2 and RQ 3 are strongly based on Moral Foundations Theory (MFT). With this theory, Graham et al. (2011) propose that moral intuitions are based on moral foundations that are innate, but malleable modules. These modules guide moral judgements and social behavior. For example, if a person observes a social interaction in which two people are kind to each other, innate moral foundations intuitively trigger moral emotions that lead this person to approve of this interaction. Conversely, if a person observes someone causing harm to another person, the observing person might feel an urge to intervene. Moral foundations thus help to structure social life.
Particularly, MFT consists of six moral foundations that guide moral judgment and social behavior (Haidt, 2012; Graham et al., 2011; Iyer et al., 2012). These are Care, Fairness, Loyalty, Authority, Liberty, and Sanctity. In the following, the six moral foundations are described in more detail.
The Care foundation addresses our instinct to protect and help others, for example children and the weak. It entails an impulse to protect, nurture, care and interact, especially related to those who suffer, are needy, in distress, or cute (Haidt, 2012, pp. 153-158). It is triggered through compassion, for example when hearing babies cry or when observing someone being threatened by violence. The Care foundation can also be activated when hearing about innocent victims that are not our kin, but for example poor people or animals. Emotions related to that foundation are compassion that we feel toward those in need, and anger towards harming predators.
The Fairness foundation is the basis of many religions and of the golden rule. It entails everything related to reciprocity and cheating. It makes us play "tit for tat" (Haidt, 2013, pp.

158-161). We feel pleasure, liking, and friendship when we witness acts of cooperation. When we experience fairness, we feel thankful, when we treat others unfairly, we feel guilt. The counterpart to this value is cheating.

Loyalty is related to our need to belong to a group. It makes us feel proud to belong to a certain group and defend it and its territory against rivals (Haidt, 2012, pp. 161-164). Loyalty ensures "group cohesion and success in conflicts between groups" (Haidt, 2012, p. 162). The foundation is triggered by "anything that tells you who is a team player and who is a traitor" (Haidt, 2012, p. 163). Being a loyal group member makes us feel proud and belonging, when we experience betrayal, we feel anger towards betrayers.

Authority (Haidt, 2012, pp. 165-169) comes with feelings of respect, obedience, and submission to those higher in hierarchy. People subordinate themselves to an authority, not due to oppression or violence, but voluntarily out of feelings of respect and appreciation.

The authority foundation shall thus not be confused with power and oppression but leadership for socially beneficial functions, such as resolving conflicts, and taking responsibility for order and justice. Authority is triggered by appearance and behavior of lower and higher ranks.

The Liberty foundation deals with oppression of minorities and the abuse of power and is consequently connected to anger towards the oppressor (Haidt, 2012, pp. 197-204). It concerns political transition and reverse dominance and is triggered by anything that imposes illegitimate restraints on people's liberty and abuse of political power or wealth. It is supposed to serve the underdogs, powerless, and victims, but also serves the rejection of dominance and control of one's own and own group.

The Sanctity foundation (Haidt, 2012, pp. 170-177) is closely related to food. We want to have control over everything that touches our body and everything that we consume. This foundation entails all ideas that see a virtue in cleanliness, sanctity, and naturalness. The Sanctity foundation is strongly related to the emotion disgust. Consequently, a violation of the foundation is felt as degradation and triggers disgust. Disgust signals infection and disease, e.g. in other people, and makes us want to go away from them. It is triggered through "smells, sights, or other sensory patterns that predict the presence of dangerous pathogens in objects or people" (Haidt, 2012, p. 173). The moral foundation Sanctity makes us want to avoid threats that "spread by physical touch or proximity" (Haidt, 2012, p. 173).

At the same time, the "untouchable" does not only refer to the bad and polluted, but also the good and sacred. Sacred can be objects, places, and principles (Haidt, 2012, p. 173). With that, Sanctity concerns religious aspects, seeing the body as a soulful temple that needs to be protected. But the value also concerns the environment, nature, and the human connectedness to nature. Related to this is the wish to free not only the body of toxins and pollution, but also to free nature of industrial capitalism and pollution.

Development of an Operationalization of MFT for Coding

In order to identify latent moral foundations in the arguments, guidelines for how to apply MFT in deductive coding have to be developed (Mayring, 2015, p. 16). Because if the differences between the six foundations are not clear to coders, a text segment might be allocated to several moral foundations, thus decreasing reliability of the coding results. Moreover, the coding guidelines have to be closely based on the theoretical groundwork of MFT, in order to maximize validity.

The proposal on how to operationalize MFT for content structuring (deductive category application) is developed in Chapter 2.
Specific to the present analysis of arguments regarding GE, an overview of how the text segments have been allocated is provided in the following section.

Content Structuring with MFT

Based on the seminal literature on MFT (e.g. Haidt, 2012; Graham et al., 2011; Iyer et al., 2012), paraphrased arguments were allocated to one of the six moral foundations depending on whether they addressed the following characteristics.

- An argument was allocated to Care if it concerned general unspecified risks and benefits of GMO, or specific risks and benefits to life or health of humans or animals.
- An argument was allocated to Fairness if it concerned the behavior of an involved actor in relation to rules, laws, and regulations, such as corruption, cheating, law/rule-breaking.
- Arguments were allocated to Loyalty if they concerned trust, or benefits and disadvantages for society as a whole. For example, whether GE or involved actors contribute to social welfare or try to enrich themselves at the costs of society.
- Arguments were allocated to Authority if they appealed to a perceived authority, such as recited expert opinions.
- Arguments were allocated to Liberty if they concerned civil liberties of affected people.
- Arguments were allocated to Sanctity if they concerned nature, contamination, environment protection, biodiversity, or sustainability.

Rearranging and Regrouping Topics and Subtopics. Split up and Merge

Allocating the inductively developed paraphrases to moral foundations is not a unidirectional process. In many cases, the paraphrases did not unambiguously indicate which moral foundation their content belongs to. In these cases, it was necessary to closely look into the coded text segments in order to identify clear indications for certain moral foundations.
Consequently, these codes had to be split up and/or renamed in order to unambiguously allocate them to a foundation.
Moreover, the allocations of codes to moral foundations were checked for coherence by colleagues not involved in the coding process. The allocations were discussed extensively in several rounds and amended where necessary.
Thus, in this specific analysis that combines an inductive with a deductive analysis, both analyses are interdependent: although the paraphrases have to be developed inductively before the deductive allocation to the moral foundations can start, the paraphrases are altered depending on the requirements of the deductive coding during the allocation to moral foundations. This demonstrates that inductive and deductive coding are not two separate processes but iterative, intertwined and somewhat dependent on each other.

Results

Table 3.A.1 and 3.A.2 report the coded arguments of GE opponents and supporters, organized according to their addressed moral foundations. These tables also show the respective

frequencies. The results are discussed in the main text. In the following, example codings of supporting and opposing position papers for each moral foundation are provided.

Table 3.A.1

Coded Arguments of GE Opponents

Moral Value	Coded Arguments Opponents (N (Contra, Total) = 1281)	N (Contra)	
Care / Harm	• High-risk technology	**89**	
	• Disadvantages for smaller / weaker entities	**63**	
	• Impairments of health	**46**	
	• Risks and disadvantages for animals	**28**	**16%**
	• Do not contribute to food security	**23**	**(210)**
	• Gaps in regulations of GMOs are a threat to humans	**24**	
Fairness / Cheating	• Players (e.g. GMO producers) do not comply with the rules of competition within the market economy	**89**	**9%**
	• Corporations corrupt politicians (e.g. through Lobbying, Corruption)	**26**	**(119)**
	• GMO supporters behave unfairly during the public debate (do not justify pro-arguments, ignore risks, not fact-based)	**4**	
Loyalty / Betrayal	• GMOs and involved players cause social injustice (inequity)	**5**	
	• Disadvantages for smaller / weaker entities	**63**	
	• Nobody informs the public	**6**	
	• Players don´t live up to their promises	**18**	
	• Producers deceit buyers, lie for profit	**47**	
	• High costs without benefits	**74**	
	• GMOs do not contribute to common welfare (failure)	**62**	**39%**
	• GMOs are a symptom of a company´s greed for profit	**57**	**(497)**
	• GMOs are not necessary, there are better alternatives	**51**	
	• Irresponsible treatment of common goods	**31**	
	• Consumers don´t want GMOs	**30**	
	• Opponents offer heroic resistance against GMOs	**20**	
	• Nobody takes responsibility although they should	**17**	
	• Impediment of innovations (through patents, power)	**15**	
	• Threat to social cohesion	**1**	
Authority / Subversion	• Experts criticise GMOs (= GMO-de-legitimizing authorities)	**66**	**5%** **(66)**
Liberty / Oppression	• Oppression of civil liberties of e.g. consumers, small farmers	**79**	
	• GMOs cause capitalism	**6**	**7%**
	• Players oppress farmers to gain more profit	**3**	**(88)**
Sanctity / Degradation	• GMOs contaminate nature	**80**	
	• Risk of destroying nature	**57**	
	• Pesticides intoxicate nature	**57**	
	• GMOs cause resistances	**32**	
	• GMOs threaten biodiversity	**25**	**24%**
	• GMOs threaten sustainability	**18**	**(301)**
	• Ethical issues (e.g. alienation from nature, violation of the dignity of the plant)	**17**	
	• GMOs are not adapted	**8**	
	• Risks of unintended mutations (roulette with nature)	**7**	

Table 3.A.2

Coded Arguments of GE Supporters

Moral Value	Coded Arguments Supporters (N (Pro, Total) = 1302)	N (Pro)	
Care / Harm	Pro – GMO (& stakeholders):		
	• Not a high-risk technology	**46**	
	• Health benefits & no evidence for health impairments	**39**	
	• GMOs contribute to food security	**22**	
	• No higher risks for animals; advantages for animals	**20**	**13% (164)**
	Against GMO – critics:		
	• Scientists are victims of the regulatory situation	**21**	
	• Producers suffer from field destructions	**3**	
	• GMOs need acceptance to become beneficial	**3**	
	• NGOs commit crime against humanity	**3**	
	Contra – GMO: further research necessary for risk assessments	**3**	
Fairness / Cheating	Pro – GMO (& stakeholders): Corporations do not abuse their power	**4**	
	Against GMO – critics:		
	• GMO opponents do not follow the rules, display criminal behaviour	**23**	**11% (147)**
	• Corruption, misuse of influence on political decision-makers	**5**	
	• GMO opponents behave unfairly in the debate, e.g. misleading information, smear campaigns against GMO supporters, propaganda of frightening images	**115**	
Loyalty / Betrayal	Pro – GMO (& stakeholders):		
	• Benefits, (e.g. higher yields, profits), for developing countries, small farmers, farmers, consumers, companies	**50**	
	• Actors (scientists, politicians) are committed to societal welfare	**156**	
	• GMOs contribute to societal welfare (e.g. necessary, efficient, successful, sustainable)	**174**	
	• GMO research promotes innovation	**37**	
	Against GMO – critics:		
	• To refuse GMOs is wrongful	**52**	
	• Opponents deceit consumers (e.g. to win the debate, for funding)	**27**	**45% (588)**
	• Regulatory deficits due to public rejection	**9**	
	• GMO-critics do not contribute to societal welfare (policies, regulations, NGOs impede innovation)	**4**	
	• Policymakers do not take responsibility, although they should (are easily influenced by voter´s demands)	**17**	
	Contra – GMO:		
	• GMOs are not wanted by consumers	**55**	
	• GMOs sometimes fail to contribute to society (e.g. because they do not fulfil requirements for market entry)	**7**	
Authority / Subversion	Pro – GMO:		
	• NGOs regret anti-GMO campaign	**3**	
	• Authors, politicians, experts, polit. organisations support GMOs	**65**	
	• German market & regulatory situation of GMOs is an exception	**16**	
	• Scientists argue in favor of GMOs	**10**	**11% (141)**
	Against GMO – critics:		
	• Scientific facts should be the basis for political decisions (evidence supports GMOs)	**14**	
	• Science should be the authority in evaluating GMOs, GMO opponents are wrong	**33**	

Liberty / Oppression	Pro – GMO: GMOs do not interfere with freedom of choice but enable more freedom for farmers	**10**	**9% (117)**
	Against GMO – critics: GMO opponents (e.g. NGOs), faulty regulations interfere with civil liberties, e.g. of scientists, biotechnology, businesses, future generations	**107**	
Sanctity / Degradation	Pro – GMO: • Contamination of nature is not a threat (e.g. because there are no negative consequences for the environment, because there are methods to keep the risk of cross-pollination low)	**46**	**11% (145)**
	• There is no higher environmental risk of GMOs compared to conventional breeding, but there are advantages (e.g. less pesticides)	**46**	
	• GMOs do not threat biodiversity, but support it	**4**	
	• GMOs do not threat sustainability, but support it	**16**	
	• Alienation from nature is not a problem, because GMOs copy nature, or are even better adapted than conventional breeds	**33**	

Examples of Paraphrases and their Allocation to Moral Foundations

Here, a coding example for each moral foundation is provided.

GE Opponents

Care. For example, one text segment reads:

> Das am häufigsten verwendete Herbizid in GV-Kulturen ist Glyphosat. Es ist ein Totalherbizid: bei Anwendung sterben alle Pflanzen außer der gentechnisch veränderten Nutzpflanze ab. Besonders deutlich werden die Schäden dort, wo großflächig gentechnisch veränderte Pflanzen angebaut werden. So hat im mittleren Westen der USA der Anbau von herbizidtoleranten Mais- und Sojapflanzen zu einem starken Rückgang der Futterpflanzen des Schmetterlings Monarchfalter geführt. Die Folgen sind massiv: Von 1999 bis 2010 nahm die Schmetterlingspopulation um 81 % ab [The most commonly used herbicide in GM crops is glyphosate. It is a total herbicide: when applied, it kills all plants except the GM crop. Damage is particularly evident where large areas of genetically modified crops are cultivated on a large scale. In the midwestern United States, for example, the cultivation of herbicide-tolerant corn and soybean plants has led to a sharp decline in the forage plants of the monarch butterfly. The consequences have been massive: from 1999 to 2010, the butterfly population declined by 81%]. (Wirz et al., 2015, p. 32)

This was counted as one argument against GE by an opposing party and paraphrased as „risks and disadvantages for animals“ because it concerned general unspecified risks to life or health of animals.

Fairness. The text segment “Zahlreiche Lobbyverbände sorgen dafür, dass die Interessen der Agrarkonzerne in der Politik Gehör finden” [Numerous lobbying associations ensure that the interests of agricultural corporations are heard in politics] (Gen-ethisches Netzwerk e.V., 2017, para 1) was paraphrased as “Corporations corrupt politicians (e.g. through Lobbying)” and allocated to the Fairness foundation because it concerns an exertion of influence that may distort fair market competition.

Loyalty. Another text segment reads:

> Für die großen Agrobiotech-Konzerne lohnt sich der GVO-Anbau doppelt: Sie verdienen nicht nur am Verkauf des Saatguts, sondern setzen gleichzeitig große Mengen des dazugehörigen Totalherbizids ab. Die eingesetzten Agrochemikalien schädigen Boden und Wasser sowie Menschen und Tiere in der Nachbarschaft. Der Anbau von Bt-Kulturen kann außerdem die Zunahme sekundärer Schädlinge wie z. B. Wanzen und Milben fördern, die dann wiederum mit Insektiziden kontrolliert werden müssen [For the large agrobiotech corporations, GMO cultivation is doubly profitable: not only do they earn from the sale of the seeds, but at the same time they sell large quantities of the associated total herbicide. The agrochemicals used damage soil and water as well as people and animals in the neighborhood. The cultivation of Bt crops can also promote an increase in secondary pests such as bugs and mites, which then in turn have to be controlled with insecticides]. (Sprenger, 2013, p. 3).

This contra GE argument was paraphrased as "GE are a symptom of a company's greed for profit" and was allocated to Loyalty because it concerns trust and benefits and risks for society as a whole.

Authority. The text segment "[i]n Pakistan wurde gar empfohlen, das Land solle wieder zu traditionellen Baumwollsorten und konventionellen Methoden der Schädlingskontrolle zurückkehren" [in Pakistan, it was even recommended that the country shall return to traditional cotton varieties and conventional methods of pest control.] (Mertens, 2018a, p. 289) was paraphrased as "Experts criticize GE". It was allocated to Authority because it refers to an expert authority that recommends to avoid the use of GE crops.

Liberty. The text segment:

> Die EU Kennzeichnungsverordnung über gentechnisch veränderte Lebens- und Futtermittel soll den Herstellungsprozess transparent machen und Orientierungshilfen bei der Kaufentscheidung geben. Doch leider weist die neue Kennzeichnungsvorschrift Lücken auf. Lebensmittel von Tieren, die mit gentechnisch veränderten Futtermitteln gefüttert werden, sind von der Kennzeichnung ausgenommen. Diese Lücke muss vom Gesetzgeber so schnell wie möglich geschlossen werden, damit der Gentechnik-Einsatz auch bei Milch, Fleisch und Eiern deutlich erkennbar wird [The EU labeling regulation on genetically modified food and feed is intended to make the production process transparent and provide guidance for purchasing decisions. Unfortunately, however, there are gaps in the new labeling regulation. Food from animals fed with genetically modified feed is exempt from labeling. This loophole must be closed by the legislator as quickly as possible so that the use of genetic engineering is also clearly recognizable in milk, meat and eggs]. (Aktionsbündnis Gentechnik freie Landwirtschaft in Baden-Württemberg [Action alliance for GMO-free agriculture in Baden-Württemberg], 2022, para 8)

was paraphrased as "Oppression of civil liberties of consumers" and allocated to liberty because it concerns the freedom of choice of consumers.

Sanctity. The text segment "Unkontrollierter Einsatz von Gene-Editing gefährdet die biologische Vielfalt" [Uncontrolled use of gene editing endangers biodiversity] (Then & Bauer-Panskus, 2017, p. 1) was paraphrased as "GE threaten Biodiversity" and allocated to the Sanctity foundation because it concerns biodiversity.

GE Supporters

Care. One text segment reads "Nach über zwei Jahrzehnten ihrer Nutzung existiert kein wissenschaftlicher Beleg dafür, dass zugelassene transgene Pflanzen besondere negative gesundheitliche Wirkungen besitzen" [After more than two decades of their use, no scientific evidence exists that approved transgenic plants have any particular adverse health effects] (BBAW, 2018, p. 38).

It was paraphrased as "No evidence for health impairments" and allocated to the Care foundation because it concerns human health.

Fairness. A text segment reads:

> […] seit Jahren von Gentechnikkritikern Horrorszenarien beschrieben, die sich angeblich aus der Nutzung der Grünen Gentechnik ergeben. So wird Stimmungsmache gegen diese Methode betrieben. Die Verunsicherung der Verbraucher ist daher groß [For years, critics of genetic engineering have described horror scenarios that allegedly result from the use of green genetic engineering. This is how sentiment is stirred up against this method. There is thus large uncertainty among consumers]. (Braun-Michels, 2014, para 6)

It was paraphrased as "GE opponents behave unfairly in the debate, e.g. through propaganda". It was allocated to the Fairness foundation because it concerns unfair debating behavior through misleading information.

Loyalty. One example for a supporting argument made by a GE supporter reads:

> Fachkräfte: Insbesondere im Bereich der grünen Gentechnologie muss das wissenschaftliche und personelle Know-how als Motor zukünftiger Innovationen langfristig in Deutschland gesichert werden [skilled workers: In the field of green genetic engineering in particular, scientific and personnel expertise as a driver of future innovations must be secured in Germany in the long term]. (BBAW, 2018, p. 14)

This was counted as an argument in favor of GE and paraphrased as "GE research promotes innovation" and was allocated to Loyalty because it concerns a benefit for society as a whole.

Authority. Another text segment reads:

> Ähnliches zeigt eine Meta-Analyse Göttinger Agrarwissenschaftler, die 147 Studien aus verschiedenen Ländern verglichen. Mit dem Anbau von gv-Pflanzen stiegen die Ernteerträge durchschnittlich um 22 Prozent. Die Menge der Pflanzenschutzmittel sank um insgesamt 37 Prozent, bei insektenresistenten Bt-Pflanzen sogar um 42 Prozent. Das Einkommen der Landwirte stieg mit dem Anbau von gv-Pflanzen um durchschnittlich 68 Prozent. In den Entwicklungsländern waren die Vorteile deutlich größer als in den Industrieländern [A meta-analysis by agricultural scientists from Göttingen, Germany, who compared 147 studies from different countries, shows similar results. With the cultivation of GM plants, crop yields increased by an average of 22 percent. The amount of pesticides used fell by a total of 37 percent, and by as much as 42 percent in the case of insect-resistant Bt plants. Farmers' incomes increased by an average of 68 percent

> with the cultivation of GM crops. In developing countries, the benefits were significantly greater than in industrialized countries]. (IVA, 2016, para 4)

It was paraphrased as "Experts support GE" and allocated to the Authority foundation because it strongly emphasizes experts and numerous scientific studies as sources. This segment was also allocated to the Loyalty foundation because the content of the findings testifies benefits for the whole society, particularly for developing countries.

Liberty. Another text segment reads:

> Die Akademien sprechen sich gegen wissenschaftlich unbegründete pauschale Anbauverbote für GVO aus und empfehlen mit Nachdruck wissenschaftsbasierte Einzelfallprüfungen. Sie sehen durch solche Anbauverbote in Deutschland die Forschungs- und Berufsfreiheit, den Schutz des Eigentums sowie die allgemeine Handlungsfreiheit und damit die Chancen der Erforschung, Weiterentwicklung und kommerziellen Nutzung der Grünen Gentechnik akut bedroht [The academies are opposed to scientifically unfounded blanket bans on the cultivation of GMOs and strongly recommend science-based case-by-case assessments. They see such cultivation bans in Germany as acutely threatening the freedom of research and occupation, the protection of property, and the general freedom of action, and thus the opportunities for research, further development, and commercial use of green genetic engineering]. (Dederer et al., 2015, p. 1)

It was paraphrased as "Faulty regulations interfere with scientific freedom" and allocated to the Liberty foundation because it concerns the freedom of scientists and scientific research.

Sanctity. One text segment reads:

> Die Nationale Forschungsstrategie BioÖkonomie-2030 hat das Ziel, eine ressourcenschonende und nachhaltige bio-basierte Wirtschaft aufzubauen. Der Pflanzenforschung und -züchtung fällt dabei eine Schlüsselrolle zu: Gentechnische Verfahren können dazu beitragen, Herausforderungen, vor denen Züchter und Landwirte heute stehen, besser zu bewältigen. So können Pflanzen beispielsweise besser an Trockenheit oder versalzene Böden angepasst werden [The National Research Strategy BioEconomy-2030 aims to build a resource-efficient and sustainable bio-based economy. Plant research and breeding have a key role to play here: Genetic engineering processes can help to better overcome challenges facing breeders and farmers today. For example, plants can be better adapted to drought or salinated soils]. (BMBF, 2014, p. 4).

It was paraphrased as "GE support sustainability" and allocated to Sanctity because it concerns the protection of the environment.

Notable Characteristics of the Analyzed Official Position Papers

During the content coding procedure, some stylistic devices became salient. These are reported in the following.

As mentioned earlier, positions can already be determined by the term used to refer to genetic engineering. While opponents appear to mostly use the negatively connoted neologism "Genmanipulation" [gene-manipulation] (see for example (BUND-Bund für Umwelt und Naturschutz Deutschland, n.d., para. 7), this term is not common among supporters. Supporters

appear to most frequently use the more positively connoted term "Grüne Gentechnik" [Green Genetic Engineering] (see for example BMBF, 2014, p. 9).

Moreover, GE opponents most frequently mention the United States of America (US) in relation to GE cultivation. It appears as though they point to the US as an example of a potential worst-case scenario. For example, headlines stating that GE contamination is already ubiquitous in America today (BUND-Bund für Umwelt und Naturschutz Deutschland, n.d., para. 34) come across as warning, not only because they use the pejorative term "Kontamination" [contamination], but also because of how the text continues:

> Gentechnische Kontamination in Amerika heute bereits allgegenwärtig[.] Was sich als mögliches zukünftiges Szenario für Deutschland und die EU abzeichnet, ist in den Hauptanbauländern von gentechnisch veränderten Pflanzen schon jetzt Realität. Die USA, Argentinien und Kanada können bereits heute nicht mehr gewährleisten, dass ihr Saatgut und ihre Ernten keine Gentechnik enthalten – zu weit fortgeschritten ist bei ihnen der Anbau gentechnisch veränderter Pflanzen, die gentechnische Kontamination ist allgegenwärtig [GE contamination already is ubiquitous in America today. What is emerging as a possible future scenario for Germany and the EU is already a reality in the main countries where genetically modified crops are grown. The USA, Argentina and Canada can already no longer guarantee that their seeds and harvests do not contain genetic engineering - the cultivation of genetically modified plants is too advanced in these countries, and genetic engineering contamination is omnipresent]. (BUND-Bund für Umwelt und Naturschutz Deutschland, n.d.).

Conversely, GE supporters most frequently mention Europe, the European Union, or Germany in their argumentation, often pointing towards potential benefits of the technology for Germany, as well as the good Germany could do in developing countries, had it more GE research and development. For example, Nüsslein-Volhard (2011) states:

> Es gibt drei Aspekte, die mir am Herzen liegen, und bei denen der Einsatz von gentechnischen Methoden große Bedeutung haben könnte, auch in Deutschland […] So kann und darf es doch nicht bleiben! Forschung ist international – Einschränkungen hierzulande verhindern ja nicht den Fortschritt weltweit, sondern klinken die deutschen Forscher wie auch die Pflanzenzüchter aus dem internationalen Wettbewerb aus. Die Vorreiterrolle Deutschlands in der Pflanzenzüchtung, die ein großes Potential und damit Kapital unseres Landes darstellt, ist ernsthaft gefährdet [There are three aspects that are close to my heart and where the use of genetic engineering methods could have great significance, also in Germany […] Things cannot and must not stay this way! Research is international - restrictions in this country do not prevent progress worldwide, but exclude German researchers and plant breeders from international competition. Germany's pioneering role in plant breeding, which represents a great potential and thus capital of our country, is seriously endangered]. (pp. 2, 7)

Generally, some stylistic devices are particularly salient among opposing position papers, some among supporting position papers. These are separately described in the following.

Notable Stylistic Devices of GE Opponents

In GE opposing position papers, some stylistic devices are prominent. First, they speculate, and thus insinuate unwanted detrimental behavior by actors involved in GE. For example, Then and Bauer-Panskus (2017) write:

> Auch wenn es in vielen Fällen zunächst keine offensichtlichen Probleme geben sollte, kann ein einziger ‚Unfall' erhebliche Auswirkungen auf die biologische Vielfalt, die Zukunft der Tier- und Pflanzenzucht und die menschliche Gesundheit haben. Dieser Unfall kann heute, morgen oder auch erst nach über hundert Jahren passieren. Wird dieses Roulette mit der biologischen Vielfalt erst einmal gestartet, gibt es später keine verlässliche Kontrollfunktion mehr [Although in many cases there should be no obvious problems at first, a single 'accident' can have a significant impact on biodiversity, the future of animal and plant breeding, and human health. This accident can happen today, tomorrow, or even over a hundred years later. Once this roulette with biodiversity is started, there is no reliable control function later on]. (p. 5)

Note that Then and Bauer-Panskus (2017) also speak of a potential accident, suggesting a negative occurrence rather than just remaining neutral.

Second, GE opponents frequently contain negative assumptions or suggestive phrasings about potential scenarios related to GE. To a reader, these may convey bad and uncertain outlooks on the use of GE even though negative consequences might not even be an inherent characteristic of the issue described. For example, Aktionsbündnis Gentechnikfreie Landwirtschaft in Baden-Württemberg, (2022, p. 1) writes: „Die Risiken der Agro-Gentechnik für Menschen und Ökosysteme sind nicht absehbar" [The risks of agro-genetic engineering for humans and ecosystems are not foreseeable]. As another example, Sprenger (2013) writes:

> Für den Anbau zugelassen sind vor allem vier Ackerbaukulturen, die weltweit über ein großes Handelsvolumen verfügen: Sojabohne, Mais, Baumwolle und Raps. Die gentechnischen Veränderungen finden sich in allen Pflanzenzellen wieder, von der Wurzel bis zum Pollen. Sie sind mit lukrativen Patentrechten geschützt und beschränken sich im Wesentlichen auf zwei Eigenschaften [The main crops approved for cultivation are four arable crops that have a large volume of trade worldwide: Soybean, corn, cotton and canola. The genetic modifications are found in all plant cells, from the root to the pollen. They are protected by lucrative patent rights and are essentially limited to two properties]. (p. 2)

Third, GE opponents frequently appeal to their readers to support them in the fight against GE. For example, Gen-ethisches Netzwerk e.V. (2015, p. 1) writes „25 JAHRE WIDERSTAND - Freisetzung gentechnisch veränderter Pflanzen verhindern" [25 YEARS OF RESISTANCE - Prevent the release of genetically modified plants]!

Fourth, GE opposing position papers contain many pejorative words that may trigger feelings of uncertainty and fear, such as „gefährden" [endanger] (IG Saatgut - Interessengemeinschaft für gentechnikfreie Saatgutarbeit IG Saatgut, 2020, p. 18), „schädigen" [harm] (Sprenger, 2013, p. 3), „Kontamination" [contamination] (BUND-Bund für Umwelt und Naturschutz Deutschland, n.d., para. 34), „Genpflanzen" [gene-plants] (Greenpeace, 2015, p. 2), or „Genmanipulation" [gene-manipulation] (BUND-Bund für Umwelt und Naturschutz Deutschland, n.d., para. 7).

Fifth, position papers by GE opposition contain many emotionalized phrasings that describe issues surrounding GE as dramatic, and thus may elicit fear and anger. For example, Gen-ethisches Netzwerk e.V. (2013, p. 2) writes: „Kontaminiert, gestohlen und umkämpft" [contaminated, stolen and contested]. Or Mertens (2018a) writes:

> Hält sich ein Landwirt nicht daran, wird er erbarmungslos verfolgt: Monsanto verklagte in den vergangenen Jahren in den USA Hunderte von Landwirten, weil sie widerrechtlich Nachbau betrieben hätten [If a farmer does not comply, he is pursued mercilessly: Monsanto has sued hundreds of farmers in the US in recent years, claiming that they were unlawfully practicing farming]. (p. 288)

And sixth, many of the arguments by GE opposition are formulated as urgent demands, suggesting that the rejection of GE is a pressing must because of their negative consequences. For example, Aktionsbündnis Gentechnikfreie Landwirtschaft in Baden-Württemberg (2022) writes „[d]er Gesetzgeber muß (…) die Existenz einer Gentechnik-freien Landwirtschaft langfristig sichern. Dazu gehört auch, dass die Reinheit des Saatgutes gewährleistet wird" [legislators must (…) ensure the existence of GE-free agriculture in the long term. This also includes ensuring that the purity of the seed is guaranteed] (p. 1).

Notable Stylistic Devices of GE Supporters

GE supporting position papers contain fewer stylistic devices, potentially because many of those are published by scientific organizations. However, supporting position papers are sometimes somewhat cynical and sarcastic. For example, Fischer (2018, para 5) writes "[d]ank dieser spezialisierten Formulierung gelten mit Hilfe radioaktiver Strahlung oder erbgutverändernden Chemikalien erzeugten Pflanzensorten als natürliche Züchtungen, die nicht unter das [Gentechnik-] Gesetz fallen" [Thanks to this specialized formulation, plant varieties produced with the help of radioactive radiation or mutagenic chemicals are considered natural breeds that do not fall under the (Genetic Engineering) Act].

and „der lange Schatten der Ideologien" [the long shadow of ideologies] (Fischer, 2018, para 1).

Similarly, Szibor (2013, p. 4) writes „[n]atürlich kann man auch demokratisch darüber abstimmen, welchen Wert die Erdbeschleunigung haben soll oder wie lang die Umlaufzeit der Erde um die Sonne ist. Aber welchen Sinn sollte das haben? Naturwissenschaftliche Wahrheit ist etwas anderes" [Of course, one can also vote democratically on the value of the acceleration due to gravity or about the orbital period of the earth around the sun. But what sense should that have? Scientific truth is something else].

As another example, describing his perception of the language of GE opponents, Szibor (p. I) speaks of „Vokabular des Schreckens" [vocabulary of horror].

Additionally, GE supporters sometimes very vividly describe how attacked they feel by GE opposition. For example, Szibor (2013, p. 3) uses extreme comparisons such as „Antigentechnik-Demagogie" [anti-GE demagogy] or Szibor (2013):

> Asymmetrischer Kampf ist bekannt aus der Terroristenszene. Terroristen müssen sich an keine ethischen Grundsätze einer demokratischen Gesellschaft halten, können Bomben dann und dahin legen, wo sie am wirksamsten sind. Die Gegenseite ist bei deren Bekämpfung an Gesetze und ethische Kodizes gebunden und damit stark eingeschränkt. [Asymmetrical combat is well known from the terrorist scene. Terrorists do not have to adhere to any ethical principles of a democratic society, can plant bombs

> when and where they are most effective. The opposing side is bound by laws and ethical codes when fighting them and is thus severely restricted]. (p. 9)

Another example provides Rauner (2017, p. 76):

> Diese beiden Forscher, so scheint es, haben der Menschheit einen großen Dienst erwiesen. Warum ist die Stimmung in Büro 2.077 so schlecht? […] Vielleicht hat er zu viele Interviews gegeben, die nie etwas verändert haben, er ist in den Texten dann immer der Forscher mit den grauen Haaren, der "müde aussieht". Er ist gar nicht müde, er hat nur auf bestimmte Rituale keinen Bock mehr. Vor Kurzem kam mal wieder eine Einladung zur Podiumsdiskussion. Er hat abgesagt [These two researchers, it seems, have done humanity a great service. Why is the mood in office 2.077 so bad? [...] Maybe he has given too many interviews that never changed anything, he is then always the researcher with the gray hair who "looks tired" in the texts. He's not tired at all, he's just tired of certain rituals. Recently, he received another invitation to a panel discussion. He declined].

Furthermore, supporting position papers use positive, approbative terms in relation to GE. For example, the BMBF (2014, p. 9) uses terms such as „Grüne Gentechnik“ [Green Genetic Engineering], „biosafety research“, „transparency“, or „scientific facts“.

Moreover, as do GE opponents, supporters also occasionally use urgent appeals. For example, Dederer et al. (2015) writes:

> Deutschland und Europa tragen in einer globalisierten Welt mit knappen natürlichen Ressourcen und einer wachsenden Nachfrage eine internationale Verantwortung, die Produktivität der Landwirtschaft unter anderem durch nachhaltige neue Züchtungsmethoden weiter zu steigern. Auch das politische Signal, das ein komplettes Anbauverbot in Deutschland an andere (z. B. afrikanische) Länder vermittelt, in denen Produktionssteigerungen zur Hungerbekämpfung zwingend erforderlich sind, sollte nicht unterschätzt werden. [In a globalized world with scarce natural resources and growing demand, Germany and Europe have an international responsibility to further increase agricultural productivity, including through sustainable new breeding methods. The political signal that a complete ban on cultivation in Germany sends to other (e.g. African) countries where production increases are absolutely necessary to fight hunger should also not be underestimated]. (p. 4)

Another example provides Bundesministerium für Bildung und Forschung (BMBF, 2014, p. 6): „Unsere Pflicht als Bürger ist es, die vorliegenden Beweise zur Kenntnis zu nehmen und die Courage zu besitzen, unsere Auffassungen zu revidieren, wenn sich die Beweise häufen“ [Our duty as citizens is to take note of the evidence at hand and have the courage to revise our views as the evidence accumulates].

And lastly, supporting position papers frequently draw on providing extensive background information and explaining the technology (see, for example DFG, 2010, pp. 10-55), while GE opponents are much more frugal in stating their arguments, they only provide some brief further information.

Quality Criteria of Content Analyses

As for every other scientific method as well, quality criteria help evaluate the results of a content analysis (Mayring, 2015, p. 29). Mayring (2015, pp. 123-129), distinguishes between quality

checks that evaluate validity and those that evaluate reliability. Building on quality checks proposed by Mayring, 2015, the conducted checks are presented in the following.

Validity: Construct Validity

Through markers of validity, it is evaluated whether the operationalization of the moral foundations actually measures the moral foundations. The first marker is that the operationalization was developed based on a systematic review of the seminal literature of MFT. Thus, the unique characteristics that describe each foundation were directly derived from the theoretical construct of MFT. More information on which these are can be found in Chapter 2.

Moreover, the developed coding criteria were extensively discussed with more than seven colleagues in numerous rounds. These colleagues were all familiar with MFT and some of the seminal literature. The purpose of the discussions was to clarify ambiguities between the understandings of the foundation and to further sharpen the identified unique characteristics of each foundation. Also, paraphrased codes were extensively discussed when there was disagreement as to which foundation they were allotted. This sometimes required going into the code in order to clarify the content and amend the paraphrases and their allocation when necessary. These discussions were seized when agreement was reached.

Similarly, as mentioned above, the paraphrases were edited during the coding process whenever ambiguities arose.

And finally, there are several outside criteria that support construct validity. First, the allocation of paraphrases to moral foundations simply had to make sense. Second, and more importantly related literature on GE attitude was consulted in order to develop predictions (hypotheses) about the results of the present analyses. Since the results are in line with previous literature on the topic, construct validity is indicated. The hypotheses are described and discussed in the main paper.

Reliability: Interrater Reliability Check

Interrater reliability (IRR) tests are the most common quality check for content analysis (Landis & Koch, 1977; Mayring, 2015; Weber et al., 2018; Hopp et al., 2020). Consequently, as a measure of external validity, i.e. systematic and objective procedure, IRR is applied here, too.

The official position papers were coded entirely by one person (the author), which ensures high consistency between codings. However, to test whether the coding was conducted according to explicit, systematic and objective criteria that can also be understood by an external individual, an interrater reliability check was conducted by a person previously not involved in the coding. The goal was to check whether an uninvolved, untrained person does understand the meaning of the text segments in the same way as the first coder did. Moreover, the IRR also served as a test whether the developed code system is clearly comprehensible to a person unfamiliar with the topic. If this second person codes similar to the author, this is a strong signal that the paraphrases are comprehensible to external people, that the allocations of text segments to paraphrases is reproducible, and that the author understood the text segments very similar to a person not involved in the topic.

Which paraphrases are allocated to which moral foundation is documented in the code system in Table 3.A.1 and Table 3.A.2 . The rules and reasoning behind the allocation decisions are

extensively explained in Chapter 2. The second coder was provided with this code system and thus knew which paraphrases shall be allotted to which moral foundation. Thus, the present IRR did test the allocation of text segments to paraphrased codes, and not the allocation of paraphrased codes to moral foundations, since the latter are already transparently provided with the code system.

Procedure

The data used for the interrater reliability test, the code systems applied to the interrater reliability test, as well as the codes of two raters are available at https://doi.org/10.7910/DVN/K9LCB1.

For the interrater reliability check (IRR), 10% of the total number of extracted text segments of both, GE supporters and opponents, were randomly selected. Due to a display error, 14 of the randomly selected opposing segments, and 23 of the randomly selected supporting segments had to be taken out. Thus, 127 opposing text segments, and 107 supporting text segments (and 234 total), were included in the IRR.

Remember that often, text segments contained several arguments for or against GE. Therefore, the respective words were marked in bold, previously to the IRR. Additionally, the code system was provided to the second coder.

Then, the second coder went through the randomly selected text segments and allocated them to the code system.

The IRR was measured with Cohen´s Kappa for two raters (McHugh, 2012).

Results

For the randomly selected opposing segments, Kappa = 0.809 (p = 0). According to the interpretation suggested by Cohen (1960) and Landis and Koch (1977), Kappa just barely passed the benchmark for “almost perfect agreement”.

For the randomly selected supporting segments, Kappa = 0.902 (p = 0). According to the interpretation suggested by Cohen (1960) and Landis and Koch (1977), this can be interpreted as “almost perfect agreement”.

For all randomly selected segments, Kappa = 0.851 (p = 0). According to the interpretation suggested by Cohen (1960) and Landis and Koch (1977), this can be interpreted as “almost perfect agreement”.

Chapter 4 –
Understanding Moral Narratives as Drivers of Polarization about Genetically Engineered Crops[10]

Abstract

Motivated by an increasing interest in narratives in economics, we investigated the relevance of moral concerns in narratives for policy preferences. Specifically, taking the German debate about genetic engineering of foods (GE) as an example, we conducted a representative online survey in Germany to identify common narratives, their moral content, and related subjective images about GE.

In line with previous research, we found that two-thirds of respondents choose to reject GE. Moreover, based on Moral Foundations Theory, we found that GE opponents much more frequently addressed the moral foundations Care and Sanctity in their stated narratives about GE. GE supporters most frequently addressed the moral foundation Loyalty in their stated narratives about GE.

Also, subjective images about GE were much more negative among opponents than among supporters. However, the subjective images of opponents and supporters were in striking accordance about GE being a deviation from what is considered normal. Both sides overwhelmingly described images related to the enhancement of plants, as something strange, supersized, or artificial.

In a linear regression model, we showed that the moral content of narratives about GE is indeed significantly related to the attitude towards this technology.

In total, the findings suggest that the moral content of narratives is highly relevant for policy preferences, and should thus be considered in science communication and policymaking.

Keywords: narratives, Moral Foundations Theory, genetic engineering, morality, polarization

[10] This chapter is joint work with Ulrich Fritsche.

Introduction

Scientific academies consider the genetic engineering of plants for human consumption (GE) to be a promising tool for tackling future challenges such as food security (National Academies of Sciences, Engineering, and Medicine, 2016; German National Academy of Sciences Leopoldina [Leopoldina] et al., 2019; Leopoldina et al., 2015). Contrary to that, non-governmental organizations (NGOs) such as Greenpeace or Testbiotech have long warned of potential uncontrollable risks of GE, and propose a ban of foods produced with this technology (see for example Greenpeace, 2015; Then & Bauer-Panskus, 2017).

Particularly in Germany, this discrepancy resulted in a long-lasting and heated debate (Inbar & Waldhof, 2022; Dürnberger, 2019; Blancke et al., 2015; Freitag, 2013; Zwick, 1998). Even more so, Pies et al. (2021) describe that GE supporters and opponents maintain their strongly polarized positions and have not been able to move towards consensus for long.

Within the public, the topic is polarizing as well, although skepticism is more frequent than acceptance, both internationally but in Germany in particular (Kennedy & Thigpen, 2020; Scott et al., 2016; BfR, 2022). For example, in a study by Inbar and Waldhof (2022), roughly two-thirds of respondents in Germany stated to be against GE foods. Similarly, Scott et al. (2019) found rejection rates as high as 73% among respondents in Germany. These findings suggest that those narratives about GE that are shared and represented by NGOs are more appealing to the majority of the German public than are those represented by the scientific academies.

In the present study, we inquire *why* this is the case. Specifically, we investigate the moral *narratives* that people rely on to inform their attitude towards GE.

A growing body of literature looks at the narratives that people hold in relation to their policy preferences (Eliaz & Spiegler, 2020; Spiegler, 2016; Andre et al., 2022). Shiller (2017) saw narratives as stories that guide people's expectations about current topics. Similarly, Eliaz and Spiegler (2020) proposed that narratives shape political beliefs. This was already formulated in 2009 by Akerlof and Shiller who related economic decisions to the belief in certain stories. Thus, narratives can be understood as heuristics that help develop preferences for policies, such as a ban of GE or an approval, respectively.

What makes narratives an interesting study object for economics is that they suggest and motivate economically relevant behavior (Roos & Reccius, 2021) and decisions, e.g. whether to vote in favor or against GE. Shiller (2019) also postulated that narratives can "drive major economic events" (p. iii). Similarly, Benabou et al. (2020) argued that moral narratives have the power to change people's beliefs about social costs and benefits. With that, narratives coordinate collective behavior in an uncertain world (Roos & Reccius, 2021). They thus impact policymaking, consumer behavior, markets, and demands of certain goods, e.g. genetically engineered crops.

At the same time, importantly, this also means that "[d]ifferent narratives will typically generate different political beliefs because they manipulate correlations between different sets of variables" (Eliaz & Spiegler, 2020, p. 3788). With that, political disagreements may be explained by a "clash of narratives" Eliaz and Spiegler (2020, p. 3786). I.e., if people believe different narratives about GE to be most relevant, they may come to opposing views on whether or not to ban GE.

Previous research provided evidence that GE attitude is related to moral beliefs (Moon & Balasubramanian, 2003; Sjöberg, 2008; Tanaka, 2004). Even more so, Inbar and Waldhof

(2022) and Scott et al. (2016) found that for many people, their position towards GE itself is a morally held belief. Other research has linked GE attitudes to moral foundations and moral values (Chapter 3; Siegrist, 1999).

Building on this previous research on GE attitudes and economic narratives, we propose in the present paper that people's moral belief systems are decisive for which narrative about GE they find most appealing. We thus assume here that the moral content of a narrative about GE guides GE attitude and respective policy preferences. This proposition is supported by research that has found that moral beliefs are particularly powerful in motivating behavior (Skitka et al., 2005; Chen, 2020), such as political engagement (Sktika & Baumann, 2008; Misch et al., 2021). Thus, the question arises of what the moral contents of narratives about GE are, and how they differ between supporters of GE and opponents of GE. Narrative research in economics increasingly addresses the role of morality in narratives. For example, Akerlof and Shiller (2009) pointed out that moral concerns such as confidence and fairness are relevant for economic behavior. Similarly, Benabou et al. (2020) argued that moral or immoral behavior results in social costs or benefits. They described moral narratives as arguments behind these costs or benefits that thus guide behavior. For Benabou et al. (2020, p. 2), such moral narratives are even the "most important narratives". Shiller (2020) also postulated that narratives transport a moral interpretation of events.

Even more specifically, Benabou et al. (2020, p. 27) called for investigating the type of moral notions in narratives, requiring going beyond "fairness-harm conception[s]". In the present study, we extended our inquiry beyond such conceptions by applying Haidt's Moral Foundations Theory (2012) to identify a likely spread of moral foundations addressed in narratives as well as potential conflicts between them.

Furthermore, we built our analysis on the idea formulated by Sloman et al. (2009) that the moral judgment of a narrative occurs through the evaluation of this narrative against a normative ideal. Similarly, Roos and Reccius (2021, p. 14) made the important suggestion that narratives are evaluated against representations about "how the world ought to be".

Following this suggestion, we propose here that narratives have a normative implication through addressing a specific moral foundation that is either catered to or violated. If the foundation is catered to, then the normative evaluation of the issue is "good", vice versa, if the foundation is violated then the normative evaluation of the issue is "bad". Depending on the evaluation, specific moral emotions are triggered that then motivate behavior (Haidt, 2003; Schwartz, 2007).

In the present paper, we point out this crucial aspect and make the argument that the evaluation of a narrative against a moral foundation drives the subsequent behavior and decision.

Relatedly, Benabou et al. (2020) point to the research domain of conflicting narratives. As mentioned above, some narratives in the official debate about GE are diametrically opposed, leading to diverging attitudes towards the technology. Similarly, Roos and Reccius (2021) pointed out that different people and groups focus on different moral values because they exhibit different value preferences. Tying in with this, we explored which narratives lead to a negative evaluation of GE, and which to a positive.

Using the GE debate in Germany as an example, the present study addressed the following questions:

1. Which moral evaluations – and conflicts between them – according to Haidt's Moral Foundations Theory lead to GE support, which lead to GE opposition?

2. Which narratives drive GE attitudes in Germany?
3. Do subjective images about GE differ between supporters and opponents?
4. What is the relative importance of moral narratives compared to other (socioeconomic) factors?

For this purpose, we conducted an online survey on GE attitudes in Germany, representative for the population according to age, gender, and region. In this survey, we used open text boxes for respondents to provide their reasoning behind their attitudes.

Furthermore, we asked participants to describe what they picture when thinking about GE (i.e., subjective images). We also collected data for other measures that have previously been shown to be relevant for attitude formation, and GE attitudes in particular. These include for example, age, gender, emotionality, experience of emotions, or regulatory preferences.

We coded the provided narratives and subjective images according to prevalent contents, and according to addressed moral foundations. We conducted a correspondence analysis, as well as a linear regression.

We found that the majority (63%) chose to reject GE for food. The narratives that participants stated to justify their decision address the moral foundations Care, Loyalty, and Sanctity. In general, the analyses reveal a striking importance of Loyalty as driving GE attitude. In particular, opponents focused much more on concerns related to Sanctity, and also addressed the Care foundation more frequently than do supporters. Interestingly, supporters focused extensively on the Loyalty foundation, thus addressing potential benefits for others and society as a whole, rather than health issues that might be more relevant to them personally.

In their narratives, GE opponents focused heavily on potential health impairments and general risk perceptions. They also frequently addressed the narratives that GE would be unnatural, or an interference with nature; as well as the narrative that GE and related products would bring damage to the environment. Supporters strongly focused on narratives about food security, and contributions to general welfare. They also often stated environmental benefits through GE, and adaptive advantages of GE.

Moreover, we found that subjective images of GE differ between opponents and supporters in that those of opponents generally refer to more negative scenarios than those described by supporters. For example, while opponents often described somewhat post-apocalyptic images, supporters often described more neutral images related to laboratories, research and modern technology.

However, the subjective images of opponents and supporters were in striking accordance with another, about GE being a deviation from what is considered normal. Both sides overwhelmingly described images related to the enhancement of plants, something strange, supersized, or artificial.

In a linear regression model, we showed that the moral content of narratives about GE is indeed significantly related to the attitude towards this technology.

We contribute to the literature of narratives in economics (Ash et al., 2021; Macaulay & Song, 2022; Spiegler, 2016; Eliaz & Spiegler, 2020; Andre et al., 2022, Shiller, 2017, 2019, 2020). We identified people's (mis)perceptions of an economically highly relevant technology. These (mis)perceptions impact people's expectation formation, and with that predict their voting behavior, purchasing behavior, and policy preferences in relation to GE. Rather than merely reporting on observed behavior, we provide evidence on what is going on in people's minds, i.e., which beliefs contribute to this behavior. With that, we also contribute to the literature on

expectation formation (Bachmann et al. [Eds.], 2022; D'Acunto et al., 2021; Bachmann et al., 2020; Cookson et al., 2020). Particularly, we contribute to research that investigates the role of values, economic ideologies and beliefs in forecasting behavior (Carroll & Wang, 2022; Hudomiet et al., 2022; Mueller & Spinnewijn, 2022; Delavande, 2022; Döpke et al., 2019; Beckert, 2016; van Dalen, 2019). This research increasingly applies text analyses and text mining methods (Grimmer et al., 2022; Ash & Hansen, 2022; Gentzkow et al., 2019; Diaf et al., 2021; Fritsche & Puckelwald, 2018; Jelveh et al., 2018). Applying qualitative text analyses to research lay people's moral beliefs about GE specifically, we also contribute to this methodological development.

While normative beliefs are increasingly incorporated in economic analyses, there is not yet much research addressing the moral content of narratives specifically. We contribute to this emerging strand of literature in economics (Roos & Reccius, 2021; Benabou et al., 2020). Specifically, we illuminate moral concerns that feed into attitude and expectation formation. We also provide evidence on the relative importance of moral narratives compared to other (e.g. socioeconomic) factors. Thus, we provide novel insights into moral conflicts between narratives. With that, we contribute to explaining how diverging moral foundations lead to diverging expectations, policy preferences and economic behavior.

Through identifying conflicting moral foundations, we help explain conflicting attitudes, and thus also contribute to the literature on polarization, and polarized debates (Tosun & Schaub, 2017, Kubin et al., 2021; Graham et al., 2012; Waytz et al., 2019; Day et al., 2014; Voelkel & Feinberg, 2018; Graham et al., 2009). We also contribute to the literature in moral psychology on moral beliefs, moral conviction, moralization of attitudes, and moralization more general (Feinberg et al., 2019; Ellemers et al., 2017; Fernbach et al., 2019; Skitka et al., 2005; Graham et al., 2011; Skitka & Mullen, 2002; Tetlock et al., 2000; Tetlock, 2003; Rozin, 1999; Rozin, 2005, Haidt, 2012).

Moreover, we contribute to the literature on GE attitude, technology adoption, and related policy preferences (Connor & Siegrist, 2010; Dürnberger, 2019; Kajale et al., 2015 Siegrist et al., 2012; Siegrist, 2000; Siegrist, 1999; Kimenju et al., 2007; Lee et al., 2018). Because through analyzing people's narratives about GE with text analyses, we shed light on the underlying belief structure and motivations beneath GE attitudes.

Concluding, our key contribution is methodological. For the analysis of economic narratives and their impact on expectation formation and economic behavior, we illuminate the role of moral concerns by introducing a concept for identifying these in text. Particularly, we show how Moral Foundations Theory can serve as a lens for analyzing economic narratives.

We also provide some practical contributions: Understanding which narratives about GE people have on top of their heads is necessary to develop solutions for a more constructive debate about GE. Thus, the present research provides the ground for developing policy recommendations, as well as recommendations for science communication.

This paper is structured as follows. We first provide theoretical background on narratives in economics and propose to follow Roos and Reccius' (2021) definition of collective narratives in economics, particularly. We then provide theoretical background on Moral Foundations Theory (Haidt, 2012), and the representation of narratives as directed acyclic graphs (Spiegler, 2016). Subsequently, we describe the coding procedure of the narratives. We report on addressed moral foundations, addressed topics, and a correspondence analysis. We also briefly report on survey comments. Next, we report on the results of the analysis of mental

models that people described. We then report on results of our linear regression model. Finally, we discuss our results and conclude with a brief outlook.

Theoretical Background

Narratives in Economics

A new strand in the economic literature investigates the role of narratives in explaining public phenomena and expectation formation. For example, Andre et al. (2022) explored the narratives people use to explain inflation surges. Similarly, Macaulay and Song (2022) investigated sentiment changes of Twitter users through engaging with a narrative portrayed in newspaper articles. Eliaz and Spiegler (2020) investigated why certain narratives spread while others do not and propose a model of competing narratives, in which people are drawn to hopeful narratives. Similarly, Benabou et al. (2020) attempted to explain the use of narratives as a means to justify one's own behavior against moral rules. Focusing even more on the role of actors in the spread of narratives, Eliaz et al. (2022) developed a model that shows how narratives can be used by political actors for political mobilization of the public. This conscious implementation of narratives has also been investigated by Antoci et al. (2020), who studied how influencers' self-interested strategic choice of narratives can impact public opinion. Ash et al. (2022) also contributed to this by developing an open-source package, RELATIO, that helps mapping the relationships between actors involved in a narrative.

While scholarly interest in narratives in economics is increasing, definitions of the term are mostly broad. Based on a literature review on narratives in economics, Roos and Reccius (2021) concluded that there is still no common understanding in economics of what narratives are. Consequently, different concepts are used which are often described rather vaguely. For example, Robert Shiller (2017, 2019, 2020) who published his popular book "Narrative Economics" in 2019, described his understanding of narratives with illustrative anecdotes.

Many of current studies on narratives in economics appear to be based on the concept described by Shiller. For example, references to Shiller are made in Benabou et al. (2020), Ash et al. (2022), Andre et al. (2022), and Roos and Reccius (2021). Shiller (2020, p. 792) described narratives as "stories that offer interpretations of economic events, or morals, of hints of theories about the economy". As he did, narratives are often described as stories. For example, Benabou et al. (2020, p. 1) wrote "[n]arratives are stories people tell themselves, and each other, to make sense of human experience." Similarly, Roos and Reccius (2021, p. 13) also understood a narrative as a "sense-making story". Ash et al. (2022) understood narratives as stories that shape beliefs about social reality.

In his book, Shiller (2019) referred to the definition of a narrative provided by the Oxford English Dictionary (OED). The strategy to refer to the OED for a definition of "narrative" is also adopted by others, for example Andre et al. (2022), or Ash et al. (2022, p. 3), even though the exact wording appears to vary. For example, while Shiller (2019, p. XVII) cited the definition of a narrative by OED as "a story or representation used to give an explanatory or justificatory account of a society, period, etc.", Andre et al. (2022, p. 6) cited this as an "account of a series of events, facts, etc., given in order and with the establishing of connections between them."

Since so far, these descriptions are rather vague, as the term "story" is vague, there is still much room for the development of an understanding of a narrative in economics.

Spiegler (2016), Eliaz and Spiegler (2020), and Eliaz et al. (2022) proposed to understand narratives as a causal account for why certain public outcomes occur. Antoci et al. (2020) also understood narratives as some sort of account (between purely fictional or based on real facts) of an event. Spiegler (2016) and Eliaz and Spiegler (2020a,b) formalized this causal account as a probabilistic belief which can be represented as directed acyclic graphs (DAGs) based on the assumption of Bayesian networks. While Eliaz and Spiegler (2020) proposed to understand a narrative as a causal relationship between a factor and an outcome, the relationship could be more precisely described as a probabilistic belief about this relationship based on a correlation between the variables. This is later explained in more detail. With that, the approach proposed by Spiegler (2016) and Eliaz and Spiegler (2020) focuses on the individual, formalizing narratives as a causal account that is needed for individual decision making.

The representation as DAGs proposed by Spiegler (2016) is also applied by other researchers investigating narratives in economics, e.g. Macauley and Song (2022), or Andre et al. (2022).

Collective Narratives in Economics According to Roos and Reccius

In 2021, Roos and Reccius developed a more comprehensive understanding of narratives in economics, and propose a definition for a "collective economic narrative" (2021, p. 13):

> "*A collective economic narrative is a sense-making story about some economically relevant topic that is shared by members of a group, emerges and proliferates in social interaction, and suggests actions."*

In their definition, Roos and Reccius (2021) emphasized the need of a narrative to be collective in order to be relevant for macroeconomic events. The authors stated that rather than private narratives that provide guidance for a specific person, collective narratives fulfill specific functions for an entire group.

At the core of this definition are five characteristics: narratives are stories that make sense of public phenomena, they are known and relevant to a group, they emerge from social interaction, and motivate action.

First, Roos and Reccius (2021) proposed to understand a narrative as a story. Their understanding is similar to those described above, but different from Eliaz and Spiegler's (2020) causal account. Roos and Reccius (2021, p. 15) described a narrative as "a partial articulation of a more complex underlying causal model". This means that the narrative itself does not necessarily convey an underlying causal relationship, but the narrative can be interpreted as a causal model, depending on the knowledge and assumptions of the interpreter.

Second, Roos and Reccius (2021) proposed that narratives help people to make sense of the world around them to guide and motivate their decision making and behavior. For such sense-making to work, it needs to connect to the belief system of the people holding a narrative (Roos & Reccius, 2021). And such a belief system consists of a set of "mental models and normative, evaluative, affective and motivational elements" (Abelson, 1979, as cited in Roos & Reccius, 2021, p. 14).

Third, since Roos and Reccius (2021) defined collective narratives, they demanded that such are relevant and known to a group, as well as shared and understood by this group.

Such a narrative can thus also fulfill the purpose of binding a group together and differentiating this group from others. With this, collective narratives can be essential for group

identity. Related to that, research on identity in economics provided evidence that the necessity to maintain and signal one's own identity can be a strong motivator for behavior and decision making (see for example Akerlof & Kranton, 2000, 2010; Shayo, 2010).

Fourth, Roos and Reccius (2021) proposed that collective narratives emerge from social interaction. Specifically, they pictured public discourses that address and develop certain narratives, and are spread through news media.

And fifth, narratives should suggest an action (Roos & Reccius 2021), such as the purchase of a product or voting behavior. The assumption that narratives motivate behavior is also central to the understanding provided by Eliaz et al. (2022) and Eliaz and Spiegler (2020). While narratives can still be important for group identity if they do not suggest an action, they only become a relevant object of investigation for economics if they motivate economic behavior and decision making (Roos & Reccius, 2021, pp. 6, 18; Eliaz et al., 2022).

Understanding of Narratives in the Present Study According to Roos and Reccius

In the present study, we understand the analyzed narratives about GE as collective narratives according to Roos and Reccius (2021).

First and second, narratives about GE are likely sense-making stories. Specifically, we assume here that the narratives that people provide to justify their position towards GE are sense-making stories that put a complex new technology into context. This helps people to evaluate its relationship with their own belief system. Third and fourth, we assume that the analyzed narratives are collective, evolved through social interaction. Specifically, they are shared by large proportions of the German public and likely emerged and spread through the public debate about GE that started in the late 1980s, early 1990s. Fifth, we assume that the analyzed narratives about GE suggest actions with significant economic impact. Specifically, we assume that they lead people to diverging regulation preferences, i.e. supporting versus opposing GE. Moreover, the widespread GE opposition in Germany has an enormous economic impact, not only in Germany, but also in other countries that are politically or economically dependent on Germany, e.g. for export and import. While we are not aware of a study investigating this for the German crop market specifically, Biden et al. (2018) estimated the opportunity cost due to the delay of the GE canola adoption in Australia between 2004 and 2014 to be over 300 million US Dollars. Similarly, van Eenennaam et al. (2021) estimated the opportunity costs of regulatory delay for GE livestock to amount to several billions of Dollars. Another example is provided by Qaim (2020) who argued GE techniques would be crucial for ensuring sufficiently high levels of food production that is both more diverse and environmentally friendly.

Because of the enormous impact of GE regulations on human welfare, the environment, and the economy, we wanted to better understand the sense-making stories people use to justify their regulation preferences towards GE. As mentioned earlier, moral beliefs are particularly stable. We therefore focused on the moral foundations that people's sense-making stories are based on, and how those of GE supporters differ from those of GE opponents.

Understanding the Narrative Selection about GE as Motivated by Personal Belief Systems

In accordance with Roos and Reccius (2021), we assumed here that people are attracted to those narratives that concur with their belief system. Similarly, Eliaz and Spiegler (2020) and Eliaz et al. (2022) also based their analyses on the idea that people's reasoning for following a

certain narrative is motivated. For example, Eliaz and Spiegler (2020) focused on voting behavior, proposing that people select the narrative that "maximizes anticipatory utility" if it is credible (p. 3768). Similarly, Benabou et al. (2020, p. 36) theorized that motivated reasoning is a decisive factor for the attractiveness of certain moral narratives.

Based on the understandings of Roos and Reccius (2021), Eliaz and Spiegler (2020), and Eliaz et al. (2022), we also assumed that people's narrative selection is motivated. Specifically, following Roos and Reccius (2021) more closely, we assumed that people are drawn to *confirming* narratives, i.e. those that confirm intuitively held mental models and moral sentiments. We relate this assumption to the literature on confirmation bias, which provides evidence about a psychological mechanism in which people tend to interpret phenomena in ways that agree with their previously formed beliefs and expectations (see for example Nickerson, 1998). It is easier to make sense of the world if observed events concur with people's mental models about these events.

For example, someone who is very open towards new technological developments and believes that technological progress generally brings social development and wellbeing, will likely be more attracted to the narrative that GE brings technological progress and social development. Chances are that this person will support GE. Similarly, someone who is generally distrusting of large corporations and perceptive of potential power abuse, will likely be more drawn to a narrative that points out potential power abuse and manipulation in relation to GE. Chances are that this person will oppose GE.

The idea that people are drawn to such narratives that confirm preexisting beliefs is also supported by the literature on motivated reasoning (see for example Druckman & McGrath, 2019; Epley & Gilovich, 2016; Kunda, 1990) and post hoc rationalization of quick and effortless judgments (see for example Kahneman, 2011; Pennycook & Rand, 2019). For example, Haidt proposed that moral intuitions can guide moral judgment, e.g. about a technology, and related reasoning then serves to justify this intuition (Haidt, 2001; Ditto et al., 2009).

Thus, following the understanding of confirmation bias and motivated reasoning in the literature, we assume that people are drawn to such narratives about GE that confirm what they already tend to believe.

Moreover, as mentioned above, because moral beliefs can be powerful drivers in polarization, we propose that new helpful insights can be generated when identifying the moral foundations of narratives about GE, as well as potential conflicts between them. Particularly, we propose to systematize the moral foundations that underlie narratives about GE according to Haidt's and colleagues' Moral Foundations Theory (Haidt, 2012; Graham, Haidt & Nosek, 2009; Graham, Nosek, Haidt, Iyer et al., 2011; Iyer et al., 2012). In the following, we provide an overview of this theory.

Moral Foundations Theory

For analyses of polarized topics, Moral Foundations Theory (MFT) has been widely applied in moral psychology and related fields. This theory, developed by Jonathan Haidt and his colleagues, aims to describe and explain why individuals and groups sometimes differ in what they perceive to be morally right or wrong (Koleva et al., 2017). MFT is built on extensive empirical findings across different cultures, suggesting that the human moral landscape consists of six moral foundations: Care, Fairness, Loyalty, Authority, Liberty, and Sanctity (Haidt,

2012; Graham, Haidt & Nosek, 2009; Graham, Nosek, Haidt, Iyer et al., 2011; Iyer et al., 2012; Haidt & Joseph, 2004).

Distinguishing a broader range of six moral foundations extends previous accounts of morality limited to concerns of harm and fairness (Iyer et al., 2017; Graham et al., 2011). Thus, MFT extends western philosophical traditions and better reflects empirical findings across non-western cultures (Graham et al., 2018; Graham et al., 2009). For example, some emphasize the well-being of the group rather than the individual (Haidt, 2008; Haidt, 2007; Graham et al., 2009; Shweder et al., 1987; Shweder et al., 1997). With this broader picture of human morality, MFT has more explanatory power than assuming moral monism (see for example Graham et al., 2018).

MFT has proven robust for a variety of international data sets (Graham et al., 2011). It matches research on virtues in fields such as anthropology, psychology, evolutionary biology and philosophy across cultures (Haidt & Joseph, 2004). Examples can be found in research on collectivism (for example Triandis, 1995), or egalitarianism (Arts & Gelissen, 2001).

Moral Emotions Related to Moral Foundations

The six moral foundations provide moral intuitions and emotions about perceived social activities and thus guide judgments about right or wrong (Graham et al., 2018; Iyer et al., 2012; Graham et al., 2009; Haidt, 2001; Haidt & Kesebir, 2010). This means that upon observing a socially relevant behavior or event, people intuitively feel a moral emotion that is related to one or more moral foundations. These emotions signal whether a moral foundation has been violated or catered to. Depending on this signal, a person is then motivated to a respective moral judgment or behavior. For example, a parent of small children could read in a newspaper article that GE foods are suspected to cause cancer. The parent might immediately experience fear and worry about their children's health. Here, the Care foundation would be addressed (see for example Chapter 2). The intuitive emotion of fear would signal to the parent that this foundation is violated. This might then motivate the parent to judge GE food as “not good” and vote for a ban of GE.

The role of moral emotions for narratives in economics has also been addressed by Roos and Reccius (2021) who argued, similar to MFT, that the feelings people experience in relation to a moral narrative serve as a signal of the evaluation of a set narrative, and consequently motivate action.

Brief Description of the Moral Foundations

According to MFT, the six foundations are activated when observing or experiencing socially relevant issues:

- Care is triggered by concerns of well-being, health and protection. Moral emotions related to Care are compassion, sympathy, or fear.
- Fairness is triggered by concerns of mutual beneficial cooperation, e.g. through following rules which involved parties voluntarily agreed on. Moral emotions related to Fairness are for example pleasure, liking, gratitude, anger, or contempt.
- Loyalty is triggered by concerns of uniformity, solidarity, and a voluntary subordination of each member below group cohesion. Moral emotions related to Loyalty are pride, trust, or distrust.

- Authority motivates voluntary subordination to an individual that is perceived as a legitimate leader. Moral emotions related to Authority are feelings of respect, admiration, or obedience.
- Liberty is concerned with detachment and individualism, and is triggered by strong emotional reactions to limits to personal freedom and autonomy.
- Sanctity motivates distance from pathogens, and motivates self-control with regards to norms, traditions, religions, or cultural norms. The typical moral emotion of Sanctity is disgust.

Moral Foundations Theory to Identify Conflicting Moral Narratives

MFT provides a systematic template for identifying moral structures and clashes of moral foundations. This is particularly useful for identifying moral sources of conflicts in polarized debates (see for example Enke, 2020; Haidt & Graham, 2007; Amin et al., 2017).
Consequently, applying MFT to narratives about GE promises to yield similarly insightful findings. Here, we built on the concept to qualitatively identify latent moral foundations in text, developed in Chapter 2. This allowed us to determine the latent moral content in narratives about GE. We represent these moral narratives as directed acyclic graphs (DAGs), as explained in the following.

Representing Narratives and their Moral Foundation as Directed Acyclic Graphs

Recall that in the economics literature, narratives are generally described as a relationship between several factors. In most cases, this relationship is assumed to be causal. Spiegler (2016) and Eliaz and Spiegler (2020) proposed to represent this relationship as directed acyclic graphs (DAGs). This proposition is built on work about causal inference by Pearl (2009) and Sloman (2005). We largely adopt this strategy as described in the following.

Spiegler (2016) assumed a decision maker with a von Neumann-Morgenstern utility function. In the attempt to maximize their utility function, the decision maker consults the probabilities of a set of variables, as well as their relationships. However, since the decision maker is non-rational and has imperfect information, their perceptions about the observations, their probabilities, and their relationships may be flawed. We thus only speak of *perceived* knowledge. Note that Spiegler (2016) thus interpreted these as subjective beliefs, possibly derived from a misspecification of facts. The decision maker relies on these beliefs to, for example, evaluate specific policy options (Eliaz & Spiegler, 2020, p. 3787), e.g. to prefer an adoption or ban of GE.

This subjectivity assumption is in line with Roos and Reccius (2021), who proposed that narratives need to connect to a decision maker's belief system in order to be adopted by them. Importantly, this also means that "[d]ifferent narratives will typically generate different political beliefs because they manipulate correlations between different sets of variables" (Eliaz & Spiegler, 2020, p. 3788).

According to Sloman et al. (2009) and Roos and Reccius (2021), this belief is then normatively evaluated against an ideal causal moral model. In our present study we assume that this ideal moral model consists of the moral foundations. If a decision maker holds a narrative that suggests that a moral foundation is violated, the decision maker will oppose GE. If, on the contrary, a decision maker holds a narrative that suggests that a moral foundation is catered to, the decision maker will support GE.

Spiegler proposed to characterize this perceived set of variables and their relationship as directed acyclic graphs (DAGs). According to Spiegler (2016, p. 2) "[a] directed graph is defined by a set of nodes and a set of directed links between nodes. The graph is acyclic if it does not contain any directed path from a node to itself".

For example, in our study, a DAG *N* can look like this:

N: GE → risks for human health → decision maker opposes GE.

The relationships between these variables are modeled as a Bayesian network (e.g. Spiegler, 2016; Eliaz & Spiegler, 2020; Macauley & Song, 2022).

Eliaz and Spiegler (2020, pp. 3788-3789) assumed that these networks are "simplified causal networks". However, while DAGs based on Bayes' network *can* encompass causal relationships, they do not necessarily do so. More specifically, according to Spiegler, these Bayes' networks are representations of a person's (mis)perception of the *probabilities of dependence* between events, i.e. correlations. However, scholars of narrative economics, e.g. Spiegler (2016), Eliaz and Spiegler (2020), Akerlof and Snower (2016), proposed to interpret narratives as causal relationships. Researchers, such as Eliaz et al. (2022), Andre et al. (2022) or Macaulay and Song (2022) have adopted this interpretation.

In the literature, several reasons are provided for this. Andre et al. (2022, pp. 4-5) argue that understanding narratives as causal accounts "is in line with a broad theoretical literature on causality and causal inference (Ellis and Thysen, 2021; Olea et al., 2021; Pearl, 2009; Spiegler, 2020a,b, 2021)." Both Eliaz and Spiegler (2020) and Spiegler (2016) referred to Pearl (2009) and Sloman (2005), who proposed a causal interpretation. All three, i.e. Spiegler (2016), Eliaz and Spiegler (2020) and Andre et al. (2022) also referred to understandings in the psychology literature (Andre et al. 2022, p. 6): "Similarly, psychologists have argued that causality is at the core of narratives (Pennington and Hastie, 1992; Sloman and Lagnado, 2015; Trabasso and van den Broek, 1985)".

We think that our survey data may best be interpreted according to the differentiated understanding of Roos and Reccius (2021) who proposed that narratives are just an excerpt of a more complex reasoning. While in most cases, the narratives provided by the respondents can be interpreted as causal models, they still provide only a snippet of their thought structure that does not make a potential causality explicit. However, it is safe to say that respondents see a dependence between GE and the justifications they provided for their position. For the purpose of the present work, it is thus useful to represent narratives about GE as DAGs, but unnecessary to go as far as to assume causality, so we rather stick with this more conservative approach.

More specifically, in the present study, we made the identifying assumption that GE attitude is the outcome variable, dependent on moral narratives that the decision maker finds most convincing. That is, we assumed a decision maker has the options to decide whether to support or oppose GE. In order to do so, they consult what they know in relation to GE.

We thus explored the narratives that people use to justify their attitude towards GE. We employed Spiegler's approach to DAGs as probabilistic representations of dependence among a (potentially misspecified) set of options. Specifically, we looked at the frequencies of employed DAGs related to GE across a representative German sample, organized according to their addressed moral foundation.

In this, genetic engineering leads to, or is related to, a specific event. This event is normatively evaluated based on whether an underlying moral foundation is violated or catered

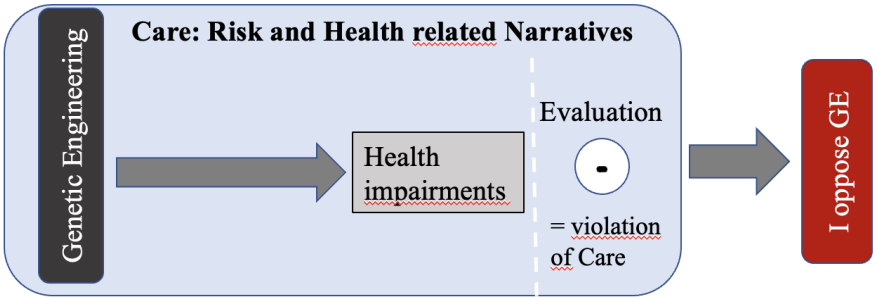
to. Based on this evaluation, GE is either supported or opposed. Here, the narrative structure is as follows:

N: GE → consequence/related event → normative evaluation → resulting GE attitude.

For example, a decision maker may hold the belief that the consumption of GE food can lead to health impairments, e.g. cancer. Health concerns address the moral foundation Care. Thus, the narrative gets evaluated against the Care foundation. Because health impairments harm life and health of an individual, they constitute a violation of the moral foundation Care. Thus, the result of the evaluation is negative, and the decision maker opts to oppose GE. Adapted from Andre et al. (2022), Macaulay and Song (2022), and Eliaz and Spiegler (2020), Figure 4.1 illustrates our representation of this health narrative about GE.

Figure 4.1

Representation of GE Narratives as DAG, and Moral Evaluation



Note. The narrative that GE leads to health impairments is evaluated against the moral foundation Care. It is found to violate Care and thus evaluated as negative. As a consequence, the decision maker opposes GE.

The Study

Sample

We conducted an online survey in Germany in August and September 2019. The survey material (in German) as well as a Codebook detailing the included variables are available at https://doi.org/10.7910/DVN/FEC7OL.

The online panel was provided by Gapfish (https://gapfish.com/). This survey was representative for the population in Germany according to age, gender, income, level of education, and region (former east Germany, former west Germany, i.e., *alte* and *neue Bundesländer*, and Berlin). After excluding those participants who did not provide informed consent and stated to be younger than 18, or did not pass the attention check, 619 were included in the analysis. Of those, 49.8% (308) respondents were female and 50.2% (311) were male. The mean age was 44 years, SD = 14. 20% (124) stated an age between 18 and 29, 30.5% (189) stated an age between 30 and 45, 45.7% (283) stated an age between 46 and 65, and 3.7% (23) stated to be between 66 and 69 years old. Of included participants, 14.7% (91) resided in the former "eastern" region (including Berlin), 80,5% (498) resided in the former "western" region, and 4.8% (30) resided in Berlin.

31% stated to earn less than 25,000 € per year, 39.9% stated to earn between 25,000 € and 49,999 €, 17.8% stated to earn between 50,000 € and 69,999€ per year, 8.4% stated to earn between 70,000 € and 99,999€, and 2.9% stated to earn 100,000 € and more per year.

Regarding the latest level of education, 73.3% selected to hold some kind of high school diploma, according to the German schooling system (29.7% "Hauptschulabschluss", 33.9% "Realschulabschluss", 9.7% "Allgemeine Hochschulreife"). 15.7% selected to hold some kind of university degree (University or University of Applied Sciences), 1.8% of respondents selected to hold no degree or other.

Table 4.1 reports on participants' free text responses to the prompt asking about the type of education they received. The answers were coded into groups by a research assistant.

Table 4.1

Type of Education – Coded Free Text Responses

Group	Examples (translated from German)	N
Business	Businessman, Office Clerk, Industrial Clerk	56
IT, Computer, Informatics & Electrical Engineering	Audio engineering, Electronics, Computer Science, Precision Mechanics, Information Processing	49
Media, Publishing, Film	Book Trade, (Digital) Media, Literature	19
Medicine, Nursing	Nursing, Dentistry, Social Work	47
Chemistry, Nutrition	Pharmacy, Chemical Technical Assistant, Bakery, Cook	26
Logistics, Transport	Bus/Truck Driver	23
Metal, Technology	Industry, Road Builder, Mining	36
Gastronomy/Hotel	Hotel Manager, Management	16
Craft	Carpenter, Locksmith, Molder, Office Machine Mechanic	66
Art, Architecture, Construction	Road Construction, Building Trade	15
Services	Florist, Hairdresser, Home Economics, Cosmetics	19
Social pedagogy	Psychology, Social work	8
Education	Teacher, Educator	20
Languages	Literature translation	3
Sports	Sports	2
Textile & Fashion	Clothing, Dressmaker, Leather goods	8
Security	Security Service	2
Administration, Public Service	Accountant, Tax Clerk, Police Enforcement Officer	54
Economy, Finance	Economics, Business Mathematics	45
Agriculture, Livestock	Animal Breeding, Animal Keeper, Horticulture	10
Trade, Sales	Retail, Wholesale	29
Not Interpretable, Nothing	Paderborn, n.A., Nothing	66
Total		**619**

Survey Flow

After providing informed consent, participants were asked for demographic information (gender, age, region, income, degree, type of education) based on the demographic standard items according to Lenzner et al. (2019). Subsequently, participants were asked to state whether they were in favor or against genetic engineering of plants for human consumption (called Green Genetic Engineering) from a binary choice item (adapted from Inbar & Waldhof, 2022). This was followed by four seven-point Likert scale items asking how much participants are interested in GE, how important GE is to them, how much GE means to them, and how relevant this topic is for them for the next federal selection (adapted from Krosnick et al., 1993).

Then, an open text box question asked respondents what they imagine in front of their inner eye when thinking about GE (own measure). Participants could state up to five such subjective images and were asked if they saw each as positive or negative. This was followed by a seven-point Likert scale recording how emotional GE as a topic was for participants (adapted from Krosnick et al., 1993). Subsequently, in randomized order, participants were asked to select from a choice of eight pictures depicting emotions, which emotion they feel

when thinking about GE (Matsumoto & Ekman, 1988). This question randomly alternated in order with another question asking, with seven-point Likert scales, how much they felt those emotions when thinking about GE (adapted from Barrett, 2004). Then, respondents were asked to indicate their grade of agreement with ten Likert-scale (seven-point) statements about regulatory preferences regarding GE in Germany (own measures). These statements addressed: strictness of regulation, field research, laboratory research, research at universities, research for commercial gains, import, export, free consumer choice, and labeling.

Following, participants were asked to write down the causal accounts (narratives) that led them to their previously stated position about GE. Specifically, participants were provided three free-text boxes, in which they could state their main reasons, organized according to personal importance.

Subsequently, participants were provided with the twenty most frequent reasons provided by official organizations in the public GE debate in Germany. These are based on the results of the content analysis described in Chapter 3 and its Appendix, and can be found in Table 3.A.1 and Table 3.A.2 of the "Results" section. Specifically, participants who stated to be against GE were asked to select the three most compelling reasons for their position from a pool of ten opposing reasons. Accordingly, participants who stated to be in favor of GE were asked to select the three most compelling supporting reasons for their position from a pool of ten. At the end of the survey, participants completed an attention check (own measure) and could provide voluntary feedback in a comment box.

Analyses and Findings

Transparency, Openness and Ethical Standards

Data and materials are available at https://doi.org/10.7910/DVN/FEC7OL[11]. Specifically, the file includes the survey materials (in German), participants' descriptions of the narratives and subjective images, the codings of the narratives according to moral foundations, all data for the regression, a codebook explaining all variables, the data for the correspondence analyses, and the code to reproduce the analyses. The questionnaire and methodology for this study was approved by the Ethics committee of the Leibniz Institute of Agricultural Development in Transition Economies (Certificate Reference Number: 03/2019).

Narratives about GE

Deductive Coding Procedure

To collect the narratives that participants used to reason about their attitudes towards GE, we included the following prompt in the survey:

> At the beginning of the survey, you indicated that you tend to have a [supporters: positive] [opponents: negative] view of the application of genetic engineering to crops overall. Can you briefly tell us your most important reasons for this? Please rank your reasons. If you have fewer than three reasons, simply leave the remaining fields blank.

[11] Waldhof, G. (2023). Replication Data for: "Understanding Moral Narratives as Drivers of Polarization about Genetically Engineered Crops". *Harvard Dataverse, V1.* https://doi.org/10.7910/DVN/FEC7OL

Participants gave their answers in up to three free text boxes. Sometimes, respondents provided more than one narrative in a single text box. In these cases, entries were split and listed separately, which is why we have up to four narrative entries for some participants.

The coding procedure of the narratives was based on the methodological principles of content analysis according to Philipp Mayring (2015). This coding procedure is extensively described in the Appendix of Chapter 3.

A research assistant deductively coded participants' responses according to the code systems developed in Chapter 3. These can be found in Table 3.A.1 and Table 3.A.2 of the Appendix section "Results". If a response contained a new narrative that was not addressed in the arguments of the official debate, i.e. not yet included in the tables developed in Chapter 3, the research assistant paraphrased this as an additional narrative. All results of the deductive coding were checked by the first author and amended were necessary.

Based on the seminal literature on Moral Foundations Theory (e.g. Haidt, 2012; Graham et al., 2011; Iyer et al., 2012), Chapter 2 developed a structural approach to identify latent moral foundations in text. This approach identified a unique contribution to a group's structure for each moral foundation. This unique contribution makes the foundations more distinguishable from one another in text. Following this approach, the first author allocated the narratives to the moral foundations. Broadly, the following contents determined the allocation:

- Care: general risks and benefits of GE, health of humans or animals,
- Fairness: behavior of involved actors in relation to rules, laws, and regulations, such as corruption, cheating, law-/rule-breaking,
- Loyalty: concerns of trust, or benefits and disadvantages for society as a whole, i.e, do actors exploit or contribute to social welfare,
- Authority: if narratives recited expert opinions as perceived legitimate authority,
- Liberty: concerns of civil liberties of affected people,
- Sanctity: concerns about nature, contamination, environment protection, biodiversity, or sustainability.

For more information on the applied procedure, see for example Mayring (2015), Chapter 2, and Chapter 3 and its Appendix.

General Results

Of the respondents included in the analysis, 33% (205/619) stated to be in favor of GE, 67% (414/619) stated to be against GE.

In the open text boxes, participants provided a total of 1226 entries. Of those, 1129 could be interpreted as narratives about GE and were coded according to topic and addressed moral foundation. The remainder were entries such as *don´t know*, *don´t care,* or *I cannot provide a reasoning.*

Of all 1129 narrative responses, 780 were provided by GE opponents, and 349 by GE supporters. The following section reports on these entered narratives and their underlying moral foundation.

Moral Foundations Addressed in Narratives

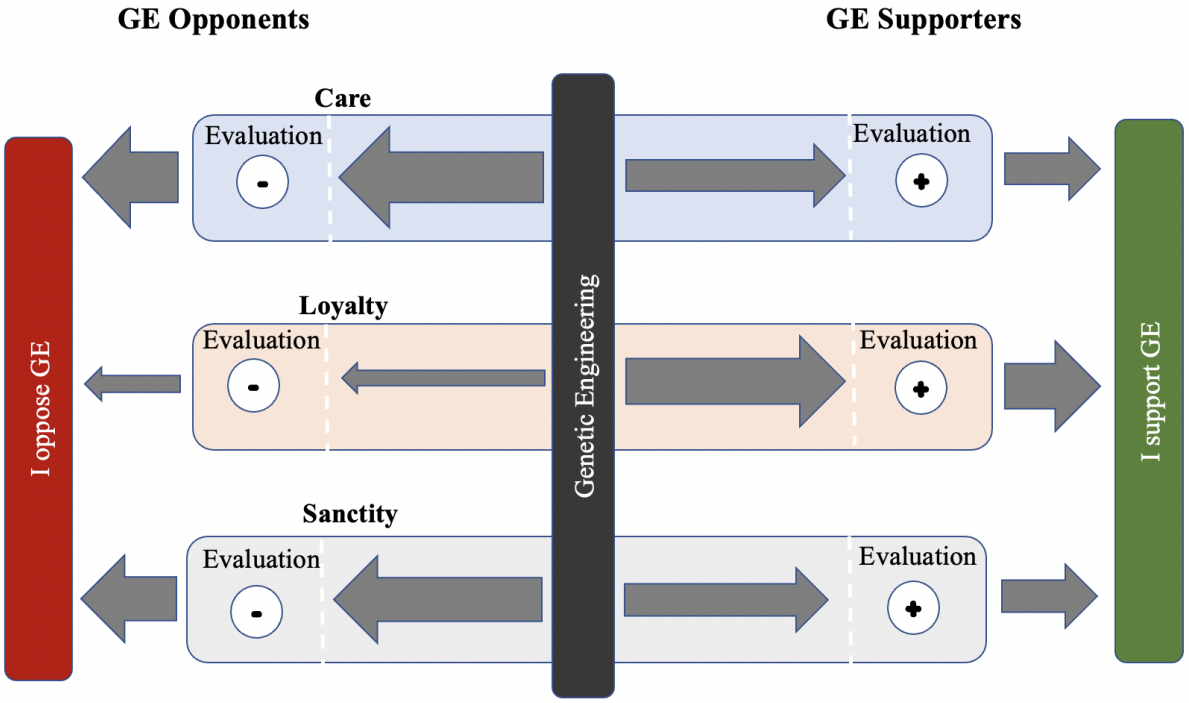
Of all 1129 narrative entries, Care is the most prominent moral foundation, being addressed in 40% (450/1129) of the narratives. Sanctity was addressed in 36% (406/1129) of all narratives. Loyalty was addressed in 23% (259/1129) of all narratives. The other three moral

foundations according to MFT, i.e. Fairness, Authority, and Liberty, were not relevant to respondents. They were addressed in less than 1% of all narratives (Fairness: five times, Authority: never, Liberty: nine times).

While opponents focused most on Care – this foundation was addressed in 45% (351/780) of their narratives –, supporters focused most on Loyalty – in 41% (142/349) of their narratives. Sanctity was much more prominent among opponents, being addressed in 39% (306/780) of all their narratives. Contrary to that, Sanctity was addressed 29% (100/349) of the time by supporters. Care was addressed in 28% (99/349) of supporters' narratives; and Loyalty in 15% (117/780) of opponents' narratives. Figure 4.2 illustrates the relative frequencies of moral foundations in the narratives as DAGs.

Figure 4.2

Relative Frequencies of Moral Foundations addressed in Narratives about GE, represented as DAGs



Note. Arrow-thickness represents the relative frequencies of moral foundations addressed in narratives. Narratives get evaluated against the addressed moral foundation. If a narrative violates a moral foundation, the result is a negative evaluation and a rejection of GE. If a narrative caters to a moral foundation, the result is a positive evaluation and support of GE. The foundations Fairness, Liberty, and Authority (according to MFT) are not shown because they were addressed in less than one percent of the narratives.

Topics Addressed in Narratives

While opponents and supporters mentioned similar broad topics, such as health, environment protection, or necessity, the resulting causal evaluations are quite different. For example, both supporters and opponents addressed health as a factor in their narrative leading to their GE attitude. However, while opponents stated that GE leads to health impairments and they thus oppose the technology, supporters stated that GE leads to health benefits and they thus support GE. Table 4.2 and Table 4.3 provide an overview of the narratives and their frequencies, organized according to the addressed moral foundation. Both tables also include

examples translated into English, as well as their German original in parentheses. Grammatical errors and misspellings are left as entered into the survey by respondents.

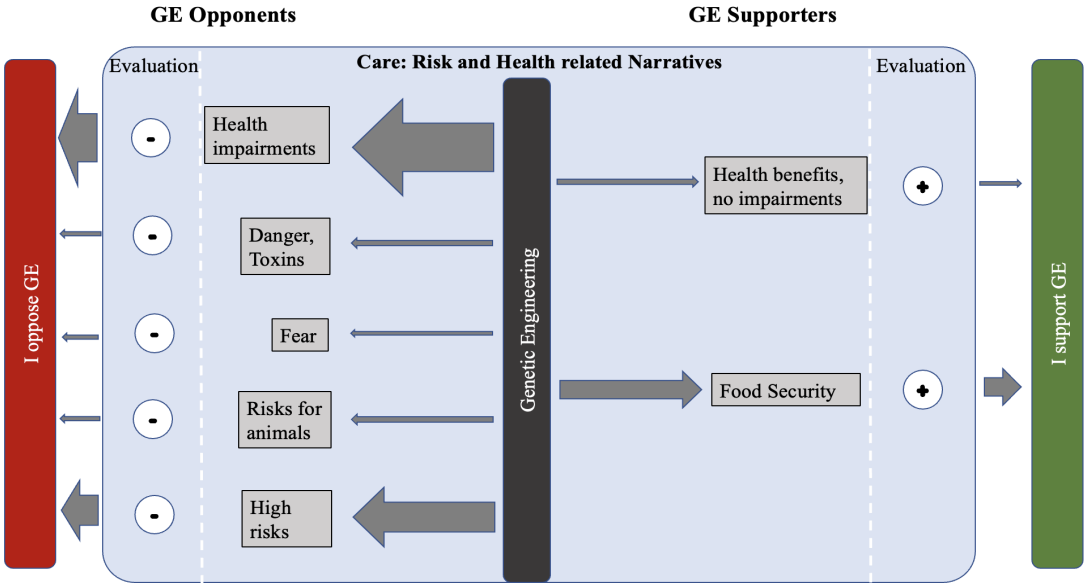
In the following, narratives are reported if they have been addressed at least 10 times. Figures 4.3 to 4.5 illustrate these narratives as directed acyclic graphs (DAGs), clustered according to the addressed moral foundations and topics.

Within the moral foundation Care, people stated risk and health-related narratives. For opponents, health impairments were the most frequently stated reason to reject GE overall (23%; 179/780), for example "unhealthy", or "cancer risk". The second most frequent reason to reject GE was that GE brings high risks as a technology (14%; 111/780), for example "incalculable risks", "unpredictable intervention". Also, within the Care foundation, opponents mentioned risks for animals (3%; 21/780), e.g. "cruelty to animals", general danger (3%; 20/780), e.g. "it is dangerous", and fear (2%; 13/780), e.g. "fear" as reasons for their opposition.

On the supporters' side, respondents stated health benefits as a reason for their GE support (6%; 20/349), e.g. "healthier crops", "healthy". Even more frequently, they stated that GE supports food security (20%; 68/349), e.g. "sufficient staple food", "end famine".

Figure 4.3

Narratives mentioned within the Care foundation, represented as DAGs



Note. Arrow-thickness represents the relative frequencies across *all* narrative-mentions in the survey responses. This usually results in thinner arrows for supporters because the number of self-proclaimed GE supporters is smaller than the number of self-proclaimed GE opponents.

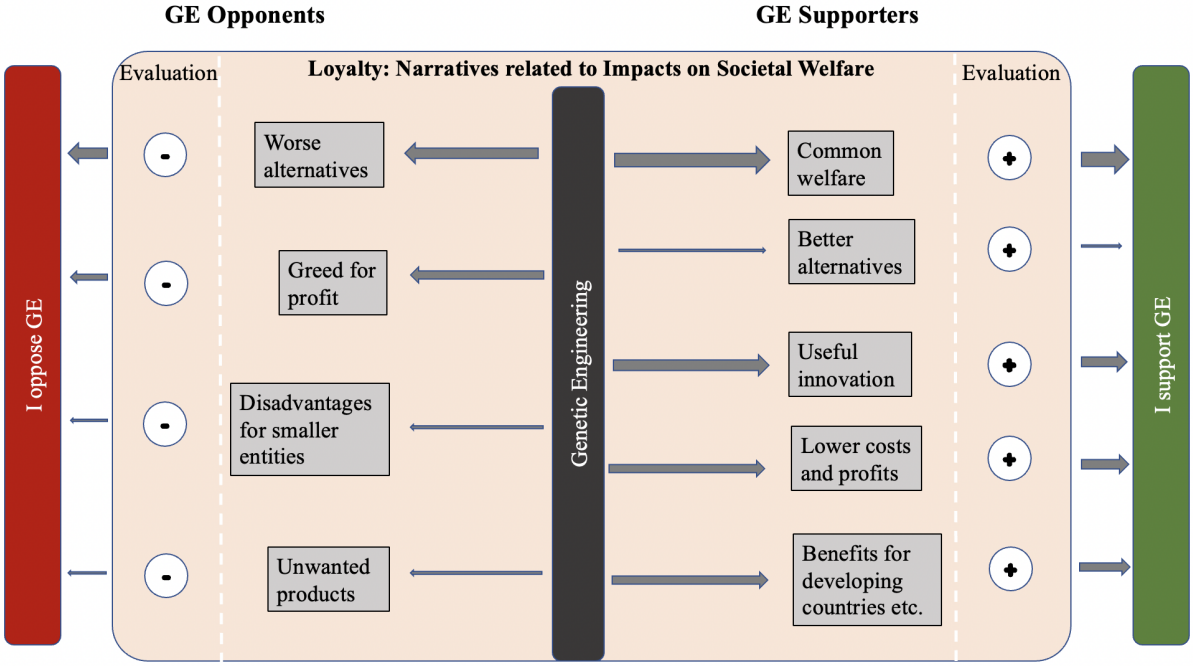
Within the moral foundation Loyalty, participants addressed impacts on general societal welfare. Among supporters, the narrative of general common welfare through useful traits of GE was very common (13%, 44/349), e.g. "quality", "effectiveness". Supporters often mentioned the narrative that GE brings benefits for developing countries and farmers (7%, 26/349), e.g. "more yield for farmers". Also, mentioning lower costs and profits was very common (7%; 26/349), e.g. "profitable". Also, supporters often mentioned that they approve of GE because they promote research and innovation (10%; 35/349), e.g. "important for future", "technological progress", and because they see GE as the better alternative (3%; 10/349), e.g.

"is already used today in an untargeted way by 'crossbreeding', genetic engineering is much more precise in this respect".

Contrary to that, opponents stated within the Loyalty foundation that they oppose GE because they were unnecessary (5%; 39/780), e.g. "unnecessary", "nonsensical", or not wanted (2%; 16/780), e.g. "I would not buy". Also, opponents stated that GE were only used for commercial gains (4%; 28/780), e.g. "profiteering", "money-making at the expense of health" and brought disadvantages for smaller entities (such as small farmers) (1%; 10/780), e.g. "the farmers have more work".

Figure 4.4

Narratives mentioned within the Loyalty foundation, represented as DAGs



Note. Arrow-thickness represents the relative frequencies across *all* narrative-mentions in the survey responses. This usually results in thinner arrows for supporters because the number of self-proclaimed GE supporters is smaller than the number of self-proclaimed GE opponents.

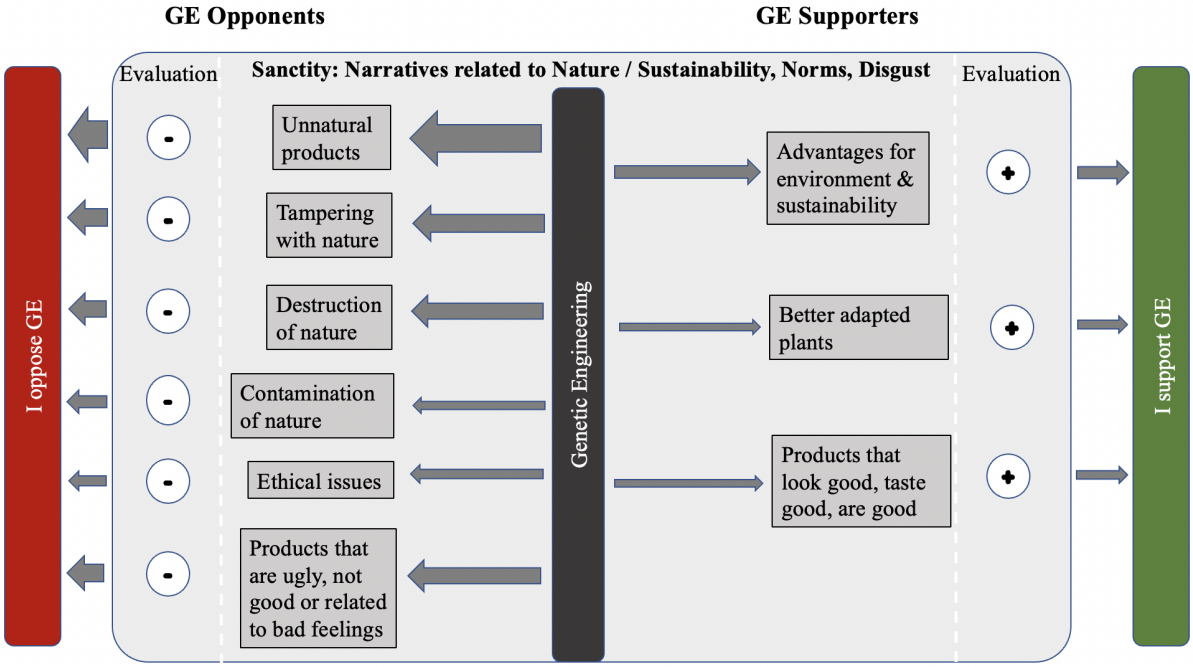
Within the moral foundation Sanctity, issues related to nature and sustainability were addressed. To Sanctity also belong narratives related to norms, disgust or a general good or bad feeling. Opponents frequently stated here that GE are unnatural (11%; 89/780), e.g. "unnatural", "against nature", and a tampering with nature (7%; 57/780), e.g. "intrusion in nature". Opponents also stated the risk of destroying nature through GE (7%; 52/780), e.g. "unpredictable consequences for nature", "harms the environment" or the contamination of nature (4%; 28/780), e.g. "contamination of the soil", "genetic engineering leads to more poison on fields". Some mentioned ethical issues with GE (3%; 27/780), e.g. "unethical", "plants are not toys!". Other narratives provided by opponents were that GE are disgusting, ugly, not good, or are related to bad feelings (7%; 52/780). Examples are "have a bad feeling", "disgusting", "ugly", and "gene manipulation is generally not good".

Supporters quite often stated that GE does not lead to risks but advantages for environment, sustainability or biodiversity (12%; 43/349), e.g. "preservation of nature by planting new trees", "greater biodiversity". Supporters also mentioned the narrative that GE are

better adapted to the environment than conventional breeds (8%; 28/349), e.g. “make drought land flourish again”. Some mentioned that they support GE because they look, taste, or are good (7%; 24/349), e.g. “looks better”, “more flavorful fruits”, “is good”.

Figure 4.5

Narratives mentioned within the Sanctity foundation, represented as DAGs



Note. Arrow-thickness represents the relative frequencies across *all* narrative-mentions in the survey responses. This usually results in thinner arrows for supporters because the number of self-proclaimed GE supporters is smaller than the number of self-proclaimed GE opponents.

Table 4.2

Coded Narratives of GE Opponents with Examples and Frequencies, Organized According to Addressed Moral Foundations

MFT	Paraphrased Narratives Opponents (n = 780)	Examples *(with German original)*	N
Care 45% (351)	Health impairments	"Unhealthy", "cancer risk" *("Ungesund", "Krebsrisiko")*	179
	High-risk technology	"Incalculable risks", "unpredictable intervention" *("Nicht kalkulierbare Risiken", "Unabsehbarer Eingriff")*	111
	Risks & disadvantages for animals	"Cruelty to animals" *("Tierquälerei")*	21
	Danger, toxic (for humans)	"It is dangerous" *("Es ist gefährlich")*	20
	Fear	"Fear" *("Angst")*	13
	Gaps in regulation are a threat to humans	"Lack of control mechanisms" *("Kontrollmechanismen fehlen")*	7
Fairness 1% (5)	Involved actors break rules of competition (e.g. corruption)	"Unseriousness", "the controls do not work anyway because the food lobby works against it to gain more profit" *("Unseriösität", "die kontrollen,funktionieren,doch,eh nicht,weil die lebensmittel lobby dagegen arbeitet,um mehr profit zu erlangen")*	5
Loyalty 15% (117)	GE are not necessary, there are better alternatives	"Unnecessary", "nonsensical" *("Unnötig", "Unsinnig")*	39
	GE are a symptom of greed for profit, only benefit large corporations	"Profiteering", "money-making at the expense of health" *("Profitgier", "Geldmacherei auf kosten von Gesundheit")*	28
	Consumers don't want GE	"I would not buy" *("Würde ich nicht kaufen")*	16
	Disadvantages for smaller entities	"The farmers have more work" *("Die Bauer haben mehr Arbeit")*	10
	Insufficient knowledge, test on GE	"Not yet properly researched" *("Noch nicht richtig erforscht")*	7
	Nobody informs the public	"Ignorance of customers", "the end user is not informed enough" *" (Unwissenheit von Kunden", "Der Endverbraucher wird nicht genug informiert")*	7
	High costs without benefits	"Too expensive", "high costs" *("Zu Teuer", "Höhe Kosten")*	3
	Irresponsible treatment of common goods, broken promises	"Economy and politics are not able to act responsibly", "no promises fulfilled" *("Wirtschaft und Politik sind nicht in der Lage verantwortlich zu handelm", "erfüllt keine Versprechen")*	5
	GE don't contribute to societal welfare	"Unsocial" *("unsozial")*	2
Authority 0% (0)			0
Liberty 0% (1)	Oppression of civil liberties	"Power of corporations" *("Macht der Konzerne")*	1
Sanctity 39% (306)	Unnatural	"Unnatural", "against nature" *("Unnatürlich", "wider der Natur")*	89
	Tampering with nature	"Intrusion in nature", "intrusion in the biosphere" *("Eingriff in die Natur", "eingriff in die biosphäre")*	57

	Risk of destroying nature, threat to biodiversity, sustainability, GE cause resistancies	"Unpredictable consequences for nature", "harms the environment", "resistant pests" *("Unberechenbare Folgen für Natur", "Schadet der Umwelt", "resistente Schädlinge")*	52
	Ethical issues, Interference in god´s creation	"Unethical", "plants are not toys!", "playing God" *("Unethisch", "Pflanzen sind kein Spielzeug!", "Gott spielen")*	27
	GE are not good, you don´t do that	"Gene manipulation is generally not good" *("Gen Manipulation finde ich im allgemeinen nicht gut")*	17
	GE contaminate nature, risk of unintended mutations, Chemistry/ Pesticides/ toxics in nature	"Contamination of the soil", "chemistry", "GE leads to more poison on fields" *("Verseuchung vom Boden", "Chemie", "Gentechnik führt zu mehr Gift auf Feldern")*	28
	Bad feeling	"Bad feelings", "have a bad feeling" *("Schlechte Gefühle", "habe ein ungutes Gefühle")*	14
	Ugly, taste bad	"Ugly", "taste bad" *("Hässlich", "schmeckt nicht")*	11
	Disgusting	"Disgust", "disgusting" *("Ekel, "Ekelhaft")*	10
	Climate	"Climate" *("Klima")*	1

Table 4.3

Coded Narratives of GE Supporters with Examples and Frequencies, Organized According to Addressed Moral Foundations

MFT	Paraphrased Narratives Supporters (n = 349)	Examples *(with German original)*	N
Care 28% (99)	GE contribute to food security	"Sufficient staple food", "end famine" *("Ausreichend Grundnahrungsmittel", "Hungersnot beenden")*	68
	Health benefits & no evidence for health impairments	"Healthier crops", "healthy", "healthier for people" *("Gesündere Pflanzen", gesund", "Gesünder für Menschen")*	20
	Not a high risk technology, no problems	"Controllable", "more accurate calculations and control over quality", "don't see any problems" *("Kontrollierbar", "Genauere Kalkulationen und Kontrolle über die Qualität", "sehe keine Probleme")*	6
	No higher risks for animals; advantages for animals	"Feed for animals" *("Futter für Tiere")*	5
Fairness 0% (0)			0
Loyalty 41% (142)	GE contribute to common welfare (successful endeavor), e.g. useful traits, promising potential	"Quality", "effectiveness", "new better plants can always be developed" *("Qualität", "Effektivität", "Es können immer neue bessere Pflanzen entwickelt werden")*	44
	GE yield lower costs and profits	"Profitable", "more yields possible" *("Profitabel", "mehr Erträge möglich")*	26

	GE research (and patents) promotes useful innovation	"Progress", "better medicine", "important for future", "Technological progress" *("Fortschritt", "bessere Medizin", "Wichtig für Zukunft", "technologischer Fortschritt")*	35
	Benefits for developing countries, small farmers, farmers, consumers, companies	"More yield for farmers" *("Mehr Ertrag für Bauerns")*	26
	GE is necessary and the better alternative	"is already used today in an untargeted way by 'crossbreeding', genetic engineering is much more precise in this respect" *("wird durch 'Kreuzen' heute schon ungezielt angewendet, Gentechnik ist da viel genauer")*	10
	World peace	"World peace" *("Weltfrieden")*	1
Authority 0% (0)			0
Liberty 2% (8)	GE do not interfere with freedom of choice but enable more freedom for farmers	"People who need it", "free market economy" *("Menschen die das benötigen", "Freie Marktwirtschaft")*	8
Sanctity 29% (100)	There is no higher environmental risk of GE compared to conventional breeding, but there are advantages (e.g. less pesticides)	"Preservation of nature by planting new trees", "development of healthy plants", "more environmentally friendly", "less use of pesticides" *("Erhaltung der Natur durch Pflanzung neuer Bäume", "Entwicklung gesunder Pflanzen", "umwelt freundlicher", "Weniger Einsatz von Pestiziden")*	26
	Is good, perfection, my opinion	"Is good", "perfection", "my opinion" *("Ist gut", "Perfektion", "Meine Meinung")*	15
	GE do not threat biodiversity/ sustainability, but support it	"Greater biodiversity", "extinction of plant species is prevented", "sustainable" *("größere Artenvielfalt", "Aussterben der Pflanzenarten wird verhindert", "nachhaltig")*	17
	GE are (better) adapted to the environment than conventional breeds	"More independent of weather", "can thrive in drought food", "make drought land flourish again" *("Vom Wetter unabhängiger", "Kann in dürre Lebensmittel gedeihen lassen", "Dürre Land wieder aufblühen lassen")*	28
	(healthy) appearance, taste, natural	"More flavorful fruits", "healthy appearance", "looks better" *("Geschmackvollere Früchte", "gesundes Aussehen", " Sieht besser aus")*	9
	Adoption to climate change	"Good for adapting to climate change" *("gut geeignet", "um sich an den Klimawandel anzupassen")*	5

Discussion

Our general attitude measure confirmed previous findings of a widespread GE opposition in Germany (e.g. Inbar & Waldhof, 2022; Freitag, 2013; Zwick, 1998; Kennedy & Thigpen, 2020; BfR, 2022). Moreover, as could be expected, the narratives of GE opponents contained negative consequences of GE, while the narratives of GE supporters contained positive consequences of GE. The fact that the majority of respondents seemed so attentive to negative narratives about GE accords with research on negativity bias that argues that negative information is much more impactful for human sense-making (see for example Vaish et al., 2008; Soroka et al., 2019; Pinker, 2018).

In general, the stated narratives most frequently addressed the Care foundation. This is mainly due to the heavy focus on general risks and health risks by opponents. A potential explanation for this provides an own unpublished pilot study, in which we found that GE opponents show significantly more risk aversion than do GE supporters. The finding is also in line with previous research on GE attitude that emphasized risk and benefit perceptions as a factor of GE attitude (see for example Yue et al., 2015; Siegrist, 1999; Lee et al., 2018). At the same time, while Care was the most frequently addressed foundation among opponents, it was only the third most frequent foundation among supporters.

The moral foundation Sanctity is highly relevant for opponents, being addressed second most frequently. As suggested by Scott et al. (2016), concerns of nature and naturalness are particularly important to GE opponents – and indeed, according to our analysis, these constitute a decisive part of opposing narratives within the Sanctity foundation. In particular, many opponents stated that they find GE to be unnatural, which is in line with findings by Hoogendoorn et al. (2021). Moreover, Scott et al. (2018) theorize that GE are perceived as unnatural because they are made by humans, i.e. through human interference. Indeed, many opposing narratives addressed a potential *intrusion in nature* and related ethical issues. These findings confirm work by Rozin (2005) who proposed that not the characteristics of a product but its process of creation is relevant for people's evaluation of whether it is considered (un)natural.

This also means that people who reject GE because they are made by humans will not be open to potential benefits of the technology because they reject their development per se.

Moreover, in line with research by Scott et al. (2016) who found that GE opposition is related to disgust sensitivity, opponents in our study also referred to GE as "disgusting" or "ugly".

At the same time, within the Sanctity foundation, naturalness was not among the topics addressed in supporting narratives. Rather, supporters often stated potential benefits of GE for the environment, or that GE would be better adapted to the environment. Potentially, naturalness is not a relevant category for evaluation among supporters.

Loyalty was the most frequently addressed foundation among supporters and third most frequent among opponents. In this foundation, narratives addressed the question of whether the technology is generally useful for society. Interestingly, previous research on GE attitude suggested that trust in related actors and institutions is a decisive factor (Siegrist, 1999; Siegrist, 2000; Kajale et al., 2015; Kimenju et al., 2008; Yue et al., 2015). This is also how the official public debate in Germany is conducted (see Chapter 3), i.e. official representatives use many ad hominem arguments, appear to discredit their opponents and compete for trust by the public.

Many examples by official representatives refer to company greed, or exploitation by "big players" or a general market skepticism.

However, this is not reflected in the narratives that respondents stated, which only rarely indicated trust as being relevant for their reasoning. Similarly, topics such as market skepticism or greed and exploitation by large corporations were irrelevant in the narratives that respondents mentioned.

Furthermore, it is striking that narratives addressing the Loyalty foundation were so predominant among supporters, taking up 41% of all narratives mentioned. These mainly addressed general welfare as well as benefits for developing countries. Even within the Care foundation, supporters most often stated the narrative that GE helps to combat famine – a cause of which, as residents in Germany, they are likely not affected by directly.

Taking the narratives together, it seems as though respondents agreed that they would not see personal benefits through the use of GE in plants. If they saw advantages, then these were perceived to benefit others, seemingly those in poorer countries. Even such supporting narratives that stated scientific progress, beneficial traits, and innovation, were quite general and without a hint to potential beneficiaries. These narratives may seem to signal a general optimism and technology openness rather than being directly related to GE.

Interestingly, some narratives referred to causal relationships for which a potential link to GE as a technology is actually not direct, or may even be reversed. Take the example of potential intoxications of the soil due to pesticides. Some media outlets and NGOs reported that farmers had overused pesticides on fields where pesticide-resistant GE plants are grown (see for example Greenpeace, 2011). In this example, such an overuse would be caused by the behavior of farmers and not by the technology directly. Moreover, agricultural economists and natural scientists report that GE plants can lead to a *reduction* of pesticide use (Klümper & Qaim, 2014). This would even reverse the relationship between GE and pesticide use.

Another example is a potential abuse of GE products by large corporations to increase their market power at the expense of the common good. Here also, the technology is not bad per se, but is used in a way that is detrimental to society.

Moreover, respondents sometimes did not state causes or reasons but more so personal impressions or emotions. Examples are mentions that GE would be "ugly", "disgusting", "perfection", "looks better" or evoke "bad feelings". Such entries can be seen as indicators that GE attitudes are at least partly based on emotional intuitions and gut feelings.

Correspondence Analyses

Recall that respondents were provided three free text boxes to enter the narratives that led them to their GE attitude. These were coded according to content and moral foundation. In cases in which respondents provided more than one narrative in a text box, entries were split and listed separately as a fourth response. In the present section, we report on co-occurring moral foundations. Therefore, we look at mentioned narratives, as well as responses such as "Don´t know", which were labeled as "nA". For this purpose, we provide the results of correspondence analyses with contingency tables and chi-square tests. These analyses were conducted using the R-package *gmodels* (Warnes et al., 2022).

All except two participants (617/619) provided an entry for the first narrative. A second response was provided by 379/619 participants, a third by 218/619 participants. 12 participants provided a fourth response. Because so few participants provided a fourth narrative, we exclude

this from the analysis. To not lose statistical power while still making use of all the entries provided, we deal with this greatly varying number of entries by running separate chi-square tests: For the first and second entry, the differences in mentions are highly significant ($p = 0.0000$). For the first and third entry, the differences are also highly significant ($p = 0.0000$). For the second and third entry, differences were not significant ($p = 0.4394$). Thus, Table 4.4 and Table 4.5 report on the descriptive results of the co-occurrences of the first and second entry, and of the first and third entry.

Table 4.4

Contingency Table of the First and Second Narrative-mentions

	2nd Narrative						Row Total
1st Narrative	Care	Fairness	Liberty	Loyalty	Sanctity	nA	
Care	**65**	5	2	**39**	**57**	2	170
Fairness	1	1	0	1	0	0	3
Liberty	0	1	1	0	0	0	2
Loyalty	19	6	1	31	23	3	83
Sanctity	**49**	4	0	24	**35**	4	116
nA.	0	0	0	1	1	3	5
Column Total	134	17	4	96	116	12	379

Table 4.5

Contingency Table of the First and Third Narrative-mentions

1st Narrative	3rd Narrative						Row Total
	Care	Fairness	Liberty	Loyalty	Sanctity	nA	
Care	**28**	3	1	20	**39**	2	93
Fairness	1	0	0	0	0	0	1
Liberty	0	0	1	0	0	0	1
Loyalty	13	3	3	17	15	1	52
Sanctity	**26**	0	0	15	**26**	0	67
nA.	0	0	0	0	3	1	4
Column Total	68	6	5	52	83	4	218

In both tables, it stands out that Care and Sanctity narratives most frequently co-occurred. Moreover, Care and Loyalty are among the most frequent co-occurrences between the first and second narrative (Table 4.4).

That most co-occurrences laid among the foundations Care, Loyalty, and Sanctity can be explained by the fact that these are addressed most frequently in general. It also seems plausible that respondents addressed the same foundation in each of their narrative mentions because they may find one topic particularly important, e.g. health or environment protection. However, the co-occurrence between Care and Sanctity is striking. Between the first and second narrative-mentions, Care and Sanctity made up the second and third most frequent contingency; and between the first and third narrative-mentions, they made up the most frequent contingency.

A potential explanation for this is that respondents saw the same underlying cause for their mentioned narratives. For example, if they perceive GE as not normal or unnatural, it can be this deviation from the known, that makes the technology risky, dangerous, unhealthy (Care) as well as detrimental for the environment (Sanctity).

Comparison of Spontaneous Narrative Mentions and Selections

In the survey, one prompt asked participants to select and rank the three most convincing narratives for their own position from a pool of ten for each, supporters and opponents. These provided narratives were based on the content analysis of arguments used by official representatives in the German GE debate in Chapter 3.

In the present study, opponents most frequently ranked "GE plants have disadvantages for human health." (number of rankings: 236/1242). The second highest rank got "GE plants contaminate nature" (number of rankings: 193/1242). The third highest rank got the narrative "pesticides intoxicate nature" (number of rankings: 186/1242). Ranked the least was "GE for plants did not live up to its promises." (number of rankings: 28/1242).

These findings are in line with the spontaneous mentions of narratives reported above. Health concerns (Care) were most prominent in the spontaneous mentions as well, followed by concerns related to the environment (Sanctity). Interestingly, while a worry about the motives of large corporations did play a smaller role in the spontaneous mentions reported above (29/831), this type of narrative was selected much more frequently when provided to participants (174/1242, Rank 4). One potential explanation for this is that the motives of large corporations are not among the most important reasons for people's GE attitude, but they find them to be particularly convincing, and thus use this narrative to support their position towards GE without necessarily seeing it among the most important aspects.

Supporters most frequently ranked "GE for plants is necessary because of the current grand challenges (hunger, climate change). And it is our best alternative." (116/615). Ranked the second highest was "GE has many advantages for developing countries, small farmers, companies, and consumers (e.g. cost reduction, yield)." (106/615). Ranked the third highest was "GE for crops is very beneficial for society because of beneficial traits (e.g. vitamin-enriched, drought-resistant)." (99/615). Ranked the least by supporters was "Over years, NGOs have used their campaigns to spread false, frightening myths about GE for crops and thus manipulated the public with fake news." (31/615).

These findings align with the spontaneous mentions made by supporters, which also mainly addressed concerns of health and hunger (Care), and even more so benefits for general welfare and developing countries (Loyalty).

Survey Comments

Roughly half of the respondents filled the voluntary comment section at the end of the survey (44%; 275/619). A research assistant coded these inductively into topics and groups (according to the procedure proposed by Mayring, 2015). Of those comments, 89 (32%) did not contain actual feedback (e.g. "no"). 29 (11%) complimented on the survey, e.g. through wishing for more surveys like this or stating that they liked the survey. Interestingly, all other comments (58%; 159/275) were further explanations about how respondents saw the topic. Of those comments, most re-emphasized that it is not good to tamper with nature (14%; 39/275). The remainder mentioned topics such as trust in producers, policies, and scientists, but also openness towards GE. This further indicates that the topic is important and relevant to many, particularly to opponents, and particularly in relation to nature and trust.

Subjective Images of GE

In one prompt, we asked participants to describe what they picture when thinking about GE. The prompt read:

> When we think of biotechnologies, we see certain images before the inner eye. What do you associate with green genetic engineering? Please describe in keywords what image you have in mind when you think of green genetic engineering. Please limit yourself to a maximum of 5 words. When I think of green genetic engineering, I see...

Below the prompt, participants could describe their mental models in an open text box.

The purpose of investigating respondents' subjective images about GE was to gain a better understanding of which mental models participants may hold. Mental models are – potentially inaccurate – simulations of a part of reality, based on generalizations, and analogies (Gentner, 2001). With that, they allow people to make inferences in order to judge or behave (Lucas & Mai, 2022).

Coding Procedure

Participants provided a total of 2139 very brief descriptions of their images about GE. The responses were coded by the first author, applying an inductive coding procedure according to Philipp Mayring (2015). Specifically, the first author systematically went through the responses and paraphrased them into topics. The author then organized these topics according to groups and subgroups.

For consistency with the above narrative analysis, the author also deductively coded these topics according to the six moral foundations following the structural approach developed in Chapter 3. However, identifying potential moral foundations in the subjective images is not straightforward. This is because moral foundations (Haidt, 2012) coordinate social interaction and thus guide evaluations about a benefit or a detriment to a person or a group. In our prompt however, participants were asked to describe their imagination about GE, and not an interpretation of their perceived consequences for humanity. Thus, while most of the entries do transport a normative evaluation (e.g. "cripple", "mutant", "beautiful"), the relationship to human wellbeing often remains ambiguous. This makes the allocation to the six moral foundations somewhat interpretative. For example, an opponent described "fruits in winter". Here, it is not clear if the respondent thought that this is a beneficial trait of GE that could contribute to preventing hunger (i.e. Care), or if this was off-putting to the participant because it does not correspond to what they know or perceive as normal (i.e. Sanctity).

In cases which remained unclear, the coding author consulted the other entries of the same respondent and decided for a foundation that best reflected the overall picture the respondent described. For example, one opponent provided the answer "a plant with many blossoms". Here, this could be seen as a generally more efficient use of resources (i.e. Loyalty), or as something that is weird or not normal (i.e. Sanctity). The other entries of the same respondent were "clone", "wrong colors", "against nature" and "an unnatural-seeming plant with many sprouts". Based on these responses, it seems most reasonable to allocate the example to the theme "not normal" (i.e. Sanctity).

However, the allocation to the moral foundations should still be taken with caution because we cannot reliably interpret consequences for human wellbeing that participants may have had in mind when describing their subjective images about GE.

Moreover, many entries were neutral (e.g. “tree”, “flower”), which makes it impossible to infer a normative evaluation from the answers. These entries could not be allocated to a moral foundation and are thus listed separately.

Findings

The 619 respondents included in the analysis provided an average of M = 3.46 entries. 67% (1432/2139) of all entries were made by GE opponents, 33% (707/2139) were made by GE supporters. 80 responses were excluded from the analysis because they were either not interpretable or statements such as “don´t know” or “nothing” (54 by opponents, 26 by supporters). Thus, 2059 responses were included in the analysis, 1378 made by opponents, 681 made by supporters. This corresponds well to the relationship between self-proclaimed opponents and supporters in the survey (67% : 33%). Table 4.6 provides an overview of the coded subjective images of GE. We provide groups and subgroups of themes, including examples.

By far most of these subjective images could be organized to the Sanctity foundation. 64% of mentions by opponents and 51% of mentions by supporters pertain to this category. Most of those describe something that is not normal, or unusual, i.e. 41% among all mentions made by opponents, and 47% among all mentions made by supporters. Mostly, this relates to the optimization or perfection of plants. For example, opponents pictured “a plant with many blossoms” or “designer fruits”. Supporters pictured plants that “grow everywhere” or are “flawless”. Also typical in this theme were descriptions of supersized plants, such as “XXL potatoes” or “huge monster plants” among opponents, and “huge tomatoes” or “masses of plants” among supporters. Common were also images that described something artificial, strange, or unnatural. For example, opponents mention “fake plants”, “squared tomato” or “unpure variety”; supporters mention “clone”, “gaudy colors”, or “unnatural”.

Within the Sanctity foundation, 14% of opponents’ entries also described images that appeared somewhat post-apocalyptic. I.e., when thinking about GE, many opponents seem to picture images such as “cripple”, “mutants”, “dead”, or “deserted environment”.

The second biggest group overall were mentions that are neutral. 16% of mentions by opponents were allocated here. Among supporters, even 33% of all their mentions can be categorized as neutral. For opponents, these mostly refer to nutrition, e.g. “corn”, “crop”, “soy”. For supporters, these mostly refer to research and modern technology, e.g. “progress”, “experiments”, “laboratory” or “experiments”.

Also common were subjective images pertaining to Care and Loyalty, although Care was more frequent among opponents (14% of opponents’ entries), and Loyalty was more frequent among supporters (11% of supporters’ entries). Related to Care, opponents mostly mentioned health risks (8%), such as “unhealthy” and “diseases”. Supporters mostly mentioned issues of food security (2%), e.g. “fight hunger”. Related to Loyalty, opponents mainly addressed excess, greed, and power (3%) through descriptions such as “overproduction”, “price gouging”, or “dumping wages”. Within Loyalty, supporters mostly (4%) stated that GE was “useful” or “great”.

Images related to Fairness were only mentioned by opponents, as rarely as six times. These relate to rule violations, e.g. “plant theft” or “dubious activities”. Subjective images related to Authority and Liberty were not mentioned.

Table 4.6

Topics of Subjective Images about GE

GE Opponents N(entries) = 1378				**GE Supporters N(entries) = 681**			
MFT	**Theme (Subtheme)**	**Examples**	**N**	**MFT**	**Theme (Subtheme)**	**Examples**	**N**
Care 14% (187)	Health risks	"Unhealthy", ("new/ unknown) diseases", "cancer"	8% (110)	**Care 5% (34)**	Food security	"Fight hunger"	2% (17)
					Health benefits	"healthy"	1% (10)
	high risks, Danger	"Uncontrollable", "unresearched", "unpredictable"	3% (39)		Health risks	"unhealthy"	1% (5)
	Animal welfare, bad breeding conditions	"Intensive mass animal farming", "insects die"	3% (38)		Danger	"Danger", "burning amazon"	0% (2)
Fairness 0% (6)	Rule violation	"Dubious activities", "not fair", "plant theft"	0% (6)	**Fairness (0)**			
Loyalty 6% (78)	Excess, greed, power	"More profit", overproduction", "price gouging", "dumping wages"	3% (43)	**Loyalty 11% (72)**	Good, useful	"Useful, "great"	4% (25)
	Involved actors	"Monsanto", "Bayer", "USA"	1% (12)		Economic benefits	"More options", "cost reduction"	3% (19)
	Unnecessary	"Unnecessary", "bullshit"	1% (11)		Welfare	"Fulfillment of demand", "farmers better off"	2% (17)
	Protests, campaign	"Debate", "protests"	0% (6)		Protests, campaigns	"Emotions", "protests"	1% (6)
	Lies, broken promises	"Suspicion", "lies"	0% (3)		Involved actors	"Monsanto", "Bayer", "USA"	1% (5)
	Capitalism	"Capitalism"	0% (3)				

Authority (0)					**Authority (0)**				
Liberty (0)					**Liberty (0)**				
Sanctity 64% (888)	Not normal / unusual	Enhancement of plants 229	Optimization (125): “plant grows faster”, “more fruits in one plant” Perfection (104): “designer fruits”, “fruits in winter”, “looks perfect”, “colorful”	41% (568)	**Sanctity 51% (348)**	Not normal / unusual	Enhance-ment of plants 211	Optimization (177): “diverse plants”, “grow everywhere”, “resistant” Perfection (34): “beautiful”, “identical”, “flawless”	47% (318)
		Supersized 129	“XXL potatoes”, “huge monster plants”				Supersized 53	“Huge tomatoes”, “masses of plants”	
		Unreal, artificial 72	“Fake plant”, “no taste”, “unrealistic colors”				Strange 32	“Gaudy colors”, “weird”, “meaty salad”	
		Strange 66	“Weird plant”, “squared tomato”, “clone”				Unreal, artificial 11	“Watery”, “clone”	
		Unnatural 61	“Unpure variety”, “unnatural plant”, “exotic plant”				Unnatural 8	“unnatural”	
		Change of nature 8 Supernatural 3	“Climate changes”, “ecosystem changes” “Alien”				Super-natural 3	“Paradise”, “usable on other planets”	
	Post-apocalyptic images		“Cripple”, “mutants”, “dead”, “deserted environment”	14% (188)		Environmental benefits		“environment protection”	3% (22)

	Tampering with nature, god's creation, ethical concerns	"Scamping in nature", "useless manipulation"	4% (56)		Pesticides	"pesticides"	0% (3)
	Environmental risk	"Environment pollution", "reduced biodiversity"	3% (36)		Conservation of naturalness	"Organic farming", "strict protection of natural plants"	0% (3)
	Bad, wrong	"Don´t like", "uncool"	2% (25)		Bad	"bad"	0% (2)
	Disgusting images	"Monster", "disgust", "despicable being"					
	Distance	"Not in Germany"	0% (3)				
Neutral 16% (219)	Nutrition / agricultural products	"Corn" **(51)**, "crop", "soy"	9% (128)	**Neutral 33% (227)**	Laboratory, research, modern technology	"Progress", "experiments", "laboratory", "microscope"	15% (105)
	Laboratory, research, modern technology	"Robots", "modernity", "petri dish"	3% (44)		Nutrition / agricultural products	"Corn" (26), "crop", "apple" "cotton"	14% (92)
	Environment	"Environment", "tree", "flowers"	2% (23)		Environment / plants	"Flower", "tree"	3% (22)
	Agriculture	"Farmer", "harvester", "sheep"	1% (19)		Animals	"Frog", "fish", "bees"	1% (6)
	Human	"Human"	0% (5)		No difference	"Just as ordinary plant"	0% (2)

Note. The topics are organized according to addressed Moral Foundations, including frequencies and examples translated from German. Percentages refer to the total number of opponents' entries, or supporters' entries, respectively.

Discussion

These findings only somewhat align with the described narratives reported above. Topics related to Fairness, Authority, and Liberty were neither relevant in the stated narratives, nor in the stated subjective images. Moreover, similar to the described narratives, Care was more frequently addressed by opponents and Loyalty was more frequently addressed by supporters.

However, both of these foundations played a much smaller role in respondents' subjective images. Interestingly, health concerns, which were the most prominent narrative used to justify GE opposition, played a relatively small role in the subjective images (8% of opponents' mentions, and 2% of supporters' mentions). Similarly, while societal welfare was most frequently used to justify GE support, it played a smaller role in the subjective images (9% of supporters' mentions and 1% in opponents' mentions).

Contrary to that, themes related to Sanctity were much more prominent in the subjective images than in the described narratives. As mentioned above, mostly descriptions of an unnatural, optimized, perfect, supersized or strange plant stand out here. These take up the largest proportions of mentions of not only opponents, but supporters alike.

Rozin (2005) theorized that people judge whether a product is natural or not based on its process of creation, rather than its characteristics. In line with that, the present findings give rise to the assumption that both, opponents as well as supporters, find GE abnormal, strange, or unnatural. The difference between both would then only be that, while this leads to a negative evaluation of GE for opponents, for supporters it does not. This adds a new perspective on previous research about GE attitude that usually inferred that only opponents would see GE as unnatural (Hoogendoorn et al., 2021, Scott et al., 2018, Scott et al., 2016).

In addition to that, GE supporters seemed to indeed picture an optimistic outlook into a potential future that profits of the biotechnology, while opponents pictured a future with GE to become a catastrophe. This is in line with previous research that found evidence that GE supporters and opponents adhere to different worldviews (see Chapter 3 of this thesis; Siegrist, 1999; Zwick, 1998).

Generally, respondents' subjective images of GE transported more emotion and affect than the narratives do. This makes sense since our narrative probe asked for a reasoning about causal relationships, while the subjective images probe asked about impressions.

What really stands out is, however, that so many respondents generally perceived GE as something strange, perfect, or unnatural. They seemed to think that GE does not fit what they are used to. Even more so, the post-apocalyptic picture that opponents painted in 14% of their entries is striking. Inevitably, these are reminiscent of science fiction movies that draw (post-)apocalyptic scenarios. Most likely, people's forecasts about the future of new technologies, as well as popular science fiction movies, are interdependent. While research postulates that science fiction movies are thought of as mirroring contemporary hopes, fears, and forecasts about the future (Miles, 1993), they are also thought of as influencing how people think of the future impact of new technologies (Livingston, 1969).

Regressions

We were interested in the relative importance of moral narratives compared to other socioeconomic factors, such as age, and more intuitive factors, such as emotions. Therefore, we ran a regression model to identify the covariates that have a significant effect on GE attitude as outcome variable. To find out which moral narratives are significantly related to GE attitude, we included respondents' entries to the first open narrative text box in the regression model. This is for two reasons: First, only about half of respondents provided a second entry, and only about a third provided a third entry. In order to not lose statistical power, we only included the first entry, which almost everyone provided (617/619). Second, since we asked respondents to order their answers according to rank, we can assume that the first answer is also considered the most relevant.

The data included in the regression, a codebook detailing all variables, and the code to reproduce the analyses are available at https://doi.org/10.7910/DVN/FEC7OL[12].

Based on previous research and our own preliminary analyses of the variables included, we hypothesized the variables to show effects on GE attitude as follows:

- Moral foundations: We only expected narratives related to Care, Loyalty, and Sanctity to be relevant in our regression model, because Fairness, Authority, and Liberty have almost never been addressed. Moreover, previous research linked GE opposition to fear and risk aversion (Royzman et al., 2017; Rzymski & Królczyk, 2016; Ventura et al., 2016; Kahan, 2016). And because these are characteristics of the Care foundation, we expected Care to be positively related to GE opposition. Furthermore, because GE opposition has been linked to disgust and protected values (Scott et al., 2016), and disgust is a moral emotion related to the Sanctity foundation, we expected Sanctity to show a significant positive effect on GE opposition. And because Loyalty was addressed much more frequently by GE supporters, we expected Loyalty narratives to be positively related to GE support.
- Gender: We ran a chi-squared test that showed a highly significant ($p = 0.0000$) relationship between gender and attitude – in which women were more likely to state to be against GE than men. This effect has also been shown in previous studies (e.g., Chen, 2011; Liu et al., 2014; Yue et al., 2015), so we expected to replicate this here.
- Age: We ran a point-biserial correlation showing a small effect in which age accounts for 2.9% of the variability of GE attitude. We thus expected older respondents to be more likely to reject GE than younger respondents.
- Region, Level of Income, and Level of Education: A preliminary chi-squared test showed no significant relationship between GE attitude and respondents living in the former GDR region or elsewhere in Germany. Moreover, preliminary chi- square tests showed no significant relationship between GE attitude and level of income and level of education. We thus expected there to be no significant relationship between GE attitude and region, level of income, or level of education.
- Interest, importance, meaning, relevance for voting, and emotionality: Previous research has related GE attitude, and GE opposition in particular, to moral beliefs

[12] Waldhof, G. (2023). Replication Data for: "Understanding Moral Narratives as Drivers of Polarization about Genetically Engineered Crops". *Harvard Dataverse, V1.* https://doi.org/10.7910/DVN/FEC7OL

and moral convictions (Inbar & Waldhof, 2022; Scott et al., 2016). Because moral beliefs and convictions are related to strong emotional reactions and motivations to act (Ginges et al., 2007; Skitka et al., 2005; Skitka & Bauman, 2008; Tetlock, 2003), we predicted that GE opponents also tend to score higher on these importance items than GE supporters.

- Extent of specific emotions: Because we expected respondents to have consistent positions and emotional experiences, we expected GE opponents to report stronger negative emotions significantly more often when thinking about GE, and GE supporters to report stronger positive emotions significantly more often when thinking about GE. Moreover, Scott et al. (2016) have shown a relationship between GE opposition and the emotion disgust, so we expected to replicate this here.
- Sentiment about mental models: similar to the expected results related to emotions, we expected a strong positive effect between GE opposition and experienced negative sentiment when thinking about images related to GE. Vice versa, we expected GE supporters to experience positive sentiment in relation to images about GE significantly more frequently.
- Preferences for regulations: We expected GE opponents to prefer stricter regulations for GE than supporters, because otherwise participants' responses would not be consistent with their stated positions. Moreover, because people's narratives about GE indicate skepticism towards commercial gains, we expected GE research at universities to be more accepted than research for commercial purposes. Similarly, because participants' narratives about GE indicate concerns about the contamination and destruction of nature, we expected GE research in laboratories to be more accepted than research in the field.

Procedure

Because we were interested in potential significant effects of the included predictor variables on the outcome variable, we used a linear model, specifically, an ordinary least square regression model (OLS).[13] Greene (2019, ch. 17.2.6 and example 17.3) points to the fact that the results from a linear probability model (LPM) deliver approximate results for the average marginal effects of the logit and probit models, a point also outlined by e.g., Jacob and Levitt (2003). Advantages of the LPM are simplicity and robustness (Greene, 2019, p. 721). We therefore restricted our reported results to the LPM case. Results of a logit model are qualitatively similar.

We tested for heteroscedasticity both visually and analytically. A plot and histogram of the residuals showed a quite homogeneous distribution of the residuals.[14] However, the Breusch-Pagan test (Breusch & Pagan, 1979) rejected the null hypothesis of homoscedasticity and a curve in the plotted line also indicated heteroscedasticity.[15] To account for this, we calculated

[13] For our regression calculations, we used the R-packages *Readxl* (Wickham & Bryan, 2022) and *MASS* (Venables & Ripley, 2002).

[14] We used the R-package *Summarytools* (Comtois, 2022).

[15] We used the R-packages *Lmtest* (Zeileis & Hothorn, 2002), *Zoo* (Zeileis, & Grothendieck, 2005), and *Parallel* (R Core Team, 2021).

heteroscedasticity consistent (i.e. robust) standard errors type HC3 for our model (Hayes, 2007).[16]

Furthermore, in order to check for multicollinearity, we calculated the variance inflation factor (VIF) for each of the covariates.[17] While all variables were below the cutoff-point of 5 (Midi & Bagheri, 2010; Ringle et al., 2015; Chatterjee & Price, 1991; Hair et al., 1995), some showed quite high factors, i.e. close to or above 4.5. All of these belonged to the regulatory preferences, i.e. commercial field research about GE (*RegFieldComm*; 4.48), import of GE (*RegImport*; 4.64), export of GE (*RegExport*; 4.88), and leaving consumers with a choice about GE (*RegChoice*; 4.90).

Because of these high VIFs, we applied the general-to-specific procedure (GETS), in which those variables with the least favorable t-values are systematically excluded.[18] This procedure resulted in a reduction of our model by seven variables. As expected from the VIFs, all excluded variables concern the regulatory preferences.

Results and Interpretation

Table 4.7[19] reports the results of the linear model with robust standard errors, before and after applying the GETS procedure. Here, we describe and discuss the results of the reduced model with robust standard errors.

Our reduced OLS model estimated nine covariates to have a significant, or close to significant, marginal effect on GE attitude. These were moral narratives related to Loyalty (*MERGED_MFT_NARRATIVE1LOYALTY*), not wanting or not being able to provide a narrative (*MERGED_MFT_NARRATIVE1nA*), the level of education (*Degree*), the sentiment felt in relation to the first, second, and third subjective image (*Sentiment1, Sentiment2, Sentiment3*), the extend of anger felt when thinking about GE (*EmoAnger*), the extend of joy felt when thinking about GE (*EmoJoy*), and requiring a label of GE foods in Germany (*RegChoiceLabel*).

- As predicted, we found a highly significant positive relationship between moral narratives within the Loyalty foundation and GE support. However, the other moral narratives showed no significant effect. Interestingly, there is a significant positive effect between GE support and statements such as “I don’t know” or “I don't care” when asked about the supporting narratives. That GE supporters were significantly more often unable or unwilling to provide a supporting narrative to their position makes sense given that previous research has shown that they are generally less convicted about the topic, and more likely to change their position when challenged (Inbar & Waldhof, 2022). Potentially, these were respondents who are not firm in their position and might not have followed the public discourse about GE in Germany. Thus, they might not have been aware of the narratives addressed in this discourse and were thus unable to state one that they find most motivating for their

[16] We calculated this with the R-packages *Sandwich* (Zeileis, 2004; Zeileis et al., 2020) and *Estimatr* (Blair et al., 2022).

[17] We calculated the VIFs with the R-package *Car* (Fox & Weisberg, 2019).

[18] To apply the GETS-procedure, we used the R-packages *Gets* (Pretis et al., 2018) and *Zoo* (Zeileis & Grothendieck, 2005).

[19] This table was produced with the R-package *Stargazer* (Hlavac, 2022).

position. Similarly, these respondents might not have engaged with the controversy, so they tended to select GE support because they see no immediate problem.

- Against our prediction, and against previous research findings, we found no significant relationship between gender and GE attitude, as well as between age and GE attitude. Potentially, previously shown effects of these variables are better explained by other variables in the model that show significant effects, e.g. respondents' level of education, or sentiments related to subjective images about GE.
- In line with our hypothesis, we found no significant effect of the region of residence, and the level of income on GE attitude. However, we found the level of education to have a significant positive effect on GE support. This suggests that information does have an impact on GE attitude. We assume that this particularly applies to knowledge on general biology and genetics which is taught in higher class levels of high school.
- Against our prediction, interest, importance, relevance for voting and emotionality did not indicate a significant relationship with GE attitude. Potentially, the relevance of the topic has decreased, and people generally did not care as much and did not react as strongly to GE as in earlier studies. Comparing the histograms and means of the items of both supporters and opponents shows that responses were generally close to the midpoint (0), indicating that generally, GE was generally not more important to participants than other topics.
- Against our prediction, the extent of specific emotions felt when thinking about GE did not have a significant effect on GE attitude. However, the extent of anger felt when thinking about GE is an almost significant predictor of GE opposition ($p < 0.1$), and the extent of joy felt when thinking about GE is an almost significant predictor of GE support ($p < 0.1$). Potentially, as proposed above, the relevance of GE as a topic has decreased, and people's emotional reactions were less strong.
- As expected, sentiments related to subjective images about GE and GE attitude showed significant and highly significant effects. While not all five sentiments showed a significant effect, three out of five did.
- As mentioned above, the GETS procedure reduced the number of variables for regulatory preferences included in the model from ten to three, because of multicollinearity. Of those remaining three, the request of a free choice for consumers about GE – on condition that GE foods are labeled – is a highly significant predictor of GE support.

In total, these results somewhat indicate that moral narratives and emotional intuitions about GE are more predictive of GE attitude than socioeconomic characteristics.

Table 4.7

Regression Results

Regression Results

	Dependent variable:	
	GE Attitude	
	(1)	(2)
Gender	0.01	0.01
	(0.04)	(0.04)
Age	0.001	0.001
	(0.001)	(0.001)
Region	0.01	0.02
	(0.05)	(0.04)
Income	-0.02	-0.01
	(0.02)	(0.02)
Degree	0.03**	0.03**
	(0.01)	(0.01)
Interest	-0.004	-0.002
	(0.01)	(0.01)
Importance	-0.003	-0.01
	(0.02)	(0.02)
Meaning	0.003	0.01
	(0.02)	(0.02)
Voting	0.002	-0.003
	(0.01)	(0.01)
Sentiment1	-0.1*	-0.1**
	(0.1)	(0.1)
Sentiment2	-0.1*	-0.1*
	(0.1)	(0.1)
Sentiment3	-0.2***	-0.2***
	(0.1)	(0.1)
Sentiment4	-0.01	-0.01
	(0.1)	(0.1)
Sentiment5	-0.1	-0.1
	(0.1)	(0.1)
Emotionality	0.01	0.01
	(0.01)	(0.01)
EmoContempt	0.01	0.01
	(0.02)	(0.02)
EmoAnger	-0.04**	-0.03*
	(0.02)	(0.02)
EmoFear	-0.02	-0.02
	(0.02)	(0.02)
EmoDisgust	-0.01	-0.004
	(0.01)	(0.01)

EmoJoy	0.01	0.02*
	(0.01)	(0.01)
EmoSurprise	0.01	0.01
	(0.01)	(0.01)
EmoSadness	-0.002	-0.002
	(0.01)	(0.01)
RegStrict	0.01	0.01
	(0.01)	(0.01)
RegFieldUni	-0.01	0.004
	(0.01)	(0.01)
RegFieldComm	-0.001	
	(0.02)	
RegLabUni	-0.02	
	(0.01)	
RegLabComm	0.01	
	(0.01)	
RegImport	0.01	
	(0.02)	
RegExport	0.03	
	(0.03)	
RegChoice	0.01	
	(0.02)	
RegChoiceLabel	0.01	0.03***
	(0.01)	(0.01)
RegNoChoice	0.01	
	(0.01)	
MERGED_MFT_NARRATIVE1LIBERTY	0.7	0.7
	(0.5)	(0.5)
MERGED_MFT_NARRATIVE1LOYALTY	0.2***	0.2***
	(0.1)	(0.1)
MERGED_MFT_NARRATIVE1nA	0.1	0.1**
	(0.1)	(0.1)
MERGED_MFT_NARRATIVE1SANCTITY	-0.1	-0.04
	(0.04)	(0.04)
Constant	0.4***	0.4***
	(0.1)	(0.1)
Observations	347	352
R^2	0.6	0.6
Adjusted R^2	0.6	0.6
Residual Std. Error	0.3 (df = 310)	0.3 (df = 322)
F Statistic	15.8*** (df = 36; 310)	18.1*** (df = 29; 322)
Note:		*p<0.1; **p<0.05; ***p<0.01

Conclusion and Future Directions

Contributing to the emerging narrative research in economics, we identified people's (mis)conceptions and moral evaluations of genetic engineering for human consumption.

Specifically, Roos and Reccius (2021) postulate that narrative research needs to extend its inquiry into the identification of people's belief system in order to understand the *meaning* of narratives. Motivated by this request, we identified the moral foundations within people's narratives, and collected descriptions of participants' subjective images of GE, as well as their sentiments. We did so by conducting a content analysis and by applying the methodological approach for identifying moral foundations in text developed in Chapter 2.

We showed how this methodological approach yields novel – and previously overlooked – insights into the polarized debate about GE. Specifically, we provide insights into the belief systems that lead people to come to different conclusions about GE. We thus contribute to the investigation of narratives in economics, moral beliefs in narratives, research on polarization and polarized debates, expectation formation, voting behavior and policy preferences, moralization and moral psychology, as well as GE attitude and technology adoption. The main conclusions are described in the following.

First, our findings suggest a significance of moral intuitions and moral foundations for narrative research in economics. Specifically, we provided evidence that moral narratives that address the Loyalty foundation are a significant predictor of GE support. Moreover, affective narratives stating that GE should be prohibited (or approved) because they *look better,* are *ugly*, *disgusting*, *perfection*, or evoke *bad feelings*, indicate that GE attitudes are - at least in part – based on emotions, intuitions and gut feeling. Contrary to that, many socioeconomic factors such as age, gender, region, or income did not show a significant relationship with GE attitude. Consequently, building on the literature about moral emotions and moral intuitions (see for example Haidt & Joseph, 2004; Haidt, 2001; Ditto et al., 2009), we can infer that moral intuitions are an important driver of GE attitude.

This is in line with previous research that found moral concerns to be related to GE attitude (Inbar & Waldhof, 2022; Scott et al., 2016), even when controlling for risk perceptions and demographics (Sjöberg, 2008; Tanaka, 2004). Our findings indicate that collectively shared moral narratives are impactful for the approval or rejection of GE, and thus for related policy preferences.

Second, our findings indicate that there are considerable differences between the narratives that are led by official public representatives and those that people found most crucial in our study. While environment protection was relevant in the narratives that opponents mentioned, it was not as prominent for people as the public debate insinuates (see for example Chapter 3). Even more so, aspects such as market skepticism and corporate behavior play a large role in the public debate (Chapter 3), but were almost irrelevant in the narratives that people reported as their causal account for their position.

Third, the fact that issues related to corporate greed and market skepticism were almost never among respondents' spontaneous mentions of narratives, but were among the most selected narratives when provided to respondents, suggests motivated reasoning within the selection question. As indicated above, the term motivated reasoning refers to a phenomenon in which people provide arguments that strengthen their position rather than reflecting the actual line of reasoning that they might have had (see for example Druckman & McGrath, 2019; Epley

& Gilovich, 2016; Kunda, 1990). I.e., respondents' provided reasoning might be motivated by wanting to foster their position, rather than by an open deliberation to reach a conclusion.

Fourth, the public debate among official representatives is often conducted with diametrically opposed narratives. For example, while BUND (n.d.) discusses potential health risks, Leopoldina (2021) argues that GE can have benefits for health. Or, while the Heinrich Böll foundation (Mertens, 2022) argues that GE increases the use of pesticides, Bayer argues that GE reduces the use of pesticides (Bayer, 2022).

Interestingly, and contrary to that, our research suggests that diametrically opposed narratives are not decisive for the diverging attitudes among the public. Rather, they may focus on different moral aspects that lead to different positions towards the technology. One example are potential health impairments, addressed in the Care foundation. These were extremely popular among opposing narratives. However, health benefits only played a very small role among supporting narratives. Rather, within the Care foundation, supporters focused on food security. Another example is the perception of naturalness. Considering the overwhelming proportion of both opponents and supporters, who described GE as something that is not normal, it is likely that opponents and supporters alike thought of GE as something unnatural. This thought is based on previous research that found that when people describe something as natural, they actually mean normal, i.e. something they are used to (Scott & Rozin, 2020). Then, GE opponents and supporters may not differ in their understandings of naturalness, or normality, but in the *relevance* it has for their position. Since supporters were asked which narratives led to their position, it can be derived that naturalness, or normality, is not an aspect that led to their support.

The here identified focus on different moral aspects also manifests itself in a focus on different moral foundations. While opponents stated much more narratives within Care and Sanctity, supporters focused heavily on Loyalty narratives. Specifically, opponents focused on health threats (Care) as well as environmental risks and unnaturalness (Sanctity); and supporters focused on general welfare, progress and benefits for developing countries (Loyalty).
This carves out the interesting observation that both, GE supporters and opponents, may have actually *agreed* that they personally, as well as their immediate surroundings, would be no direct beneficiaries of GE. Rather, the difference may just be that supporters focused more on narratives that suggested general welfare and development aid.

Thus, our findings suggest that rather than diametrically opposed narratives about GE, diverging foci on moral issues seem to be decisive for the polarization about GE. Without applying qualitative content analysis and MFT here, these novel insights could not have been generated.

The present study also yields a practical recommendation for improving science communication and public debates. The analysis suggests that to the German public, immediate benefits, particularly related to health and the environment, remain largely unclear and intangible. Thus, for scientists engaged in the debate, it seems sensible to point out and explain such immediate benefits much more strongly.

Moreover, it may be useful to get involved in a debate about naturalness. As supporters seem to also find GE unnatural without this being decisive for their attitude, it might be worth debating when and if naturalness should be pivotal for approving or rejecting GE as a technology.

At the same time, it has to be considered that the causal relationship between GE attitude and the predictor variables has to be interpreted with caution. In the present study, we included the identifying restriction that GE attitude is dependent on the other variables included in the study. However, this direction of dependency is not unambiguous. For example, from our study we cannot infer whether respondents felt a negative emotion *that then* led them to reject GE, or whether people experience a negative emotion when thinking about GE *because* they reject the technology. Based on the theory of moral emotions and moral foundations (see for example Haidt, 2007; Haidt, 2012), we assumed that negative (moral) emotions guide people towards a rejecting GE.

Similarly, we cannot infer from this study whether respondents considered a variety of narratives about GE and *then* formulated their attitude based on the narrative they find most convincing, or whether the narratives were post hoc rationalization of e.g., a preceding gut feeling about GE. Because of the phenomenon of motivated reasoning addressed above, the latter may indeed be a reasonable alternative. In the present paper, as explained above, we assumed the former i.e., that people are drawn to the narrative that best fits into their belief system, and then formulate their attitude based on this confirming narrative.

Our approach for identifying the moral content of narratives can also be applied to other settings. For example, polarizing issues such as vaccine hesitancy, renewable energy sources, or climate change may hold moral conflicts in popular narratives whose identification may be the first step towards their solving.

Author Note

Data and materials are available at: Waldhof, G. (2023). Replication Data for: "Understanding Moral Narratives as Drivers of Polarization about Genetically Engineered Crops". *Harvard Dataverse, V1.* https://doi.org/10.7910/DVN/FEC7OL. Specifically, the file includes the survey materials (in German), participants' descriptions of the narratives and subjective images, the codings of the narratives according to moral foundations, all data for the regression, a codebook explaining all variables, the data for the correspondence analyses, and the code to reproduce the analyses.

The questionnaire and methodology for this study was approved by the Ethics committee of the Leibniz Institute of Agricultural Development in Transition Economies (Certificate Reference Number: 03/2019).

For funding this project, the authors would like to thank ScienceCampus Halle - Plant-based Bioeconomy, EFRE funds, under Grant ZS/2016/06/79644. The authors would also like to thank the Leibniz Institute of Agricultural Development in Transition Economies (IAMO) for financial and infrastructural support of this project.

The authors also thank Valerija Gottselig, Anna Martin, and Julia Jarikova for excellent assistance in coding the narratives and demographic entries.

The authors have no competing interests to declare.

Chapter 5 –
Mitigating Consequence Insensitivity for Genetically Engineered Crops[20]

Abstract

Many opponents of genetically engineered (GE) food say that it ought to be prohibited regardless of the risks and benefits (Scott et al., 2016). If many people are truly unwilling to consider risks and benefits in evaluating GE technology, this poses serious problems for scientists and policymakers. In a large demographically representative German sample (N = 3,025), we investigate consequence-insensitive beliefs about GE crops among GE supporters and opponents, as well as whether these beliefs can be mitigated. We find that a large majority of opponents and a substantial minority of supporters are consequence-insensitive: They say that risks and benefits are irrelevant to their views. At the same time, the responses of consequence-insensitive participants to subsequent belief probes show substantial flexibility. Participants often gave responses inconsistent with the unconditional prohibition or permission of GE crops. These results suggest that professed consequence insensitivity should be taken as an expression of a strong moral belief rather than as literal endorsement of policy.

Keywords: genetically engineered crops; GE; GMO; protected values; morality; attitude change

[20] This chapter is joint work with Yoel Inbar. It is published as: Inbar, Y., & Waldhof, G. (2022, July 27). Mitigating Consequence Insensitivity for Genetically Engineered Crops. Accepted at: *Journal of Experimental Psychology: Applied.* https://doi.org/10.31234/osf.io/bnq8c

Introduction

Genetic engineering (GE) is the laboratory alteration of an organism's DNA or RNA to add or change a phenotypic trait (National Academies of Sciences, Engineering, and Medicine [NASEM], 2016). One common use of GE in crops for human consumption (also commonly referred to as GMOs, or "genetically modified organisms"[21]) has been to add herbicide and pest resistance, but GE crops can particularly benefit people in the developing world by making staple crops more pest-resistant, drought-tolerant, or vitamin-rich (Ahmed et al., 2020; Qaim, 2016; Barrows et al., 2014; Klümper & Qaim, 2014; Tang et al., 2009; Guleria et al., 2017; Wang et al., 2014; Narayanan et al., 2019).

Despite the scientific consensus that GE crops do not pose greater health risks than conventionally-bred crops and that their environmental risks are acceptable (NASEM, 2016), the public is broadly negative toward GE crops (Gaskell et al.1999; Frewer et al., 2013; Scott et al., 2016, Inbar et al., 2021). In Germany, GE skepticism is particularly high. In a recent study only 13% of German respondents said they thought GE foods were safe to eat (Kennedy and Thigpen, 2020); another study found that 61% of consumers said that they were "somewhat" to "very" concerned about GE foods (Federal Institute for Risk Evaluation [BfR], 2021). Although there is technically not a blanket ban on the cultivation of GE crops in Germany, due to extremely strict regulations there are currently no GE crops approved for commercial cultivation (Federal Ministry of Food and Agriculture [BMEL], 2019).

Previous research has found that in the United States, substantial proportions of GE food opponents say they think that it ought to be prohibited *regardless of its risks and benefits* (Scott et al., 2016)—that is, they claim to be opposed to GE food no matter the consequences.[22] We describe this position as "consequence-insensitive" because respondents explicitly indicate that consequences (i.e., risks and benefits) are irrelevant. In the current research, we investigate the prevalence and characteristics of consequence insensitivity for GE crops in members of the German public. We also investigate whether consequence insensitivity can be mitigated.

Lay Attitudes Towards GE Food

In the hundred years or more that social psychologists have been studying attitudes, they have developed a diversity of theoretical conceptions and methodological approaches (e.g., Allport, 1935; Eagley & Chaiken, 1993; Fazio, 1995; McGuire, 1985; Petty & Cacioppo, 1981). As varied as these are, they all share a core conception of an attitude as an evaluation of some target of judgment (see Maio & Haddock, 2010). Eagly and Chaiken (1993), for example, define an attitude as "a psychological tendency that is expressed by evaluating a particular entity with some degree of favor or disfavor." This definition distinguishes the underlying evaluative tendency—i.e., the attitude—from the mode of expressing it (which could be choice, questionnaire responses, reactions times on a measure such as the Implicit Association Test, and so on; see also Eagly & Chaiken, 2007).

Likewise, research on GE food attitudes specifically has largely adopted this definition (though see Poortinga & Pidgeon, 2006). Building on cognitively-oriented models of attitude change

21 Biologists prefer the more precise term "genetically engineered" because "genetically modified" can refer to any type of genetic modification, including conventional breeding (National Academies of Sciences, Engineering, and Medicine [NASEM], 2016, p. 58).

22 We use the broader term "GE food" to describe research where participants were also asked about non-plant products (e.g., Scott et al., 2016 asked about "genetically engineering plants and animals").

such as the Elaboration Likelihood Model (ELM; Petty & Cacioppo, 1981), this research has often presumed that laypeople rationally use information (primarily perceptions of risks and benefits) to arrive at a considered evaluation of GE food (for a review, see Scott et al., 2018).

A large amount of research has focused on perceived risks. Laypeople see GE food as quite risky, and specifically are concerned about its risks to human health (Gaskell et al., 2010; Hallman et al., 2013). People who see GE food as risky are also more opposed to it (Moon & Balasubramanian, 2001, 2004; Siegrist, 2000; Sjöberg, 2008), and so some researchers have argued that perceived risks are of primary importance in determining attitudes (Gray & Schein, 2016; Royzman et al., 2020). Indeed, risk perceptions often explain more variance in attitudes than perceptions of benefits (Moon & Balasubramanian, 2001, 2004); and some other predictors of GE attitudes (such as trust or sociodemographic variables) may be related to attitudes indirectly, via risk perceptions (Moon & Balasubramanian, 2004).

Negative attitudes towards GE crops may also result from people's perceptions that they provide no benefits, since the most common GE crops are engineered for traits such as herbicide and pest resistance, which directly benefit producers, not consumers (Lusk et al., 2005). Consistent with this reasoning, greater perceived benefits are associated with more positive attitudes toward GE food (Jin, 2022; Siegrist, 2000; Sjöberg, 2008; Traill et al., 2006) and greater willingness to pay for it. A meta-analysis examining willingness to pay found that what premium consumers are willing to pay for non-GE food over GE food is roughly halved when the GE food offers a direct consumer benefit (e.g., enhanced nutrition; Lusk et al., 2005). For some people, rejection of GE food may even result solely from its perceived lack of benefits (Gaskell et al., 2004).

Despite the considerable progress made by research focusing on risks and benefits, there is reason to think that some opposition to GE food is based on moral values rather than consequence-based reasoning. We turn to this evidence below.

Morally-based Beliefs

Tetlock and colleagues (Tetlock et al., 2000; Tetlock, 2000) posited that people see some moral values as sacred, "possessing transcendental significance that precludes comparisons, trade-offs, or indeed any mingling with secular values" (Tetlock, 2003, p. 320). Beliefs based on these kinds of moral values have been called "protected values" (Baron & Spranca, 1997) or "moral mandates" (Skitka, 2002; Skitka & Houston, 2001; Skitka & Mullen, 2002).[23] These are usually beliefs about specific behaviors—e.g., "abortion should be prohibited" or "natural environments must be protected" (Skitka et al., 2005). Sacred values may not be traded off against other considerations (particularly material and financial considerations) and people react with outrage when they are transgressed (Ginges et al., 2007; Mullen & Skitka, 2006; Skitka & Wisneski, 2011; Tetlock, 2003). Even weighing the costs and benefits of transgressing sacred values is seen as morally outrageous (Tetlock et al., 2000). For example, many people think that human life is sacred, and thus that a market in human organs is so morally repugnant that it should be banned even if it is virtually certain to make both buyers and sellers better off.

[23] Moral mandates are defined as beliefs based on "moral convictions"—i.e., the "strong and absolute belief that something is right or wrong, moral or immoral" (Skitka et al., 2005, p. 896). Moral convictions are equivalent to sacred values, although they are typically measured differently (see Kovacheff et al., 2018).

Even the consideration of the welfare benefits of organ markets is seen by many as highly offensive (Roth, 2007).

Compared to non-moral attitudes, even strong ones, morally-based beliefs are particularly likely to motivate people to act (Skitka et al., 2005). This can mean increased political engagement for issues seen as morally relevant (Skitka & Bauman, 2008) but also a willingness to ignore procedural safeguards and due process, as those motivated by moral beliefs are often more concerned with achieving the "right" outcome than with the process by which it was reached (Skitka & Mullen, 2002). Likewise, seeing a scientific issue as moral is generally associated with a stronger willingness to act and more attention to information about the issue. Perceived moral obligation is associated with greater intentions to take action on climate change (Chen, 2020), and greater moral identity is associated with passive and active support for protests for climate policies (Misch et al., 2021). Likewise, participants reporting moral conviction about climate change were more persuaded by a text arguing that climate change was a serious problem and reported more negative emotions about it (Heddy et al., 2022). Finally, U.S. conservatives became more pro-environment and more supportive of environmental protection legislation if they were shown proenvironmental messages emphasizing conservative-friendly moral values (e.g., protecting the purity of nature; Feinberg & Willer, 2013).

Moral Opposition to GE Food

Moral values seem to play a role in GE food opposition as well. Moral concerns about genetic engineering have been shown to be associated with overall evaluations of it even when accounting for demographics and perceptions of risks (Sjöberg, 2008; Tanaka, 2004; though see Moon & Balasubramanian, 2003; Spence & Townsend, 2006). The most direct evidence for moral GE food opposition was reported by Scott et al. (2016), who found that many GE food opponents believe that it ought to be categorically prohibited (that is, prohibited regardless of its risks and benefits). In a sample of U.S. respondents selected to be representative of the population on age, gender, and income, 71% of opponents thought GE food "should be prohibited no matter how great the benefits and minor the risks from allowing it" (Scott et al., 2016, p. 317). These respondents were 46% of the entire sample. Scott et al. described these consequence-insensitive respondents as "moral absolutists" (p. 317), because rejection of consequence-based trade-offs is a hallmark of holding moral values (Baron & Spranca, 1997; Tetlock, 2003, p. 320). If many GE food opponents are truly unwilling to consider risks and benefits, this suggests that they will not be responsive to informational appeals from scientists and policymakers.

Consequence Insensitivity Among GE Supporters

Past research has examined insensitivity to consequences only among GE food opponents. Because people are more likely to moralize negative attitudes than positive ones, it may be that there are no consequence-insensitive GE supporters (Philip-Muller et al., 2021). However, in a pilot study (described in more detail in the Supplemental Material), we found that both GE crop supporters and opponents said they based their attitudes on their "gut feelings" to a surprising extent (M = 4.0 for supporters; M = 4.2 for opponents on a 1 ["Not at All"] - 6 ["Absolutely"] scale). It is therefore possible that GE supporters might also reject consequence-based reasoning (i.e., they might assert that GE crops should be *allowed* regardless of the risks and benefits). In

the current research, we therefore examine the rejection of consequence-based reasoning among GE crop supporters as well as opponents.

The Current Research

In the current research, we examined the prevalence of consequence insensitivity among GE crop supporters and opponents in a sample representative of the German population. We also verified that consequence-insensitive respondents saw their beliefs as moral using a previously-validated measure assessing moral conviction, defined as the "strong and absolute belief that something is right or wrong, moral or immoral" (Skitka et al., 2005, p. 896). Finally, we tested whether consequence insensitivity can be mitigated by "belief probes" developed to test people's commitment to consequence-insensitive beliefs (Baron & Leshner, 2000).

Probing Consequence Insensitivity

The claim that consequences don't matter is extreme, but it may be that some people who initially reject the consideration of consequences will reconsider when challenged. Prior research on other polarizing topics has found that many people who say that risks and benefits are irrelevant nonetheless often change their beliefs when they are pushed on the implications of this statement, so much so that these statements have been described as "strong opinions, weakly held" (Baron & Leshner, 2000, p. 193). Indeed, in the paper initially demonstrating consequence-insensitive GE opposition, Scott et al. (2016) wrote that "[GE] attitudes may be like many other protected values that people claim to hold as absolute but routinely violate in practice…suggest[ing] that [GE] absolutism should be flexible at least to some degree" (p. 321). In the current research, we tested whether people's initial consequence insensitivity for GE crops is flexible when people are asked to reconsider it.

We did this by asking consequence-insensitive respondents to respond to one of four belief probes. Our probes were based on those developed by Baron and Leshner (2000), who theorized that apparent consequence insensitivity can result from what they called "incomplete thinking" (Baron, 1973). People may agree that "all apples are red" not because they have never seen a green apple, but because the prototypical apple is red and because they do not take the time to think of exceptions. Similarly, people may agree that something should be prohibited "regardless of the risks and benefits" because they have not taken the time to think about how meaningful the benefits might be, or how trivial the risks might be compared to those routinely encountered in everyday life. If consequence insensitivity is, for some people, unreflective, prompting people to reflect (for example, by asking opponents to list any benefits that would make GE crops acceptable to them) might lead them to rethink their unconditional opposition (for example, to name some benefit that would in fact be great enough to justify permitting GE crops). Three of the four probes (*Open Reflection, Risks/Benefits,* and *Counterexamples*) pushed people to think harder about their positions by asking them to generate or endorse circumstances under which they would change their minds. The final probe (*Hidden Consequentialism*) tested whether respondents would say that *in principle* there might be exceptions to their stances even if these didn't exist (or couldn't be reliably known to exist) in practice. All probes are described in more detail in the Methods and Materials section.

Based on past research (e.g., Baron & Leshner, 2000), we expected that at least some people who professed that risks and benefits are irrelevant would, when probed, admit to exceptions.

We did not know, however, how many people might do so, nor whether some probes would be more effective than others at eliciting consideration of consequences.

Belief Change

A final contribution of the current research is to test whether exposure to the probes caused participants to change their attitudes towards GE crops overall. We measured overall attitudes towards GE crops and consequence sensitivity once at the beginning of the survey (i.e., before participants encountered any probe) and again at the end of the survey. This allowed us to test whether any of the probes led to changes on either of these measures.

Research Questions

In sum, we have the following research questions:

1. How common are consequence-insensitive beliefs about GE crops? That is, what proportion of respondents claim that risks and benefits are irrelevant?
2. Do consequence-insensitive respondents report greater moral conviction regarding GE crops?
3. What proportion of consequence-insensitive respondents will concede that consequences do sometimes matter when they are challenged to reflect more deeply about their beliefs?
4. Will exposure to the belief probes change consequence sensitivity and/or overall GE food attitudes?

Study Overview

All participants first completed measures of attitudes towards GE crops and consequence sensitivity. We then randomly assigned participants to complete one of four probes adapted from those developed by Baron and Leshner (2000). These probes, which are described in detail below, ask participants to consider what, if anything, would change their beliefs. After completing one of the four probes, all participants were asked to complete the attitude items a second time.

Method

Transparency, Openness and Ethical Standards

All data, survey materials (in German), and analytic code to reproduce the analyses are available at https://researchbox.org/488[24]. We preregistered our study design, hypotheses, and analytic plan at https://aspredicted.org/qv645.pdf[25].

The research was approved by the IAMO Research Ethics Committee at the Leibniz Institute of Agricultural Development in Transition Economies.

Survey Flow

The study took about ten minutes to complete. After providing informed consent and demographic information, participants indicated their overall attitudes towards GE crops and

[24] Inbar, Y., & Waldhof, G. (2022). ResearchBox # 488 – 'GE Germany'. *ResearchBox. Wharton Credibility Lab.* https://researchbox.org/488

[25] Waldhof, G., & Inbar, Y. (2020). GM Attitudes & Moral Absolutists (#40574). *AsPredicted. Wharton Credibility Lab*. https://aspredicted.org/qv645.pdf

completed a measure of consequence sensitivity (see "Measures" section below). Depending on participants' responses, they were assigned to subsequently see items designed for supporters or opponents of GE crops. All participants then completed four moral conviction items (adapted from Feinberg et al., 2019 and Skitka et al., 2005). Participants were then randomly assigned to one of four belief probes (described below). Each probe had a supporter version and an opponent version, so that participants always saw a probe that matched their stance on GE crops. Following the intervention, all participants completed the GE attitude and consequence sensitivity measures a second time. The survey ended with an attention check and with an opportunity to give feedback on the study.

Measures

All measures were presented to participants in German, but most were based on items originally written in English. Items were translated by a native German speaker fluent in English and then back-translated into English by a native English speaker fluent in German. Finally, the original and back-translated versions were checked for meaning equivalence by another native English speaker.

Attitudes towards GE crops

We asked participants to indicate whether they supported or opposed GE crops on two items. Participants first indicated their overall attitude as a binary choice ("What is your overall attitude towards genetic engineering of plants for human consumption?") with response options being "I am for GE crops" and "I am against GE crops." They were then asked to select how strongly they supported or opposed "genetic engineering of plants for human consumption" on a six-point Likert scale anchored by "Absolutely against the genetic engineering of plants for human consumption" and "Absolutely for the genetic engineering of plants for human consumption." These face-valid items were created by us, so there is no previous validity evidence available.

Sensitivity to Consequences and Moral Conviction

Based on our pilot study, we hypothesized that some supporters of GE crops might also have consequence-insensitive beliefs regarding them. We therefore asked about the importance of consequences for both opponents and supporters of GE crops. This was assessed with a agree/disagree statement adapted from previous research (Baron & Spranca, 1997; Scott et al., 2016).[26] For opponents, this was: "Genetically engineered crops should be prohibited no matter how great the benefits and minor the risks from allowing them."

For supporters, the same item read: "Genetically engineered crops should be allowed no matter how great the risks and minor the benefits from allowing them."

This "consequence sensitivity" item has been validated for other topics in previous research (Baron & Spranca, 1997, 2000). It has also been validated for GE opponents (with minor wording differences) by Scott et al. (2016). The GE supporter version is new and there is no previous validity evidence available.

26 As in previous research, we also asked two other questions to assess *quantity insensitivity* and *universalism*, two other belief attributes associated with sacred/protected values. These are described in the Supplemental Materials.

We also measured respondents' moral conviction regarding GE crops. We used four items adapted from Skitka et al. (2005): 1) "To what extent is your position on GE crops a reflection of your core moral beliefs and convictions?"; 2) "To what extent are your feelings about GE crops deeply connected to your beliefs about 'right' and 'wrong'?"; 3) "To what extent do you feel the issue of GE crops is a moral issue (An issue where your attitude is based on moral values)?"; and 4) "When thinking about GE agriculture, to what extent do you 'just know' that it is wrong [right]?" Participants responded to each of these on 6-point scales anchored by "Not at all" and "Completely." These moral conviction items have been validated on other topics by (among others) Skitka et al. (2005) and Feinberg et al. (2019), but their use for GE crops here is new.

Belief Probes

We presented participants with one of four probes adapted from Baron and Leshner (2000).[27] Three of the four probes ("Open-Ended Reflection," "Risks and Benefits," and "Counterexamples") asked participants to consider whether risks and benefits might be relevant to their beliefs after all. The final probe ("Hidden Consequentialism") tested whether respondents would say that *in principle* there might be exceptions to their stances.

Open-Ended Reflection. The open-ended reflection probe asked participants to think of any circumstances under which prohibiting or permitting GE crops might be necessary. For opponents, the probe read "Under which circumstances could permitting GE be necessary? Please think about in which cases genetic engineering should be permitted and use the field below for your answers. The more examples you can think of, the better." For supporters, the probe read "Under which circumstances could a prohibition of GE be necessary? Please think about in which cases genetic engineering should be prohibited and use the field below for your answers. The more examples you can think of, the better."

Risks and Benefits. The risks and benefits probe asked people to identify risks/benefits of GE crops that would justify prohibiting/permitting this technology. GE opponents read that "Many people say, 'genetically modified plants for human consumption are not acceptable, no matter how great their benefits are.' Perhaps, in some cases, people can imagine benefits large enough to justify genetic engineering in plants—if they would try. Try to imagine the benefits of genetically modified plants for human consumption and write them down. If you can imagine several cases, write down the most realistic one. If you just cannot imagine any case, say so." GE supporters read that "Many people say, 'genetically engineered plants for human consumption are acceptable no matter how great their risks are.' Perhaps, in some cases people can imagine risks that are too great to justify genetic engineering in plants—if they would try. Try to imagine the risks of genetically engineering plants for human consumption and write them down. If you can imagine several cases, write down the most realistic one. If you just cannot imagine any case, say so."

Counterexamples. The Counterexamples probe asked participants to consider specific circumstances that might change their beliefs. We included this probe because we thought that participants might respond to counterexamples presented to them even if they were unwilling or unable to generate convincing ones on their own. For opponents, the prompt read, "Genetic

27 Although we focus our analyses on participants who indicated insensitivity to consequences, all participants completed these measures.

engineering of plants for human consumption is acceptable if/when it…" followed by an instruction to "please take your time to think about the following scenarios and select all those that make genetic engineering of plants for human consumption acceptable for you." Participants could choose any, all, or none of a) "has economic benefits," b) "saves human lives," c) "increases quality of life," d) "stops a global problem," e) "is good for moral reasons," f) "through its use, prevents the use of more genetic engineering."

For GE supporters, the prompt read, "Genetic engineering of plants for human consumption is NOT acceptable if/when it…" followed by an instruction to "please take your time to think about the following scenarios and select all those that make genetic engineering of plants for human consumption unacceptable for you." Participants could choose any, all, or none of a) "has economic harms," b) "kills humans," c) "decreases quality of life," d) "causes a global problem," e) "is bad for moral reasons," f) "through its use, creates a need for more genetic engineering."[28]

Hidden Consequentialism. The Hidden Consequentialism probe asked participants to choose one or more justifications for their stance on GE crops. This probe was intended to test whether participants truly were insensitive to consequences or were instead making assumptions that took consequences into account. For example, someone might believe that there are situations in which GE crops are acceptable, but that people are not able to recognize those situations reliably. In this case, a blanket prohibition could lead to better outcomes than case-by-case decisions (see Hare, 1981), and thus one might indicate support for a blanket prohibition despite sensitivity to consequences.

For opponents of GE crops, the prompt read, "Genetic engineering of plants for human consumption is unacceptable because…" followed by an instruction to "please take your time to think about the following reasons and select all those that apply to you personally." Participants could choose any, all, or none of a) "I cannot imagine situations where it would be acceptable," b) "I can imagine situations where the benefits would be large enough justify it, but in reality these situations do not exist," c) "There are situations in reality where the benefits would be large enough, but people cannot recognize them. Therefore, it is better to never allow genetically engineered plants," d) "As a general rule, this is not acceptable, but we should make exceptions if we are certain enough."

For supporters of GE crops, the prompt read, "Genetic engineering of plants for human consumption is acceptable because…" followed by an instruction to "please take your time to think about the following reasons and select all those that apply to you personally." Participants could choose any, all, or none of a) "I cannot imagine situations where it would be unacceptable," b) "I can imagine situations where the negative consequences would be too large justify it, but in reality, these situations do not exist," c) "There are situations in reality where non-genetically engineered plants would be more beneficial for consumption, but people cannot recognize them. Therefore, it is better to allow genetically engineered plants," d) "As a general rule, this is acceptable, but we should make exceptions if we are not certain enough."

We interpreted the first response ("I cannot imagine situations where [GE crops] would be [un]acceptable") as indicating "true" consequence insensitivity. We interpreted the remaining responses as showing sensitivity to consequences under some circumstances.

28 The wording of the last option reflects our desire for symmetry with the options for opponents. Of course, supporters may not have considered a need for more genetic engineering to be a bad thing.

Post-Probe Attitudes

Following the probe, all participants completed the consequence insensitivity and continuous GE crop attitude measures (except for moral conviction) a second time. We included these measures so that we could calculate attitude change in response to the probes. These questions were identical to the versions described above.

Participants

We preregistered that we would collect responses from 2,920 participants (this number was based on our budget and the minimum effect sizes of interest). Our per-participant cost was slightly lower than expected, so in the end we were able to collect responses from 3,109 participants, who were recruited and paid by the online panel provider GapFish (https://gapfish.com/). These participants matched the German population on age, gender, and education. Eighty-two participants were excluded because they did not pass our preregistered attention check, leaving 3025 participants. A sensitivity analysis showed that this sample gave us 80% power to detect a regression coefficient with effect size $f^2 = .004$ for opponents and $f^2 = .007$ for supporters (this analysis was conducted in G*Power 3.1.9.6, specifying a test of a single coefficient in a linear multiple regression).

Demographics

The ages of our participants ranged from 18 to 100 (M = 44; SD = 14.6); 51% (1,549) were female and 49% (1,476) male. The majority (59%; 1,781) had completed their school degree (high school or a similar form of basic education that qualified them for higher education). Twenty-four percent (729) had completed vocational training (a qualification for specific professions such as tradesman, clerk or hairdresser). Fifteen percent (443) held a university degree (Bachelor, Master, or the German Diplom) and 0.5% (15) held a PhD. One third (987) earned up to 25,000 € per year, 36% (1,079) earned between 25,000 € and 50,000 € per year, 11% (337) earned between 50,000 € and 70,000 € per year. Seven percent (206) earned more than that. Fourteen percent (416) declined to provide information on their income. Because asking about race is considered unusual in Germany, we did not collect race or ethnicity data.

Results

We divide the results into two parts. The first part is descriptive; it includes the prevalence of consequence insensitivity and the responses to the belief probes among supporters and opponents. The second part contains the preregistered confirmatory analyses (https://aspredicted.org/qv645.pdf). These analyses largely concern which (if any) of the probes led to significant changes in attitudes (including changes in self-reported consequence sensitivity).

GE Stances and Consequence Sensitivity

Of the total sample of 3,025 participants, 1,821 (60.2%) were GE crop opponents and 1,204 (39.8%) were supporters. Of the opponents, 80.6% (1,468) were opposed regardless of the consequences (i.e., they indicated that GE crops ought to be prohibited regardless of risks and benefits). In contrast, only a minority of the supporters (31.1%; 375/1,204) were consequence-insensitive (i.e., they indicated that GE crops ought to be *allowed* regardless of the risks and benefits).

The continuous attitude measure was consistent with the binary-choice results. Overall, opponents' mean scores were close to the bottom of the scale, and significantly below the scale midpoint of 3.5 (higher values indicated greater support for GE crops); $M = 1.87$, $SD = .98$, $t(1,820) = -71.10$, $p < .001$. Consequence-insensitive opponents were more strongly opposed than were consequence-sensitive opponents, $M_{consequence\text{-}insensitive} = 1.67$ ($SD = .87$), $M_{consequence\text{-}sensitive} = 2.68$ ($SD = 1.00$), $t(1,819) = 19.06$, $d = 1.13$. Conversely, supporters' mean scores were significantly above the scale midpoint of 3.5, $M = 3.89$ ($SD = 1.29$), $t(1,203) = 10.60$, $p < .001$. Consequence-insensitive supporters were more strongly supportive than were consequence-sensitive supporters, $M_{consequence\text{-}insensitive} = 4.35$ ($SD = 1.29$), $M_{consequence\text{-}sensitive} = 3.69$ ($SD = 1.24$), $t(1,202) = 8.45$, $d = .53$.[29]

Thus, consequence-insensitive respondents were consistently more extreme across measures. This was particularly the case for consequence-insensitive opponents, who constituted the large majority of opponents overall.

Responses to Belief Probes

We next describe participants' responses to each of the probes. Because these probes were designed to assess flexibility in people's stated insensitivity to consequences, we only analyze data from the 1,468 opponents and 375 supporters who indicated pre-intervention that GE food should be prohibited or allowed regardless of the risks and benefits. Participants were randomly assigned to one of four probes: open-ended reflection (opponents: n = 366, supporters: n = 92), risks and benefits reflection (opponents: n = 359; supporters: n = 83), counterexamples (opponents: n = 369, supporters: n = 101), and hidden consequentialism (opponents: n = 374, supporters: n = 99).

Open-Ended Reflection

The open-ended reflection probe asked participants to write down any circumstances under which prohibiting or permitting GE might be necessary. Participants could provide up to five responses. Since the number of responses varied across participants, the total number of responses does not match the number of participants. All responses were coded by a trained research assistant who paraphrased them into topics. These topics were then checked by the second author and edited where necessary. After coding was completed, the research assistant and researcher identified broader categories according to which the topics were subsequently grouped. Coded categories and their share of all responses are shown in Table 5.1.

29 Ninety-one respondents (3%) gave contradictory responses to the binary-choice and continuous measures (that is, they indicated opposition on the binary-choice measure but then chose "absolutely support" on the continuous measure or indicated support on the binary-choice measure but then chose "absolutely oppose" on the continuous measure). We did not preregister that we would exclude respondents for contradictory responses, so we made the more conservative choice to include them in analyses. However, excluding them does not change the results of any statistical tests reported below.

Table 5.1

Open-Ended Reflection (Share of Consequence-insensitive Respondents Mentioning a Topic).

Opposition Status	Coded Categories	Paraphrased Topics (Examples)	Share of consequence-insensitive respondents
Opponents	Reaffirmation of position	Reasons against GE crops	16% (60)
	Stated they cannot think of anything	Don't know, don't care, nothing	23% (84)
	No response	No response	9% (33)
	Food Security	Famine, poverty, overpopulation, food	23.2% (85)
	Health	Fight diseases, medicine / health	12.8% (47)
	Environment	Dying species, environment protection, sustainability	11.2% (41)
	Emergency	Fight wars and crises, save lives, no alternative	11.2% (41)
	Resilience	Fight pests / plant diseases, adapt to climate or soil conditions	9.8% (36)
	Efficiency	Higher yield, product optimization	2.5% (9)
	Safety	If proven to be harmless, strict labelling, separation of GMO / non-GMO	1.9% (7)
	Research	For research purposes	1.4% (5)
Supporters	Reaffirmation of position	Reasons in favor of GE crops	3% (3)
	Stated they cannot think of anything	Don't know, don't care, nothing	17% (16)
	No response	No response	23% (21)
	Health	Medical risks, unhealthy food	29.3% (27)
	Safety	Danger, mutations, loss of control	17.4% (16)
	Environment	Risks for animals, risks for environment	17.4% (16)
	Abuse	Use for war, weapons, moral concerns, human trials	14.1% (13)

Note. Totals do not match the number of respondents (and percentages do not sum to 100) because participants could provide up to five responses.

Risks and Benefits

The risks and benefits probe asked participants to write down any risks [benefits] of GE crops that would justify prohibiting [permitting] them. Participants could provide up to four responses. Since the number of responses varied across participants, the total number of responses does not match the number of participants. These responses were coded by a trained research assistant who paraphrased them into topics. These topics were then checked by the second author and edited where necessary. After coding was completed, the research assistant and researcher identified broader categories according to which the topics were subsequently grouped. Coded categories and the number of respondents mentioning each are shown in Table 5.2.

Table 5.2

Risks and Benefits (Share of Consequence-insensitive Respondents Mentioning a Topic)

Opposition status	Coded categories	Paraphrased topics (examples)	Share of consequence-insensitive respondents
Opponents	Reaffirmation of position	Reasons against GE crops	16% (58)
	Stated they cannot think of anything	Don't know, don't care, nothing	41% (147)
	No response	No response	11% (41)
	Efficiency	Higher yield	14.8% (53)
	Food Security	Famine, poverty	12.3% (44)
	Resilience	Resist pests / plant diseases	7.2% (26)
	Health	Medical reasons	3.6% (13)
	Safety	If enough research, if proven to be safe	2.8% (10)
	Environment	Environment protection	1.1% (4)
Supporters	Reaffirmation of position	Reasons in favor of GE crops	2% (2)
	Stated they cannot think of anything	Don't know, don't care, nothing	37% (31)
	No response	No response	31% (26)
	Health	Change in human body cells, cancer, diseases	19.3% (16)
	Environment	Changes in nature, dying species	7.2% (6)
	Food	Reduced quality, taste, nutrition	1.2% (1)
	Safety	Toxic substances	2.4% (2)
	Greed	Companies' greed for profit	2.4% (2)

Note. Totals do not match the number of respondents (and percentages do not sum to 100) because participants could provide up to five responses.

Counterexamples

The Counterexamples probe asked participants to consider specific circumstances that might change their beliefs. Participants could choose any, all, or none of six different circumstances (see Table 5.3).

Opponents. Almost every opponent (361/369; 97.8%) selected at least one option—thus, nearly every opponent who said that their view did not depend on the consequences indicated that there were some circumstances under which GE crops would be acceptable. Participants could choose as many options as they wanted (including zero), but the median number chosen was one (M = 1.76, SD = 1.02). The percentage of respondents choosing each option is shown in Table 5.3.

Supporters. Nearly every supporter (100/101; 99%) selected at least one option. Thus, like opponents, almost every supporter indicated that there were some circumstances under which their attitude towards GE crops would be consequence-sensitive. Participants could choose as many options as they wanted (including zero), but the median number chosen was two (M = 2.23, SD = 1.4). The percentage of respondents choosing each option is shown in Table 5.3.

Table 5.3

Counterexamples (Percentage of Consequence-insensitive Respondents Selecting Each Counterexample)

Opposition status	Genetic engineering of plants is acceptable if it…	Selected by
Opponents	Saves human lives.	63.7% (235)
	Prevents a global problem.	44.2% (163)
	Prevents more of the same thing.	24.7% (91)
	Improves living conditions.	18.2% (67)
	Has economic benefits.	13.3% (49)
	Is for a good moral cause.	12.2% (45)
	Genetic engineering of plants is NOT acceptable if it…	
Supporters	Reduces the quality of life.	49.5% (50)
	Kills people.	47.5% (48)
	Causes a global problem.	46.5% (47)
	Has economic disadvantages.	35.6% (36)
	Causes more of the same thing.	23.8% (24)
	Is bad for moral reasons.	19.8% (20)

Note. Totals do not match the number of respondents (and percentages do not sum to 100) because participants could select multiple responses.

Hidden Consequentialism

The Hidden Consequentialism probe asked participants to choose one or more justifications for their stance on GE crops. This probe was intended to test whether participants actually were insensitive to consequences or were instead making assumptions that took consequences into account.

Opponents. We interpreted the first response ("I cannot imagine situations where [GE crops] would be acceptable") as indicating "true" consequence insensitivity. We interpreted the remaining responses as showing sensitivity to consequences under some circumstances. We excluded 28 participants who selected the first response but also selected a further response, which resulted in a sample size of 346 for this probe. Forty-one percent of participants (142/346) selected the first option, indicating true consequence insensitivity. The remainder chose one or more of the other options—thus, most opponents who described themselves as consequence-insensitive nonetheless showed some sensitivity to consequences on this measure. The percentage of respondents choosing each option is shown in Table 5.4.

Supporters. For supporters, we interpreted the response "I cannot imagine situations where [GE crops] would be unacceptable" as indicating "true" consequence insensitivity. We interpreted the remaining responses as showing sensitivity to consequences under some circumstances. We excluded 15 participants who selected the first response but also selected a further response, which resulted in a sample size of 84 for this probe. Fourteen percent of participants (12/84) selected the first option, indicating true consequence insensitivity. The remainder chose one or more of the other options—thus, most supporters who described themselves as consequence-insensitive nonetheless showed some sensitivity to consequences on this measure. The percentage of respondents choosing each option is shown in Table 5.4.

Table 5.4

Hidden Consequentialism (percentage of consequence-insensitive respondents selecting each justification).

Opposition status	Genetic engineering of plants is unacceptable because…	Selected by
Opponents	I cannot imagine any situations in which this is acceptable.	41.0% (142)
	There are situations in the real world in which the benefits are great enough, but people cannot recognize these situations, so it is best never to do this.	28.9% (100)
	This is unacceptable as a general rule, but we should make exceptions to it if we are sure enough.	18.2% (63)
	I can imagine situations in which the benefits are great enough to justify this, but these situations do not happen in the real world.	15.9% (55)
	Genetic engineering of plants is acceptable because…	
Supporters	I cannot imagine situations where this would be unacceptable.	14.3% (12)
	There are situations in the real world in which GE-free foods are more beneficial. However, people cannot implement these. Therefore, it is better to use GE in plants.	32.1% (27)
	This is acceptable as a general rule, but we should make exceptions to it if we are not sure enough.	39.3% (33)
	I can imagine situations in which downsides are too large to justify this, but these situations do not happen in the real world.	23.8% (20)

Note. Totals do not match the number of respondents (and percentages do not sum to 100) because participants select multiple responses.

Preregistered Analyses: Attitude Change

We next turn to our preregistered analyses. These largely test the extent to which the probes changed respondents' minds. Recall that after completing one of the four probes, participants completed the consequence sensitivity measure and the continuous GE food attitude measure a second time. We could therefore test for attitude change overall in response to the probes, as well as differences in effectiveness between different probes. Unlike the descriptive analyses reported above, these analyses included all participants (i.e., consequence-sensitive and insensitive opponents and supporters) unless otherwise specified.

Our first preregistered analysis focused on the continuous attitude measures. To make scores comparable between supporters and opponents, we rescaled opponents' responses by subtracting their scores from seven. We then subjected attitudes pre- and post-intervention to a repeated-measures ANOVA, entering condition, opposition status, and their interaction as between-subjects predictors. This analysis showed significant effects of time point, $F(1, 3017) = 29.02$, $p < .001$; time point x condition, $F(3, 3017) = 5.48$, $p < .001$; and time point x condition x opposition, $F(3, 3017) = 4.08$, $p = .007$. This means that the probes shifted attitudes overall, but that different probes were differentially effective for supporters and opponents. We therefore conducted follow-up analyses in which we computed attitude change scores for each participant (these are scaled such that higher numbers indicate greater attitude change for both opponents and supporters). These are shown in Table 5.5. Descriptively, the Open Reflection probe produced the greatest attitude change among supporters (although not always significantly so), whereas the Counterexamples probe was most effective among opponents. However, all changes were small, with the most effective probe (Counterexamples for opponents) changing attitudes by a quarter of a scale point on average (Cohen's $d_z = .31$). The only other probe producing significant attitude change was Open Reflection (Cohen's $d_z = .18$ for supporters and .12 for opponents).

Table 5.5

Attitude change after each probe for supporters and opponents.

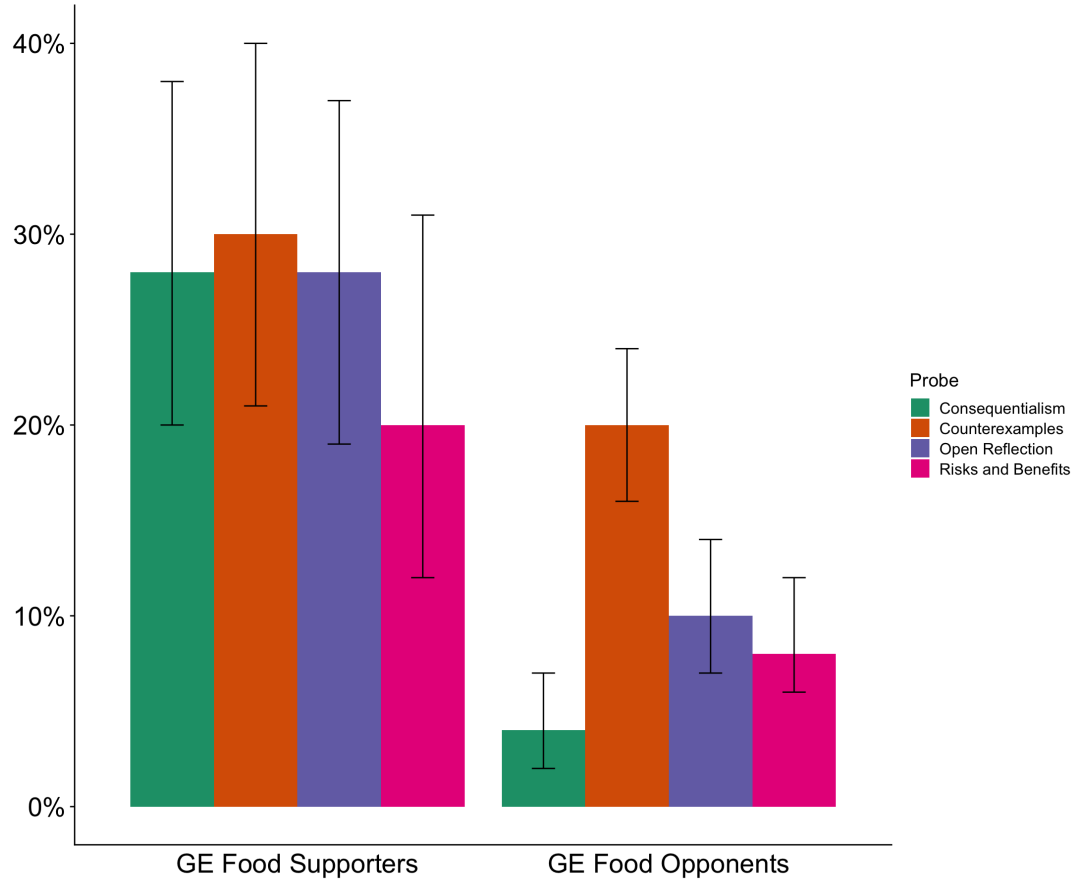
Note. Responses are scaled such that positive numbers reflect more moderate attitudes post-intervention. Within a row, cells with different superscripts differ at $p < .05$. Cells are bolded if pre- and post-intervention attitudes differ at $p < .05$.

	Condition			
GE Opposition	Open reflection *M* (*SD*)	Risks and benefits *M* (*SD*)	Counterexamples *M* (*SD*)	Consequentialism *M* (*SD*)
Supporters	**.17 (.97)**[a]	.08 (.91)[a,b]	.08 (1.06)[a,b]	.02 (.90)[b]
Opponents	**.10 (.84)**[a]	-.03 (.80)[b]	**.26 (.83)**[c]	.02 (.71)[a,b]

Our second preregistered analysis focused on changes in sensitivity to consequences. We computed a variable that was coded as 1 if the participant was consequence-insensitive at the beginning of the survey and not at the end and coded as 0 if the participant was consequence-insensitive at both time points (thus, this analysis included only participants who reported consequence insensitivity at the beginning of the survey). We then regressed this variable on condition, opposition status, and their interaction in a logistic regression. This model showed a significant effect of opposition status, such that opponents were less likely to become consequence-sensitive, OR = .29 [95% CI: .16, .50], Z = -4.33, $p < .001$. It also showed significant effects of condition, $\chi^2(3) = 14.88$, $p = .002$, and a significant interaction between condition and opposition, $\chi^2(3) = 21.88$, $p < .001$. This means that different probes differentially caused changes in consequence sensitivity for supporters and opponents. We therefore conducted follow-up analyses where we separately compared the effectiveness of probes for supporters and opponents. These showed that for consequence-insensitive supporters, the percentage who became consequence-sensitive did not differ significantly by probe (Open Reflection, 28.3%; Risks and Benefits; 20.5%; Counterexamples, 29.7%; Hidden Consequentialism, 28.3%). For consequence-insensitive opponents, the pattern was different: the least effective probe was Hidden Consequentialism, after which 4.3% became consequence-sensitive. The most effective was Counterexamples, after which 19.5% did. Open Reflection (10.1%) and Risks and Benefits (8.4%) fell in between and differed significantly from each of the other two probes (ps < .03) but not from each other. These results are shown in Figure 5.1.

Figure 5.1

Percentage of Consequence-insensitive Supporters and Opponents Becoming Consequence-sensitive After Each Probe.



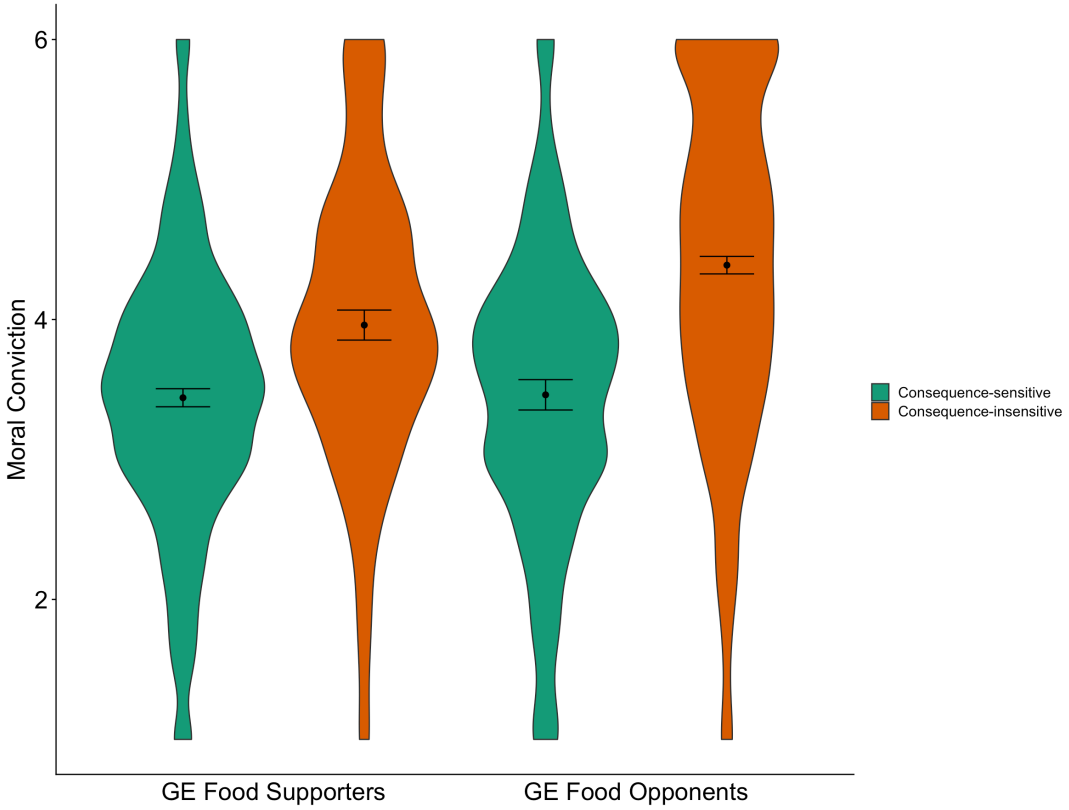
Note. Error bars show 95% confidence intervals.

Preregistered Analyses: Moral Conviction

As in previous research (Skitka et al., 2005), responses to the four moral conviction items were highly correlated (opponents $\alpha = .81$; supporters $\alpha = .69$). We averaged them into a single moral conviction composite, with higher scores indicating greater moral conviction. Moral conviction was higher among consequence-insensitive GE opponents ($M = 4.39$, $SD = 1.22$) than among consequence-sensitive opponents ($M = 3.46$, $SD = 1.04$), $t(1{,}819) = 13.16$, $p < .001$, $d = .78$. It was also higher among consequence-insensitive supporters ($M = 3.96$, $SD = 1.06$), than among consequence-sensitive supporters ($M = 3.44$, $SD = .95$), $t(1{,}202) = 8.49$, $p < .001$, $d = .53$. The interaction between opposition and consequence sensitivity was significant, $F(1, 3{,}021) = 18.22$, $p < .001$, indicating that moral conviction was particularly high among consequence-insensitive opponents (see Figure 5.2).

Figure 5.2

Distributions of Moral Conviction Scores for Consequence-Sensitive and Consequence-insensitive GE Food Supporters and Opponents.



Note. Means and 95% confidence intervals are overlaid in black.

In our final set of preregistered analyses, we tested whether moral conviction moderated attitude change. We first examined whether moral conviction moderated changes in consequence sensitivity (thus, this analysis only includes participants who reported consequence insensitivity at Time 1). We refit the logistic regression model above, this time including moral conviction and the interactions between moral conviction and opposition status as predictors. There was a main effect of moral conviction, such that the greater a participants' moral conviction, the less likely they were to become consequence-sensitive post-intervention, OR = .68 [95% CI: .54, .85], Z = -3.32, p < .001. However, the interaction between moral conviction and opposition status was not significant, OR = 1.28 [95% CI: .98, 1.67], Z = 1.82, p = .07, indicating that moral conviction was not differentially associated with becoming consequence-sensitive for supporters and opponents.[30]

Finally, we examined whether moral conviction moderated attitude change using the continuous measure. We ran an ANCOVA on attitude difference scores (scaled, as above, such that larger numbers indicated greater attitude change) with the following predictors: opposition status, condition, opposition status x condition, consequence sensitivity, moral conviction, moral conviction x opposition status, and moral conviction x consequence sensitivity. This model showed no significant effect of moral conviction or any interactions of other variables

30 Our preregistration incorrectly stated that the model would include an interaction term between consequence sensitivity (called "absolutism" in the preregistration) and moral conviction, which was not possible because this analysis only included consequence-insensitive respondents.

with moral conviction, all *p*s > .25.[31] This was the case whether or not consequence sensitivity and its interaction with moral conviction were included in the model.

General Discussion

We investigated the prevalence and malleability of consequence insensitivity for GE crops in a German sample representative of the population on age, gender, and education. As in previous studies, we found a high prevalence of consequence insensitivity among GE crop opponents. Of the 1,821 opponents in our sample, 81% (1,468) said that GE crops ought to be prohibited regardless of risks and benefits. Furthermore, consequence-insensitive opponents differed from other opponents in theoretically consistent ways, showing more extreme anti-GE crop attitudes and greater moral conviction compared to other opponents.

Previous studies have not examined whether some GE crop supporters might hold consequence-insensitive beliefs as well. This was indeed the case, although the prevalence of consequence insensitivity among supporters was dramatically lower (31.1%, or 375/1,204). Nonetheless, these consequence-insensitive supporters responded to other measures in theoretically consistent ways, showing more extreme *pro*-GE attitudes and greater moral conviction compared to other supporters (although they still reported lower moral conviction than consequence-insensitive opponents).

At the same time, respondents who professed to be insensitive to consequences commonly gave responses to the attitude probes that were inconsistent with a literal commitment to the unconditional prohibition or permission of GE crops. Rather, these responses showed more flexibility than one might expect given the unyielding stances these people had just expressed.

Responses to Belief Probes

Two of the probes—Open-Ended Reflection; and Risks and Benefits—asked participants to generate reasons that (depending on whether they supported or opposed GE crops) would justify banning or permitting them. Many respondents in these conditions either declined to generate any reasons or simply reiterated their positions (this was true of 48.4% of consequence-insensitive opponents and 43.5% of consequence-insensitive supporters in the Open-Ended Reflection condition and of 68.5% of opponents and 71.1% of supporters in the Risks and Benefits condition). Still, substantial numbers of participants who claimed that risks and benefits were irrelevant were able to generate some circumstances that would justify changing their minds. Often these had to do with human welfare—for example, reducing the risk of famine or increasing crop yields for opponents, or new risks to health and safety for supporters. When circumstances were explicitly provided for participants in the Counterexamples probe, almost all consequence-insensitive respondents (97.8% of opponents and 99% of supporters) endorsed at least one reason that would justify changing their minds. As in the Open-Ended Reflection and Benefits conditions, the most-endorsed options directly concerned human welfare ("saves human lives" for opponents and "reduces the quality of life" for supporters). Finally, the Hidden Consequentialism probe showed that most respondents who professed consequence insensitivity (59% of opponents and 85.7% of supporters) endorsed one or more

31 This model differs slightly from what we preregistered, which was a repeated-measures ANCOVA. However, with two time points the results from an ANCOVA on difference scores and a repeated-measures ANCOVA are identical (i.e., F- and p-values are exactly the same). Because repeated-measures ANCOVA in Stata is very slow, we report the identical results from an ANCOVA on difference scores.

options compatible with consequentialism—for example, that GE is generally [un]acceptable, but that exceptions could be made if people are sure enough. Taken together, this pattern of results is most compatible with what Baron and Leshner (2000) called "incomplete thinking." For many, the claim that risks and benefits are irrelevant seems to be relatively unconsidered. When they are asked to generate exceptions or counterexamples (or, better yet, when these are provided for them) they seem willing to contradict their stated unconditional stances. This would seem to indicate substantial flexibility in beliefs. However, the attitude change data are less consistent with this proposition.

Belief Change in Response to Probes

Given how many putatively consequence-insensitive respondents were willing to admit to exceptions, it is striking that the large majority maintained that risks and benefits were irrelevant immediately after doing so. The patterns differ somewhat between supporters and opponents, but no probe caused a majority of consequence-insensitive respondents to change their stated positions. For consequence-insensitive supporters, there were no statistically significant differences in effectiveness between probes, and the percentage becoming consequence-sensitive after each ranged between 20 and 30 percent. Consequence-insensitive opponents were overall less likely to become consequence-sensitive: Counterexamples, the most effective probe, reduced consequence insensitivity by about 20 percentage points. The two probes that asked participants to generate reasons themselves (Open Reflection and Benefits) had markedly weaker effects, reducing consequence insensitivity by eight to ten percentage points, and the effect of the Hidden Consequentialism probe was weaker still.[32] We believe the most plausible explanation for the differences between probes are that the Counterexamples probe provided participants with compelling reasons to rethink consequence insensitivity (rather than asking them to come up with such reasons themselves).

We also tested changes on the continuous attitude measure, which was given pre- and post-intervention. Here we were able to include all participants (not just the consequence-insensitive), so one might expect the larger and more reliable effects. However, this was not the case. The most effective probe (Counterexamples for opponents) changed GE attitudes on the rating scale measure by about a quarter of a point on average. As Table 5.5 shows, most produced no significant change in attitudes at all.

One possible explanation is that GE food attitudes are particularly difficult to change. Debates about GE crops have been prominent in the U.S. and Europe over the last thirty years (Scott et al., 2018). Particularly in Europe, where most people disapprove of GE crops, many opponents are likely strongly committed to their views. Indeed, previous research has found mixed results of interventions to change GE food attitudes. Explicit arguments debunking GE food misconceptions seem to be most effective; at least in one study, these produced large positive changes in GE food attitudes (Heddy et al., 2017). However, many other interventions have shown minimal effects on attitudes. For example, Frewer et al. (2003) found that providing information has little effect on attitudes towards GE food, and McPhetres et al. (2019) found that a mini-course about basic GE facts had only a small positive effect (about half a scale point)

32 The particularly weak effect of the Hidden Consequentialism probe on attitude is unsurprising, as this probe asked participants to choose reasons *justifying* their positions, rather than circumstances that might justify abandoning them. If anything, it is surprising that this probe had a substantial effect on consequence sensitivity for GE supporters.

on subsequent attitudes. In a German sample, Wuepper et al. (2019) found that providing information about GE crops had no overall effect on the choice share of GE food in a hypothetical-choice paradigm. In fact, information provision can often lead to attitudes and preferences that are more *negative* towards GE food. Scholderer and Frewer (2003) found that providing information about the benefits of hypothetical GE foods did not affect GE food attitudes overall, but did make participants *less* likely to (hypothetically) choose those specific foods. Zhu and Xie (2015) found that whereas information about benefits of GE food had no effect on attitudes, information about risks made attitudes more negative. One possible explanation is that because many people have pre-existing negative evaluations of GE food, anything that makes it more salient that a food has been genetically engineered (even describing benefits) can lead to more negative evaluations of it (Scholderer & Frewer, 2003).

However, it may be that attitudes towards GE food are much like other topics where people have consequence-insensitive (i.e., moral) beliefs. Previous research has also found that insensitivity to consequences is difficult to change, regardless of topic. For example, Baron and Leshner (2000, Study 1) asked consequence-insensitive opponents of thirteen different practices to think of benefits large enough to justify allowing them, and found that participants became consequence-sensitive only 10% of the time. More evidence is needed to determine whether GE food attitudes are especially hard to change compared to other attitudes where moral values are implicated.

GE Food Supporters

How are we to think about the fact that some GE crop *supporters* say that risks and benefits are irrelevant? They are a minority, but—at about 31.1% of supporters—not a negligibly small one. And although they are, on average, not as extreme in their beliefs as consequence-insensitive opponents are (that is, compared to consequence-insensitive opponents they reported lower moral conviction and less extreme attitudes on our continuous measure), still, they reported higher moral conviction and more extreme attitudes than consequence-sensitive supporters did. This speaks against the possibility that consequence-insensitive supporters were simply confused or inattentive (and, of course, we also included attention checks to screen out inattentive participants). So, we think their stated disregard of risks and benefits should be taken as seriously as that of opponents. Stated consequence insensitivity among GE crop supporters may at least in part be a reaction to the heated public debates about the topic, i.e., as a rhetorical counter to consequence-insensitive opponents. Other potential drivers could be high trust in and affiliation with science and scientists or high openness towards new technology and innovation. Exploring these possibilities is a promising area for future research.

Additionally, we find that compared to opponents, consequence-insensitive GE crop supporters were more likely to become consequence-sensitive after the belief probes, and this did not depend on the specific probe content. This is somewhat surprising, as the content of the probes was quite different; for example, the Counterexamples probe presented participants with specific circumstances that might change their minds, whereas the Hidden Consequentialism probe asked participants to select reasons supporting their beliefs. Taken together with the lower moral conviction and more moderate attitudes shown by consequence-insensitive GE supporters compared to opponents, this suggests that supporters' beliefs are weaker and more subject to change. Reasons for this could be intrinsic or extrinsic. Supporters might differ from GE opponents in intrinsic characteristics such as a generally higher persuasibility. Or,

alternatively, supporters might find themselves confronted with social pressure. Since the large majority of Germany's population rejects GE crops, it may be against the cultural norm to support such crops. Thus, when challenged, consequence-insensitive supporters might be more willing to reconsider their positions. While we find the latter explanation to be more likely, this is an empirical question for future research.

Relation to Previous Research and Theoretical Implications

The Meaning of Consequence Insensitivity

How should the current data change how we think about professed insensitivity to risks and benefits on issues like GE crops? Respondents who claimed their beliefs to be independent of consequences showed many of the hallmarks of holding moral beliefs. In the current study, their attitudes were more extreme and were held with more moral conviction; in previous research on GE food attitudes, consequence-insensitive opponents also reported more moral emotions (such as disgust and anger) when imagining people consuming GE food (Scott et al., 2016). Yet their responses to the belief probes in this study often showed a willingness to admit to exceptions, which is inconsistent with a literal interpretation of a stated endorsement of a ban or permission regardless of risks and benefits. Finally, the great majority of consequence-insensitive respondents reaffirmed their consequence insensitivity immediately after acknowledging exceptions, suggesting that they themselves don't think that these responses are incompatible.

Is it the case, then, that professed insensitivity to consequences is actually illusory? Some researchers have argued that it is, because people are misunderstanding what is asked or are unable to consider the relevant hypotheticals (e.g., Royzman et al., 2018). The current results certainly show that participants are not logically consistent if their answers are taken literally. Yet we do not think this means that their beliefs are simply the expression of a cost-benefit analysis. Rather, the results signal that participants hold a strong moral belief that, at the same time, is at least somewhat malleable. Thus, expressed consequence insensitivity seems to be more about proclaiming a moral belief than a literal policy prescription.

Reframing Opposition by Highlighting Competing Moral Values

Our results suggest that while professed insensitivity to consequences on moralized issues might be hard to change, there is significant potential for mitigating extremity on moralized topics by shifting attention towards competing moral values. A substantial proportion of consequence-insensitive respondents indicated they would be willing to make exceptions to their stated beliefs, particularly when these exceptions entailed protecting human lives. For example, in the Counterexamples probe, 64% of consequence-insensitive opponents indicated that GE crops would be acceptable if they saved lives. Similarly, 50% of consequence-insensitive supporters indicated that GE crops would *not* be acceptable if they reduced quality of life.

This is in line with the distinction between taboo trade-offs and tragic trade-offs pointed out by Tetlock (2003). While trading off sacred values against secular values (i.e., a taboo trade-off) evokes moral outrage, trading off a moral value for another moral value (i.e., a tragic trade-off) is seen as much more acceptable. It is also consistent with more recent research on moral reframing (see for example Luttrell et al., 2019, Voelkel & Feinberg, 2018, Feinberg et al., 2019). For example, Luttrell et al. (2019) show that moral appeals in messages can be effective

in changing attitudes grounded in morality. Moreover, Day et al. (2014) find that conservatives and liberals are most persuaded by arguments that cater to specifically conservative and liberal values, respectively (see also Feinberg & Willer, 2013, 2015; Voelkel & Feinberg, 2018; Wolsko et al., 2016). Finally, in unpublished data Scott et al. (2022) find that moral arguments are most convincing to moral GE food opponents. The current results are another piece of evidence suggesting that moral appeals are a uniquely potent way of reaching people who are not responsive to the cost-benefit calculus policy-makers often focus on.

Are GE Food Beliefs "Truisms"?

People can have strong beliefs that they have not thought much about. McGuire (1964) described what he called "truisms" as beliefs that are endorsed strongly, but unreflectively—for example, the (at the time) widespread belief that it is desirable to see a doctor regularly for a physical examination. Because truisms are culturally uncontroversial, people do not need to seek out reasons supporting them. And because of this lack of supporting reasons, truisms are much more tenuous than their strong endorsement would seem to indicate. When people are given arguments against truisms, support for them declines dramatically (McGuire & Papageorgis, 1961). Subsequent research proposed that support for some values (e.g., honesty, helpfulness, equality) is similar—these values are widely seen as important, but asking people to think of reasons that equality (for example) is important changes subsequent importance ratings, suggesting that people see these values as important without having thought very hard about *why* (Maio & Olson, 1998).

Superficially, truisms seem similar to the consequence-insensitive GE crop beliefs that we have described here. Like truisms, expressions of consequence insensitivity are seemingly strong beliefs that are less strong than they seem once people are asked to think about justifications. An important difference, however, is that whereas support for truisms can change substantially when people are given arguments against them, the belief probes in the current research caused only small changes in attitudes (or, sometimes, no significant changes at all). We believe the key difference is that truisms are defined as *uncontroversial* (Maio & Olson, 1998). "Everybody knows" that seeing a doctor for a yearly physical is a good idea, and thus it is possible to believe in the truth of this statement without ever thinking of supporting reasons. However, GE crops are not like this—they are controversial, and, for many people, moral. In the case of moral beliefs people may concede that the supporting reasons are bad, but maintain the belief all the same (Haidt, 2001). Likewise, in the current research many consequence-insensitive respondents maintained their positions shortly after having admitted to exceptions logically incompatible with them.

Practical Implications

Expressions of moral values are often rife with inconsistency. As in the current research, Baron and Leshner (2000) found that substantial numbers of self-proclaimed consequence-insensitive opponents of different practices were willing to admit to exceptions under some circumstances, and Tetlock (2003) pointed out that sacred values are both sincerely held and routinely violated in day-to-day life. But despite their inherent inconsistency, expressions of sacred values have real downstream consequences for policy. Economists advocating for a market in donor kidneys on human-welfare grounds, for example, have found themselves stymied by the moral outrage this idea evokes—but, in keeping with the idea that sacred values are not particularly consistent,

workarounds such as "donor chains" (where multiple unrelated donors "swap" kidneys) have gained more acceptance (Roth, 2008). In the current case, we suspect that the strongly moralized views held by many GE crop opponents are the source of the prohibitively strict regulation of GE leading to the current de facto ban on the cultivation of GE crops for human consumption in Germany (Federal Ministry of Food and Agriculture [BMEL], 2019).

Our results suggest that in public debates, people may regularly express a disregard of consequences while, in fact, they consider some moral causes as acceptable exceptions to their stance. This implies that policymaking may often be misguided by reacting to strongly communicated moral positions that are actually weakly held. However, the results also suggest that constructive dialogue is possible. Even the consequence-insensitive seem to be indeed open to persuasion, when they are presented with compelling reasons (as in the Counterexamples probe). Future research could further test whether switching attention to higher shared moral values proves as an instrument for constructive debates on other polarizing issues such as vaccine hesitancy or climate change.

Limitations and Future Directions

Our sample was entirely German, and therefore some of our results might depend on that cultural context. In the U.S., for example, though consequence-insensitive GE food opposition is still common, it is less common than in Germany. It might be that in countries where consequence insensitivity is less prevalent, it is also more readily abandoned in response to belief probes (this is suggested by the fact that in the current study GE crop supporters, who were less likely to be consequence insensitive to start with, were also more likely to become consequence-sensitive after seeing any of the probes).

The fact that GE crop supporters showed substantial levels of consequence insensitivity is somewhat surprising, although given the social debate around GE, the fact that some supporters espouse extreme pro-GE views might be expected. Future research should investigate the prevalence of consequence insensitivity among GE supporters in other countries. It might be that as the proportion of supporters in the population goes up, more of them are consequence-insensitive (because, for example, when a view is more socially accepted, it is also more acceptable to express an extreme version of it). Conversely, it might be that a high proportion of consequence-insensitive *opponents* prompts some supporters to adopt extreme positions as well. To answer this question, we need data on GE support, opposition, and consequence insensitivity across many more countries.

Finally, survey research allows one to reach a broad and representative sample, but it sacrifices depth. Especially given the striking behavior of many consequence-insensitive participants—in which they endorsed exceptions but then maintained consequence insensitivity immediately afterwards—more in-depth techniques such as cognitive interviews (Willis, 2015) or thought-listing tasks (Cacioppo et al., 1997) would provide more insight into the underlying cognitive processes.

Conclusion

We find that consequence-insensitive beliefs about GE crops are both common and hard to change. Nonetheless, many consequence-insensitive opponents state that there are at least some cases in which GE crops may be permissible and many consequence-insensitive supporters say there are some cases in which it better be banned, particularly when competing moral

considerations are made salient. This suggests that professed consequence insensitivity should be taken as an expression of a strong moral belief rather than as literal endorsement of policy.

Author Note

All data, materials, and analysis code are available at Inbar, Y., & Waldhof, G. (2022). ResearchBox # 488 – 'GE Germany'. *ResearchBox. Wharton Credibility Lab*. https://researchbox.org/488. We preregistered our study design, hypotheses, and analytic plan at Waldhof, G., & Inbar, Y. (2020). GM Attitudes & Moral Absolutists (#40574). *AsPredicted. Wharton Credibility Lab*. https://aspredicted.org/qv645.pdf.

The research was approved by the IAMO Research Ethics Committee at the Leibniz Institute of Agricultural Development in Transition Economies.

The authors would like to thank ScienceCampus Halle (Plant-based Bioeconomy, EFRE funds, under Grant ZS/2016/06/79644), the Social Sciences and Humanities Research Council of Canada (Insight Grant # 435-2017-0304) for financially supporting this project. We would also like to thank the Leibniz Institute of Agricultural Development in Transition Economies (IAMO) for financial and infrastructural support of this project.

The authors thank Anna Martin for her help coding the free-text answers, and Christine Pitson for back-translating the probes.

The authors declare no competing interests.

Chapter 6 – General Discussion, Evaluation, and Interpretation of the Results[33]

Normative Evaluation and Interpretation of the Results

As mentioned above, it is a mission of new institutional economics to not only positively describe social phenomena, but to also derive normative reform recommendations from this positive description. For this purpose, the thesis applies a new institutional economics approach to economic ethics (Erlei et al., 2007; Pies, 1993) to evaluate and interpret the results.
Recall that the goal of the present thesis is to contribute to explaining why the German GE debate has been going on for so long without agreement, and why scientific information does not seem to contribute to advancing the debate.

Why is the German GE Debate so Stable? – Economic Ethics Interpretation.
The results indicate that for many people, the issue has become linked to their own moral identity in a way that they no longer pay attention to factual arguments. The ban on GE (or approval thereof) has become a (moral) goal in itself. This means that the debate is blocked because of a *confusion of goals and means:* When means become the moral goal, objective deliberations about their utility are impeded (Pies et al., 2021). This is because positions based on moral beliefs are more extreme and more stable than those derived from fact-based objective deliberation (Haidt, 2001; Ellemers et al., 2019; Inbar & Waldhof, 2022).
These thought-blockages can lead to adverse democratic policy decisions. The problem is that the relationship between the debating parties is perceived as a pure conflict of interests (tradeoff). For example, in the yearly demonstrations in Berlin called "Wir haben es satt!" (https://wir-haben-es-satt.de/), the relationship between the interests of conventional and organic agriculture is perceived as a tradeoff. In the dispute about agriculture, genetic engineering is a topic of which the positions "in favor" and "against" GE are clearly assigned as diametrically opposed. Due to this tradeoff-thinking, consensus appears impossible (see for example Pies, 1997).

Why Does Scientific Information not Help? – Economic Ethics Interpretation.
In the German GE debate, moralization led to a confusion of goals and means. Recall that so far, the official debate did not help to overcome this confusion of goals and means, but contributed to it. Reasons identified above are the prohibitively high transaction cost for

[33] Parts of the argumentation presented here have previously been published in: Pies, I., Waldhof, G. & Valentinov, V. (2021). Diskursblockaden in der Debatte um grüne Gentechnik — Analysen und Reformempfehlungen aus ordonomischer Sicht [Discourse Blockages in the Debate on Green Genetic Engineering - Analyses and Reform Recommendations from an Ordonomic Perspective]. *in: Edmund Rehwinkel-Stiftung der Landwirtschaftlichen Rentenbank (Ed.): Green Deal — Was kommt auf die Land- und Ernährungswirtschaft zu? Schriftenreihe der Rentenbank, Band 37, Frankfurt a.M., S. 93-146.*

detailed information, diametrically opposed argumentations by involved parties, incentives of debating parties, the media, and the public.

Scientific organizations attempt to solve this confusion of goals and means by contributing their expert assessment to the debate. Recently, Leopoldina et al. (2019) started arguing to evaluate the product rather than the process. GE should then no longer be evaluated as an entire technology, but case by case. Evaluating the individual products promises a more differentiated assessment of whether a certain GE product is a suitable means for some goals.

However, in reaction to this attempt, the NGO Testbiotech alleges that involved experts have close industry affiliations and interests in patents (Then & Bauer-Panskus, 2020).

Similarly, in 2016, 100 Nobel Laureates addressed Greenpeace and the governments of the world in an open letter (Roberts, 2016). In this letter, the Nobel Laureates strongly appeal to Greenpeace to cease and desist its campaigns against Golden Rice[34] and genetic engineering in particular. In general, the authors position themselves against opposition based not on scientific facts but on "emotion and dogma" (para. 7). They also call on governments to reject such campaigns. The criticism of Greenpeace in the letter is sharp: the NGO is accused of ignoring or misinterpreting scientific evidence, and of supporting field destruction. Implicitly, the Nobel laureates accuse Greenpeace of being responsible for the deaths of “poor people” (para. 8). They also speak of a "crime against humanity" (para. 8) in this context.

In response to the Nobel laureates’ letter, Greenpeace does not show the desired reaction, but insinuates bias: the NGO asked the lead author to be honest, and to disclose economic interests in the technology (Johnston, 2016).

These examples illustrate why scientific information has difficulty debunking misinformation in the German GE debate from an economic ethics perspective: scientists are not perceived as solving the thought-blockages, but as *part of* the tradeoff (see also Pies et al., 2021). In the public perception, enhanced by the mutual accusations of scientists and NGOs, scientists are perceived as competing party in the debate.

And since they focus on other moral foundations than those that the majority of the German public refers to, their insights are likely less efficient.

Concluding, the present results show that the debate is indeed moralized, and that this moralization results in two polarized positions about GE. Moreover, moral foundations seem to have a decisive contribution to this moral polarization. Additionally, the majority of the German public seems to align more with the moral foundations addressed by debating NGOs, than with those addressed by scientific organizations.

Thus, moral foundations as informal institutions can indeed be interpreted as problem-relevant restriction in new institutional economics because the results suggest that they

1) contribute to the ongoing polarization of the public GE debate,
2) and are a bottleneck for whether scientific information is effective.

Resulting Recommendations: Reforming the German GE Debate

The purpose of the normative evaluation and interpretation of the results is to eventually derive reform recommendations for public debates, science communication, policymaking, and

[34] Among products developed through genetic engineering, the so-called “Golden Rice” is a particularly prominent example. Called “golden” because of its yellow coloring, this rice is enriched with beta-carotene. Golden Rice can thus reduce the deficiency of beta-carotene, of which many people, particularly children, in developing countries suffer. Beta-carotene deficiency can lead to blindness (Golden Rice Humanitarian Board, 2022).

economic policy consulting. These are based on the assumption that a constructive, science-based debate is possible, and would lead to desired societal outcomes. Recommendations resulting from the present findings are described in the following.

In order to solve the moralized polarization, the confusion of goals and means has to be overcome. For this purpose, the present work proposes to identify *common* moral goals between the apparently conflicting positions. Building on these, arguments could be developed. These arguments could discuss whether GE products would be an appropriate means for common moral goals, or not. This can be achieved with actors who take the relevant moral goals seriously, and with incentives that support a constructive debate.

Arguments

The results of Chapter 5 suggest that there exist many of such common moral goals, even among the most extremely moralized in the debate. Specifically, in the probes applied in Chapter 5, many of the self-proclaimed consequence-insensitive supporters and opponents were able to state exceptions that would make them abandon their moral belief. These exceptions usually refer to moral goals that are congruent among supporters and opponents, such as human well-being or environment protection. This means that even those participants with strong moral beliefs about GE demonstrated openness to a consequence-based deliberation about GE, when presented with common moral goals.

Building on these common moral goals, arguments could be developed that shift the focus towards the moral goal and open the discussion about whether or not GE would be an appropriate means.

For example, an argument against GE can be reconstructed as syllogism, as shown in Table 6.1.

Table 6.1

Current Argumentation About GE and Economic Development

1. Normative Assumption:	It is a moral goal to sustainably promote economic development in poor countries.
2. Positive Assumption:	GE leads to the economic disadvantage of small farmers.
3. Conclusion:	Under the aspect of poverty reduction, GE should be **banned**.

Note. Adapted from Pies et al. (2021).

While adhering to the normative assumption, the positive assumption can be tested by drawing on a wealth of empirical research (see also Pies et al., 2021).

First, Klümper and Qaim (2014) conclude from a meta-study about the impacts of genetically modified crops, that they lead to a reduced pesticide use, as well as to yield and profit gains. From those, particularly farmers in developing countries benefit.

Second, similarly, Ahmed et al. (2020) find that the cultivation of genetically modified eggplants in Bangladesh increased small farmers' crop yield while reducing their pesticide use. And Zilberman et al. (2018, p. 1) conclude from a review article that „GMOs increase yields, lower costs, and reduce the land and environmental footprint of agriculture. The benefits of this

technology are shared among innovators, farmers, and consumers. Developing countries and poor farmers gain substantially from GMOs."
Concluding, the normative assumption, that effective development aid is a moral goal, is kept unchanged. However, the positive assumption must be revised because it does not align with the scientific evidence. The new syllogism is shown in Table 6.2.

Table 6.2
Syllogism with a Science-based Positive Assumption and Revised Conclusion

1. Normative Assumption:	It is a moral goal to sustainably promote economic development in poor countries.
2. Positive Assumption:	Small farmers benefit in many ways from GE, especially in the form of significant increases in income.
3. Conclusion:	Under the aspect of poverty reduction, GE should be **approved**.

Note. Adapted from Pies et al. (2021).

With this procedure, new arguments can be developed that focus on the common moral goals and test whether GE could be an appropriate means for achieving them.

Actors
Renowned scientists argue that GE would be an ideal support for a more sustainable and ecological agriculture. For example, Urs Niggli assesses that current organic agriculture is not suitable to solve the global problem of food security. Rather, products made with genetic engineering could be excellent support: identical to the natural active ingredient, produced ecologically and with low energy consumption (Deutschlandfunk, 2021).
Similarly, a team of scientists around Kai Purnhagen, Matin Qaim, and Stephan Clemens states that expanding organic agriculture further under the current legal restrictions on biotechnology could easily lead to less sustainability instead of more. Yet CRISPR in particular offers promising potential for sustainable agriculture (Lehmann, 2021).
However, as demonstrated earlier, scientists on their own have difficulties to make the debate more constructive. Rather, in order to effectively join the conversation with science-based moral arguments, the debate needs additional innovative and communicative actors that also care about the moral goals, and use modern and interesting communication formats. With their support, the public discourse can elaborate whether GE are useful for reaching these moral goals.
By now, the debate is increasingly joined by new NGOs and other groups who try to overcome the confusion of goals and means with evidence-based arguments. Examples are Die Progressive Agrarwende (https://progressive-agrarwende.org/), MaiThink X (https://www.zdf.de/show/mai-think-x-die-show), maiLab (https://www.youtube.com/channel/UCyHDQ5C6z1NDmJ4g6SerW8g), Grain Club (https://grain-club.de/), or transGEN (https://www.transgen.de/).

Incentives

The results suggest that an increased investment in science communication seems necessary to prevent misinformation. Here, the support of actors that care about the moral goals, and use modern and appealing communication strategies seems particularly promising.

More generally, the standards of public debates need to be raised. For this, strategies should be identified that make self-commitment services such as Accountable Now (https://accountablenow.org/) more effective. Moreover, people in the public could be provided with tools that help distinguish good arguments from bad arguments, or reliable sources from unreliable sources. An example for such tools is the application Cranky Uncle (https://crankyuncle.com/), that uses climate change conspiracies as an example to teach logical fallacies.

Furthermore, the Precautionary Principle (see for example Umweltbundesamt, 2021) plays a large role in the restrictive law about genetic engineering. This points to the necessity to take concerns about potential risks related to GE seriously. Specifically, it seems useful to develop a procedure that reduces the risk of abuse of this technology. However, at the same time, the Precautionary Principle needs to be addressed symmetrically (see also Pies et al., 2021). As a study by the European Commission (2021) finds:

> The use of NGTs raises ethical concerns, but so does missing opportunities as a result of not using them. [...] Any further policy action should be aimed at reaping benefits from innovation while addressing concerns. A purely safety-based risk assessment may not be enough to promote sustainability and contribute to the objectives of the European Green Deal […]. (para. 16, 21)

Outlook and Conclusion

Potential Future Research

Based on the work done in this thesis, there are many future avenues for research. Generally, it may be worth inquiring how the results of the content analyses would differ, if another moral theory was applied, and what this means for the validation of MFT for content analyses.

Moreover, it seems to be a valuable future research inquiry to combine the structural approach to MFT with computer-assisted methods. This way, the approach could be tested, validated, further developed and scaled. It could then be applied on a larger scale, and to a variety of topics other than GE. Specifically, the structural approach promises to contribute to the crowd-based approach developed by Weber et al. (2018).

Furthermore, the approach could also support the development of various computer-assisted methods, such as dictionary models, scaling, topic modeling, or classifications, e.g. wordfish or naive bayes approaches (Grimmer et al., 2022).

Moreover, new institutional economics could investigate under which circumstances moral foundations have desired effects, and when they have adverse effects. It also seems useful to further develop the theory as to how adverse effects of informal institutions can be regulated.

Similarly, approaches from individual ethics could identify further potentials for overcoming moral polarization and misinformation about new technologies. Research in experimental ethics or experimental economics could empirically test these new ideas as approaches to mitigate polarization and misinformation. Building on the results, strategies for science communication could be developed and tested.

And moral psychology could test whether GE opponents and GE supporters in the public generally differ in which moral foundations they find more important for their judgment.

The German GE Debate

Generally, it seems that the German GE debate is changing, and some of the above-mentioned reform recommendations are already being implemented. First, the debate is moving away from a dichotomous yes-no debate towards a more differentiated debate about what genetic engineering can and cannot do. Second, science-based arguments appear to be gaining increasing salience in the debate.

This is happening, not at least because more and more actors, that call for a science-based evaluation of products developed from GE technology, are joining the debate, such as Progressive Agrarwende [Progressive Agricultural Change] (https://progressive-agrarwende.org/). Moreover, the call for a science-based assessment of GE is gaining more media attention. For example, the TV show MaiThink X (2022) dedicated an entire episode to argue for a science-based evaluation of GE. Similarly, in December 2022, the TV show Heute Show [Today Show] (2022) argued that a general fear of GE is not science-based and should be reconsidered.

Interestingly, GE disappeared from the front page of the German Greenpeace website. Even more so, it does no longer belong to its main topics (see https://www.greenpeace.de/). Statements about this technology can only be found on this website through a direct keyword search (see for example https://www.greenpeace.de/biodiversitaet/landwirtschaft/anbau/gentechnik). While these statements are still opposing the technology, they are backed up by a link to an acceptance study by the market research and consulting company Kantar (2020), which shows developments away from a clear GE opposition among the public in Germany. In this study, respondents were asked whether GE plants should generally be prohibited in Germany. Among those respondents older than 39 years, the majority still agreed to this somewhat suggestive question. However, the majority of participants between the ages fourteen and thirty-nine disagreed. Kantar (2020) also organized these responses according to voting behavior. Strikingly, among those who vote for the Green Party in Germany, the majority disagreed to a general prohibition of GE plants. This is particularly interesting, because the Green Party maintains its general opposition against GE in its most recent version of its "Manifesto of Principles" (Bündnis 90/Die Grünen, 2020). Potentially, Greenpeace does not report on these results on their website because they are less favorable for Greenpeace's proclaimed unconditional rejection of GE.

In sum, these current developments align with the theoretical recommendations derived from the empirical results of this thesis. Fortunately, this trend gives rise to the hope of a more constructive debate about the genetic engineering of crops in the not-so-distant future.

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List of Publications

Inbar, Y., & Waldhof, G. (2022, July 27). Mitigating Consequence Insensitivity for Genetically Engineered Crops. Accepted at: *Journal of Experimental Psychology: Applied.* https://doi.org/10.31234/osf.io/bnq8c

Declarations

Liste der Titel, Koautoren und Selbstdeklarationen

Kapitel 2

Kapitel 2 mit dem Titel „A Structural Approach to Moral Foundations Theory – for Theory Development and a more reliable Application in Latent Content Analyses“ wurde von Gabi Waldhof in Alleinautorenschaft verfasst. Für diese Arbeit liegt die von Gabi Waldhof erbrachte Eigenleistung für Konzeption, Durchführung und Manuskripterstellung bei 100%.

Kapitel 3

Kapitel 3 mit dem Titel „Opponents and Supporters of Genetically Engineered Foods Emphasize Distinct Moral Foundations and Exhibit a Clash of Two Diverging Worldviews“ wurde von Gabi Waldhof in Alleinautorenschaft verfasst. Für diese Arbeit liegt die von Gabi Waldhof erbrachte Eigenleistung für Konzeption, Durchführung und Manuskripterstellung bei 100%.

Kapitel 4

Kapitel 4 mit dem Titel „Understanding Moral Narratives as Drivers of Polarization about Genetically Engineered Crops“ wurde in Koautorenschaft mit Ulrich Fritsche verfasst. Die folgende Einschätzung in Prozent über die von Gabi Waldhof erbrachte Eigenleistung wurde mit dem am Artikel beteiligten Koautor einvernehmlich abgestimmt.

- Konzeption: 75%
- Durchführung: 90%
- Manuskripterstellung: 90%

Kapitel 5

Kapitel 5 mit dem Titel „Mitigating Consequence Insensitivity for Genetically Engineered Crops“ wurde in Koautorenschaft mit Yoel Inbar verfasst. Die folgende Einschätzung in Prozent über die von Gabi Waldhof erbrachte Eigenleistung wurde mit dem am Artikel beteiligten Koautor einvernehmlich abgestimmt.

- Konzeption: 40%
- Durchführung: 60%
- Manuskripterstellung: 50%

Hamburg, den 31. Januar 2023

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Gabi Waldhof

Erklärung
Hiermit erkläre ich, Gabi Waldhof, dass ich keine kommerzielle Promotionsberatung in Anspruch genommen habe. Die Arbeit wurde nicht schon einmal in einem früheren Promotionsverfahren angenommen oder als ungenügend beurteilt.

Hamburg, den 31. Januar 2023

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Gabi Waldhof

Eidesstattliche Versicherung
Ich, Gabi Waldhof, versichere an Eides statt, dass ich die Dissertation mit dem Titel „Text Analyses for Identifying and Mitigating Moral Polarization about Genetically Engineered Food Crops“ selbst und bei einer Zusammenarbeit mit anderen Wissenschaftlerinnen oder Wissenschaftlern gemäß den beigefügten Darlegungen nach § 6 Abs. 3 der Promotionsordnung der Fakultät Wirtschafts - und Sozialwissenschaften vom 18. Januar 2017 verfasst habe. Andere als die angegebenen Hilfsmittel habe ich nicht benutzt: Software MaxQDA, GABEK, R, R Studio, SoSci Survey, Microsoft Office, Panelanbieter GapFish und die im Quellenverzeichnis angegebene Literatur.

Hamburg, den 31. Januar 2023

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Gabi Waldhof

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