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Field-Specific Mediatization: Testing the Combination of Social Theory and Mediatization Theory Using the Example of Scientific Communication[1]

Abstract. In contemporary media and communication science, mediatization is regarded as an "emerging paradigm", but the term itself is diffuse and highly contingent. An attempt is made in this paper to integrate structural and individual concepts of mediatization theory by combining it with Bourdieu's field theory using the example of science. After outlining the notion of mediatization underlying this text, the special features of scientific communication and the scientific field are presented. Hypotheses mentioned in the literature on the influence of new media technologies on science are contrasted with the state of research. This reveals that the impact of media innovations cannot be seen in a monocausal manner. In field-specific mediatization, they interact with various structural and individual elements.

Keywords: mediatisation; mediated communication; Bourdieu; field theory; science communication; scholarly communication; post-normal science

Introduction

Mediatization has developed into one of the most important theoretical concepts in media and communication science. Sonia Livingstone and Peter Lunt [2014] pose the question of whether mediatization is an "emerging paradigm for media and communication research". But the term "mediatization" is used differently in many contexts and appears diffuse. Nick Couldry and Andreas Hepp [2013] even speak of "two traditions of mediatization research". The concept is also highly contingent, something that is most certainly related to the permanent change of what it describes. In

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communication science and in sociology, the influence of mass media or journalism on society or politics was described as mediatization until the turn of the millennium. Due to the differentiation of the media landscape with digitalization and the Internet, mediatization has become increasingly broader. Niels O. Finnemann [2011] reconstructed the development of the term "mediatization", starting from the "logic of traditional mass media" [Altheide and Snow 1979] to "media logic of contemporary media" [Strombäck 2008] and "structural relations between different media" [Schulz 2004] up to a "meta-process as a conceptual framework" [Krotz 2007]. Contemporary mediatization research can be divided into different areas. As a *framework concept*, mediatization has the function of encompassing the various theories of media communication or these individual theories serve as building blocks for a growing and collectively developed mediatization theory. Examples include action theory, media repertoires and media convergence, media development research or domestication. *Everyday mediatization* has until now been the main topic of empirical mediatization research, and deals with specific *cultural spheres* such as culture, intellectuals, film or religion. *Mediatization by individual media* focuses on new and mobile media such as mobile telephones. These aspects are more or less established. One shortcoming is the theoretical integration of individuals and structural concepts in mediatization theory. Another shortcoming as stated by Couldry [2014] is "mediatization's social theory deficit". This paper agrees with Couldry's propose that these shortcomings can be remedied by combining mediatization theory and Pierre Bourdieu's field theory. But it also responds to weaknesses of Couldry's attempt which can be seen in the lack of integration of theory and empirical analysis, the lack of integration of Bourdieu's different theoretical instruments, the lack of integration of individual and structural components and the lack of adjustment to a special social field. Bourdieu's theoretical concepts are distinguished by the fact that they are not overly rigid; rather, as flexible instruments or theoretical building blocks, they can be adapted to each phenomenon under consideration. André Jansson [2015] already applied mediatization in combination with field theory to the domain of UN organizations. In this paper, field-specific mediatization is conducted using the example of the scientific field.

In the first step, the notion of mediatization underlying this paper is explained. After outlining the particular features of scientific communication, an overview of the potential impact of mediatization on scientific communication is presented. These theses are then contrasted with the state of research, which reveals that new media technologies are used to a far lesser extent in scientific communication than assumed. This is due to the specific nature of the scientific field and its relatively innovation-resistant and historically evolved structures, which, on the one hand, interact with the media change and, on the other hand, with the individual habitual disposition of scientific agents. A specific scientific field is then presented in which all conceivable forms of mediatization can be observed, unlike in the state of research. Climate research is an example of post-normal science and demonstrates the influence of

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general socio-cultural change. Science as a social field interacts with the social sphere. The impact of media innovation cannot be considered in a monocausal manner; it interacts with various structural and individual elements in a complex and dynamic system. These elements vary qualitatively and are specific to each of the social spheres examined and to a given society.

Mediatization

Mediatization theory is constantly changing and the term "mediatisation" is used with varying meanings. This paper is based on a combination of the concepts coined by Friedrich Krotz and Winfried Schulz. Mediatization means the influence of the media change [Krotz 2007] on human communication and interaction, on social and cultural reality and, therefore, on each social and cultural phenomenon [Krotz 2009]. Media can be seen as agents of social and cultural change [Hjarvard 2008]. Mediatization is a historically defined, constantly progressing meta-process (comparable and related to globalization and commercialization), in which more media are steadily emerging and being institutionalized. Media in a general sense is something that modifies communication. "Being mediated" is, therefore, an attribute that is generally associated with communication. "Being mediatized", in contrast, implies that every social and cultural phenomenon depends on media [Krotz 2009, p. 24]. This brings us to the communication theory basis of the mediatization concept. The starting point is *communication as a fundamental human practice* on the level of direct communication (face-to-face, gestures and language). With technical media, the mediation of communication begins. Krotz [2009, p. 24] differentiates between three forms of mediation:

- *Mediated interpersonal communication* – this entails a reciprocal communication of at least two persons using a technical medium. The medium is used as a means of transport for communication over space and time (e.g. telephone, letters, e-mail, chat, forum, etc.).
- *Interactive communication* – communication *with* machines, whereby the machine has been programmed by people and is, therefore, better described as indirect communication between two people.
- *Mass communication* – communication as the production and reception of broadly addressed, standardized content.

Schulz [2004] arranged the meta-process of mediatization into four sub-processes, which, in turn, can be divided into two classes [Lüthje 2012] – mediamorphosis and limited mediation. *Mediamorphosis* includes Schulz's sub-processes of extension, substitution and amalgamation, and describes the holistic technological influence on the individual agents, their (not only communicative) action and their relations to other agents. With *extension*, the natural limitations of human communication by

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space and time are eliminated. With *substitution*, interpersonal activities and social institutions are replaced by media activities and institutions. With *amalgamation*, former non-media and media activities ultimately merge together. *Limited mediation* includes the sub-process of accommodation. Non-media agents adjust to the rules of media (e.g. values, formats and routines). This process is regarded as limited with respect to Krotz's concept because only the mass media level is included. It is a special field's effect that can be best interpreted as blurring the boundaries between social fields. The three sub-processes of mediamorphosis, therefore, tend to affect individuals, whereas limited mediation is a more structural concept.

Mediatization as a meta-process is regarded as a phenomenon that concerns society as a whole and as a framework concept. But the focus until now in empirical mediatization research has been mainly on everyday mediatization. Both levels of mediatization – structure and individual – have not been connected until now in either mediatization theory or in mediatization research. That both concepts are considered in parallel is shown in Table 1 (on sub-processes (Schulz) and mediation forms (Krotz) [Lüthje 2012, pp. 117–118], shown in Table 1 as a matrix). Substitution and amalgamation, i.e. replacing and merging, are summarized as relatively similar, chronologically successive and empirically nearly inseparable sub-processes. Table 1 demonstrates that the individual action component of mediamorphosis (extension, substitution, amalgamation) corresponds to the more individualized forms of mediation (interpersonal and interactive communication), while accommodation corresponds to mass communication.

Table 1. Sub-processes and mediation forms

Mediatization sub-processes	**Forms of mediation**		
	Mediated interpersonal communication	**Interactive communication**	**Mass communication**
Extension	Extension of the communicative potential of people (range and accessibility).	AI: Extension of the communicative abilities of people.	*Not integrated until now.*
Substitution/ amalgamation	Communicative practices, relationship patterns, identities.	Relationship patterns: Replacement of human interaction partners, communicative practices.	*Not integrated until now.*
Accommodation	*Not integrated until now.*	*Not integrated until now.*	Reception practices; "mediation" as adapting to media rules.

Source: Author's own study.

Between the meta-level and micro-level, however, there is still space to consider the meso-level, in which the structure and individual are integrated. Society is differ-

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entiated into social fields, each with its specific rules and practices. The quality and intensity of mediatization varies in the different social fields. The use of media is determined not only by our individual preferences, but is rather field-specific. Elements of the social practice of media use are (1) the respective media repertoire and (2) the type of use (frequency, duration and form of the use). In this paper, the concept of field-specific mediatization is developed using the example of science.

Scientific communication

Scientific communication can be divided into external and internal communication. External scientific communication includes public science communication and cross-field science communication. Internal scientific communication includes formal and informal scholarly communication [Voigt 2012].

External scientific communication seeks to convey scientific findings, recruit new scientific talents, inspire trust and credibility, and secure the provision of sufficient financial and structural resources for science. It is also the negotiation of socially legitimate forms of science and the manner in which society deals with scientific knowledge [Hagenhoff et al. 2007].

Public science communication can be divided into the communication of science to the public and the communication of science with the public. This science communication includes science journalism, science PR as well as events, shows or exhibitions that are addressed to as wide an audience as possible [Pansegrau, Taubert and Weingart 2011]. Important key points are knowledge transfer, popularization, public science or public understanding of science.

Cross-field science communication, in contrast, relates to the communication of agents in the scientific field with agents from other social fields such as politics, economy and media. On the one hand, communication with the political field has to do with the existential conditions of science (e.g. financing, social status). On the other hand, scientists are important as expert advisers for the decision-making of politicians.

In contrast to external communication, *internal scientific communication* is essentially designed to provide follow-up communication, such as a subsequent publication or citation [Kaden 2009]. There is a certain chronological order to this: formal scholarly communication is always preceded by informal scholarly communication. This sequence, however, is not mandatory, and not every informal scholarly communication is followed by a publication. Both forms of scholarly communication follow strict rules, whereby all *rules are generated within science and developed through history* and, at the same time, are *in principle mutable* through the interaction of field rules and individual *habitus*.

Formal scholarly communication can be understood as scientific public communication. It is a scientific publication, that Ben Kaden [2009] views as the central

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communicative practice of science because it assesses and presents scientific knowledge. Formal communication relates to authoring and publishing scientific texts, legitimate text types (monographs, book chapters, journal articles) and media as well as all related practices (e.g. peer review, publications, citation rules, formal structure of texts, etc.) [Gloning and Fritz 2011]. Formalization is based on *fixed written communicative rules* and *verification of their adherence* in a *regulated process*. Accordingly, this communicative process is characterised by a relatively high degree of awareness. Although the publication rules are habituated and are incorporated the longer the agent has belonged to the scientific field, they are not made fully invisible. Prior to submission, each text is reviewed by the author him/herself since access to publication is denied if the rules are ignored, irrespective of its epistemological value. Controlled adherence to the rules is necessary to ensure the structure of the scientific field and to demarcate the environment (social space and other social fields) [Kaden 2009]. The functions of formal scholarly communication are (1) assigning authorship, (2) quality control, (3) making knowledge visible for further use (state of research, follow-up research) and (4) storage and archiving [Hagenhoff et al. 2007, p. 8]. To this end, it is important that the products of formal scholarly communication are in principle open to the public (e.g. in university libraries, through the book trade). The real barrier is not media-related but rather linguistic: each academic discipline utilizes a specific, subject-esoteric language (terminology), which is difficult for laypeople as well as colleagues from other fields to decode. In addition, scientific literature has an extremely high number of conditions, and the process of producing a scientific publication is time-consuming. It is, therefore, older and long-term information.

Informal scholarly communication includes all other areas of scholarly communication. Although it *does not follow fixed written rules*, it is no less strictly regulated than formal scholarly communication. The practices of informal scholarly communication correspond to *field logic and are habituated and made invisible*. Informal scholarly communication is a product and, at the same time, generates social networks, most of which are relatively closed. Here it is mainly about interpersonal communication, which is protected and limited by barriers preventing access to the network. It is the latest information but only conditionally because (1) it is only temporarily valid at the time of the first communication, (2) it is found in the communicative construction process itself, (3) it is correspondingly mutable, and lastly (4) it has not yet been reviewed. To sum up, the functions of informal scholarly communication are the social exchange among scientists, the development of ideas, and cooperation in implementing them [Voigt 2012]. To this end, it has two objectives: (1) the production of scientific publications and (2) the creation of a communicatively closed community [Kaden 2009, p. 58]. *Publication preparation* is communication in the actual research process during the communicative construction or production or fabrication of knowledge, e.g. in the laboratory [Knorr-Cetina 1984; Latour and Woolgar 1986], but also when preparing to cooperate. It is about collaboration, the division of labour, reciprocal

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coordination of mutual information and updating knowledge in personal exchanges, as well as the creation of proposals to procure funding [Gloning and Fritz 2011]. Communication forms consist of direct and personal discussions, disciplinary meetings or research group meetings, workshops, symposiums and conferences [Kaden 2009]. *Community-building communication* is, on the one hand, strategic communication on individual positioning and, on the other hand, expert communication to transmit the "tacit knowledge about structure and rules of communication" [Kaden 2009, p. 74], i.e. mediation and habituation of field-internal communication rules. This transmitted communication is directed to the next generation and includes (1) scientific training, (2) the integration of young scientists in the research process [Kaden 2009, p. 75] and (3) strategically introducing young scientists into networks (e.g. through a mentorship).

Scientific communication – internal as well as external – is subject to a permanent transformation. This communicative change has an impact on the communicatively constructed science and the communicatively constructed scientific knowledge. Scientific communication (increasingly also informal scholarly communication) is to a large extent media communication. And communication media also finds itself in a permanent change. What impact does the media change have on scientific communication?

Mediatized scientific communication: Assumptions

Mike S. Schäfer [2014, p. 574] took the idea of the combination of sub-processes of mediatization (Schulz) and Krotz's forms of mediation and applied them to the scientific field. Until now, there has only been a narrow empirical research base. For this reason, Schäfer integrated assertions, assumptions and hypotheses represented in the current literature. He showed that with the focus of a particular social field, it is possible to integrate agent and structure into the mediatization concept. He also showed that the media change and the subsequent changes in communication can have profound consequences on the nature of science, its relationship to the environment (social space and other social fields), the knowledge generated by it and the professional self-conception of scientists. Two synthesis steps were carried out in tandem in this attempt. Mediated interpersonal communication was subsumed directly under scholarly communication, which, in turn, is not divided into informal and formal communication. External communication, in contrast, emerges only as mass communication and, thus, as public communication; cross-field communication was omitted. In Table 2, a step back is thus taken again, and mediated forms are associated with the forms of scientific communication.

Looking at Table 2, it should be noted that the most important consequence of the media change on science is most likely communicative and societal *delimitation*.

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Table 2. Forms of mediation and forms of scientific communication

Forms of mediation	Scientific communication			
	Public	**Cross-field**	**Formal**	**Informal**
Mediated interpersonal communication	Citizen participation in science: participating in production of knowledge, evaluation, definition of quality criteria.	New modes of communication and negotiation.	New submission and evaluation practices, involving external agents in the evaluation process.	Informal scholarly communication occurs in public, is accessible and can be commented on.
Interactive communication	Transfer of knowledge generates knowledge, research takes place in the public sphere, research can be reviewed.	Consultation is facilitated.	New evaluation methods for scientific work and, therefore, new quality criteria.	Extending research laboratories to a virtual space.
Mass communication	New journalistic information sources and research practices.	New action roles for scientists, boundaries between social fields blur.	Distinction between formal scholarly communication and mass communication fades.	Risks to publicly mediated informal scholarly communication: Internet skills necessary.

Source: Author's own study.

But it also indicates that the three forms of mediation are not (or no longer) clear-cut. Mediated interpersonal communication is becoming mass communication in blogs, forums and microblogs. Especially in science, mediated interpersonal communication can become interactive communication when netnography is used in research methods. Both the differences between the forms of scientific communication as well as the boundaries between science and overall social space on the one hand, and between science and other social fields on the other hand, are becoming blurred. Informal scholarly communication is becoming public, and science communication is becoming less formal. Overlaps are emerging.

In the area of *public communication*, mediated interpersonal communication is enabling a new form and intensity of participation in science, culminating in the production of knowledge (informal scholarly communication) and the assessment of scientific quality. This is achieved by amateur blogs on science, discussions in forums (e.g. blogs by scientists), microblogging and open peer review. In the field of interactive communication, the linear transfer of knowledge through new platforms can become interactive means of generating knowledge. On the other hand, agents from outside the field of science can examine the quality of scientific work using special software such as plagiarism scanners, and the results of these reviews are discussed openly in social media. The current discourse on plagiarism is an example of this, with both positive and negative consequences; while the examination of quality is transparent, computerized examinations of texts are able to reveal only one element

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of scientific quality. What remains hidden, for example, are the criteria of innovation and originality, which are qualitatively quite high, as well as the software and the external agent. At the same time, these publications exert social pressure on the scientific field, which is in danger of losing its autonomy. Journalists use social media as a new form of sources of information, as they do with blogs by scientists. This is causing research practices to change.

Cross-field communication has changed. Mediated interpersonal communication is influencing cross-field communication because it enables new modes of negotiation via online discussions or Delphi. Likewise, consultation is being facilitated by intuitive interaction presentation platforms.

Formal scholarly communication is seeing its boundaries being lowered through the inclusion of non-science agents in the assessment process (open peer review). New submission and assessment practices (online procedures) are evolving through mediated forms of interpersonal communication among scientists. Interaction communication is enabling new evaluation methods of scientific work. In addition to bibliometrics, webometrics and, therefore, new quality criteria are occurring. New publication media and platforms for formal scholarly communication (e.g. open access) are also facilitating access to scientific publications. The boundaries between formal scholarly communication and mass communication are permeable.

Lastly, *informal scholarly communication* is making its way into the public via blogs and forums, and it is accessible and can be commented on. Through interactive communication and computerization, the research laboratory is being extended into the public sphere. But with the media change come threats, e.g. when informal scholarly communication, such as Web 1.0 applications like e-mails, are hacked, published by non-science agents and turned into a scandal, as occurred for instance in the "Climategate" scandal in the lead up to the climate summit in Copenhagen in 2009. The combination of mediatized interpersonal communication and mass communication is necessitating the development of specific Internet skills. These are the hypothetical consequences of media change on scientific communication. But what does the state of research say?

Media change and science: State of research

The impact of new media technologies on scientific communication has been of interest to information science since the beginning or early forms of the Internet (ARPANET beginning in 1969). There is a wealth of information science studies on this, especially out of the US. Shortly before the release of the Internet for commercial use, Leah A. Lievrouw and Kathleen Carley [1990] developed a model on how scientific communication could change through the use of telecommunications technology. Telecommunication is defined by Lievrouw and Carley "as the existence of

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geographically dispersed, intensively communicative research groups and collaborators, electronic journals, and teleconferences" [1990, p. 459]. The new communication channels thus allow for a more intense contact over great distances. The structure of informal scholarly communication includes expanded research groups, cross-university mentor-student groups and larger and more disperse interpersonal networks. At the same time, however, group membership is also dependent on access to certain communication channels. According to this model, new communication technologies promote in the medium term mostly informal scholarly communication within specific disciplines or scientific communities, consolidation and homogenization within scientific fields, and distinctions versus other disciplines. It was generally accepted that with the technological change, invisible colleges would also change [Lievrouw and Carley 1990; Walsh and Bayma 1996; Carley and Wendt 1991; Clark 1995; Noam 1995; Ginsparg 1994; Harnad 1991].

From the mid-1990s until the turn of the millennium, one can observe a drop in research interest. Only afterwards can empirical studies once again be found [Costa and Meadows 2000; Cronin 2003; Fry 2004a; 2004b; Fry and Talja 2007; Kling 2004; Kling and Callahan 2001; Kling and McKim 2000; Tuire and Erno 2001], but now with a notably low theoretical foundation and without using communication modelling. Since 2004, a few surveys have been conducted [Bader, Fritz and Gloning 2012; Barjak 2006; Frandsen 2009; Koch and Moskaliuk, 2009; Matzat 2004; Procter, William and James, 2010; Voigt 2012], and scholarly communication via digital media was the subject of the German-Austrian project group Interactive Science from 2008 to 2011 [Gloning and Fritz 2011]. The studies from this period differ according to the disciplines, status groups and countries examined, as well as the different survey methods used (e.g. face-to-face, paper-pencil or online). Nevertheless, they reach similar conclusions. The use of online methods for science differs according to a country, discipline and status group or generation. Web 1.0 media (such as e-mail or mailing lists) are used across the board, unlike social software (Web 2.0). The use is more passive and geared towards searching for information. Overall, the potential of new media technologies for scientific work is not being exploited.

In the studies that emerged shortly after the turn of the millennium, young scientists do not yet reveal themselves to be trendsetters. As might be expected, they use social media in their private lives, but they have not transferred this practice into their professional lives. However, recently published studies indicate a new development [Al-Aufi and Fulton 2014; Cimenler, Reeves and Skvoretz 2015; Gruzd, Staves and Wilk 2012; Gu and Widén-Wulff 2011; Nicholas and Rowlands 2011; Noonan and Stratton 2015]. Disciplinary differences still exist. Blogging is still not widespread, and even microblogging (such as Twitter) is not yet commonly accepted. But Facebook has since become very widely and positively regarded for networking.

Another current line of research focuses on specific scientific social media such as ResearchGate or Academia.edu. In their study, Spencer Goodwin, Wei Jeng and Daqing

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He [2014] examined the development of community interfaces on ResearchGate (from forums to topic tags and Q&A platform) and the influence of these interfaces between the user and machine as an invitation or barrier for the communicative activities of the users. Mike Thelwall and Kayvan Kousha are interested in the question of whether these platforms reflect established science structures or whether they create new ones. In their study on ResearchGate [Thelwall and Kousha 2014b], they confirmed the well-known national differences in the acceptance and use of social media for scientific communication due to the different national media environments and traditions. In their study on Academia.edu [Thelwall and Kousha 2014a], they asked if it is more a social network (such as Facebook) or more an academic one (invisible college). They observed a continued dominance of science structures, and reputations are still the central value here. However, young scientists are cited more often than older ones, which they attributed to the fact that older scientists are less likely to upload their texts and make them available than the younger ones. It appears that a generational change and a gradual change in the communicative practices are developing.

Nevertheless, it is important to note that the potential of new communication media is not being fully realized, and it is clearly being used in scientific communication with a time lag. The scarce resource of time is named as one of the most important reasons for this. Prior to using new media technologies, their utility is weighed, with utility being measured in professional scientific tasks according to the known canon and in a process characterized by pragmatism. A second reason named is the resilience of established professional cultures and traditions as well as (symbolic) power relations. Young scientists in particular fear a loss of reputation by circumventing or extending the traditional communicative practices in their own disciplines. A social theory framing can be used to explain these findings. This paper proposes applying Bourdieu's concept of socio-cultural theory. *Field-specific mediatization* pertains to the *interplay of field logic, individual habitus and media change.*

Science as a social field

Modern societies are differentiated into various social fields, each with their own logic and social practices, which also includes communicative practices. Science is a sub-area of society. It is found in society and is constituted on the one hand, by its internal rules and on the other hand, by being rooted in society at large and its relationship to other sub-areas of society such as politics, economy or media. Bourdieu did not devise a self-contained overarching theory of culture and society. Nevertheless, it is important to consider the interdependence of his flexible theory components, which in each case must be empirically applied and adapted to the respective research object. The interdependence between individual and structural components can be expressed in a formula [Bourdieu 1987, p. 175]:

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[(*Habitus*) (Capital)] + Field = Practice

Bourdieu's cultural and social theory is based on the notion of society as a *social space* which is divided into sub-areas called *social fields*. Space and fields are subject to the same operating principles [Papilloud 2003]. Social fields are embedded in the social space but are relatively independent and clearly distinguished from one another. Nevertheless, they exist in a systematic interrelationship and interact. One of these social fields is science [Bourdieu 1992; Münch 2007]. Each social field has its own field logic, meaning that a specific mixture of *types of capital* (economic, cultural, social or symbolic) is relevant for each one, and every field is characterized by a specific *habitus* and specific *practices*. In the social field of science, there are individual agents (scientists) and groups of agents (in fact, "sub-fields": academic disciplines and institutions such as universities and their faculties and departments, research institutes, professional associations, etc.). These agents and groups assume specific positions within the field and define themselves and the social field through their *relations* to each other. In science, a certain mixture of types of capital is relevant, whereby economic capital is traditionally more subordinate but is strongly gaining in importance. Important scientific capitals are (1) external funding (economic); (2) scientific socialization and knowledge or incorporating the rules of science and scientific work (incorporated cultural capital); (3) publications, number of staff and scientific equipment (objectivized cultural capital); (4) academic titles such as doctorate, habilitation and professor (even when it is strictly speaking a job title), which were acquired from the "right" institutions, as well as prizes awarded (institutionalized cultural capital); (5) access to important networks and membership in the invisible college (social capital); and (6) scientific reputation and standing (symbolic capital).

A social field is also a field of power: the higher an agent's position in the field, the greater his/her *symbolic power* to assert relevant attributions of meaning and designations for the field. In the scientific field, this relates to both the internal constitution of science (field logic) and the "legitimate" knowledge that is disseminated. Although the scientific ideal is peer evaluation, experience shows that position in the field, reputation and social relational capital are important for disseminating, delaying the dissemination and sometimes even suppressing innovative knowledge. *Habitus* means the schemes of perception, thought and action [Bourdieu 1993, p. 99] of social agents in social fields. *Habitus* forms are systems of enduring and transferable dispositions and act as generative and ordering bases for practices and conceptions [Bourdieu 1993, p. 98]. The *habitus* is incorporated and rendered invisible and is thus an unconscious practice. Therefore, a practical action is almost an unconscious one; it is not reflected but can be seen as the result of an acquired social instinct, which ensures that it is perceived as "appropriate". The habitual constitution of social groups or their specific field logic can be reconstructed by observing their practices. In this respect, social agents and fields are interdependent. Both the *habitus* and the field rules have evolved

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over time, but also in relation to one another through a mutual communicative exchange. Bourdieu examined the practices of recruiting university lecturers in France. Implicit criteria underlined the "tacit, if not unconscious" [Bourdieu 1992, p. 224] decisions about the candidates made by the professors involved. These criteria were discipline-specific combinations of capital (e.g. academic titles, place of education and place of work, publications, etc., but also age and gender). In contrast, Richard Münch [2007 p. 10] describes the German "academic elite", which stands out with its "academic excellence from the university mass operations" and which is regarded by the "naive everyday view as exhibiting outstanding performance", as a "social construction" from a sociological perspective.

An important feature of the scientific field is that the individual types of capital are interdependent. There are positive feedbacks between the different capitals, leading to the Matthew effect in science as described by Robert K. Merton [1968]. The greater a scientist's reputation, the greater the likelihood that his/her publications will be cited and his/her proposals will be approved by referees for external funding. Reputation means that texts are recognized and deemed relevant, which is extremely important for the rising tide of scientific publications. Citation comes only after recognition. For externally funded applications, not only a project's excellence but also the applicant him/herself is evaluated. Academic reputation is based to a large extent on publication output (number of publications, publication medium, citation rate). In double-blind peer-review processes, the publication of scientific findings, in turn, also depends strongly on the reputation of the author and his/her social relational capital, as Gerhard Fröhlich [2008] demonstrated, because before the blind assessment comes the publisher who decides whether an article even enters the review process and who should assess it. The choice of an expert reviewer is essential to the success or failure of the submission.

Central scientific practice is the practice of communication. It determines (1) the negotiation of internal field rules, (2) the positioning of the scientific field in the social space, and lastly (3) the production of knowledge. The practice of knowledge production is as discipline-specific as the recruitment practice. Scientific disciplines differ not only according to their objects of knowledge but also at the level of theory (philosophy of science, epistemology, theories on the subject area, methodology), methods used, terminology, and last not but not least, the everyday communicative practices. Science as a social field offers as a knowledge context an overarching structure in which each respective disciplinary structure is embedded. Each discipline is a specific thought collective with its own thought style [Fleck 1980] in which knowledge is socially constructed. This social construction is a process that is based on communication. Knowledge and scientific knowledge are communicatively constructed or produced [Knorr-Cetina 1984; Latour and Woolgar 1986]. From an organizational point of view, communication is the "essence of science" [Garvey 1979]. From the perspective of the sociology of knowledge, communication can be seen as the essence of knowledge.

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With this social theory foundation, one can develop a model of conventional scientific communication, which takes a *matryoshka* structure as its starting point (Figure 1). Both external and internal scientific communication as well as the four forms of public communication, cross-field communication, formal communication and informal communication can, in principle, be clearly distinguished from one another. The individual layers of communication are interlaced and, therefore, arranged hierarchically. The framework forms the overall social space in which there are the social fields, then in those there are the sub-fields (disciplines or institutions), and in these the individual agents.

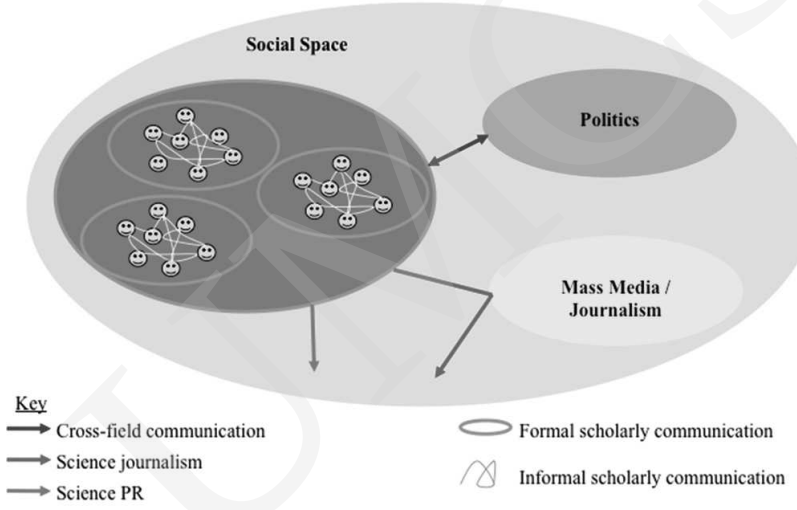

Figure 1. Model of conventional scientific communication
Source: Author's own study.

The effects of media change are not yet integrated into this model. The concept of mediatization provides the theoretical basis for this. The use of media is a social and cultural practice that is part of the field-specific logic. Media change exerts change on the practical and habitual level. The individual *habitus* is an accumulation of the relevant types of capital in the individual biography and is also strongly determined by the generation to which one belongs. Field-specific mediatization pertains to the interplay of field logic, individual *habitus* and media change in the social space. Young scientists are socialized in relatively innovation-resistant and historically evolved field structures. This pertains to both science as a whole as well as the individual disciplines. From their weak position in the social field of science, they have asserted a limited symbolic power potential and, therefore, limited opportunities, media innovations or communicative-practical innovations in the field. They adapt. Nevertheless, they do participate and, at the very least, advance a gentle change.

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Science change: Post-normal science

Notwithstanding the previously documented state of research on media change and science, lively activities in social media can be observed in certain scientific fields. Some prominent climate scientists can be found among the active bloggers, such as Stefan Rahmstorf and the KlimaLounge (http://www.scilogs.de/wblogs/blog/klimalounge), the group blog Klimazwiebel (http://klimazwiebel.blogspot.de/) led by Hans von Storch, or Roger Pielke Jr.'s blog (http://rogerpielkejr.blogspot.de/). Climate research is a relatively recent field of science, which has its beginnings in natural sciences. Until the 1970s, climate research was considered to be part of meteorology. With growing awareness around the complexity of the processes, a multi- and/or interdisciplinary research field developed by the end of the 1980s; since the 1990s, it has also come to include social, economic and cultural sciences. For now, climate research is still regarded as an interdisciplinary field of research, but it is on the way to becoming an independent, integrative discipline [Kappas 2009]. Since the 1980s, awareness of the political dimension of the subject has developed in the field of climate research. The Intergovernmental Panel on Climate Change (IPCC) was founded in 1988 by the World Meteorological Organization and the United Nations Environment Programme (UNEP). With the establishment of the IPCC at the latest, the step into the transdisciplinary was taken. In the first IPCC report in 1990, the demand for a global "climate treaty" was formulated. The Earth Summit in Rio de Janeiro in 1992 underscored the social and political significance of the climate issue. Building on Rio '92, an annual UN climate conference (COP: Conference of Party) has taken place since 1995, where politicians strive to reach an internationally binding treaty on the basis of scientific expertise. Public interest in climate issues is strong worldwide. At the same time, the political and social implementation of climate targets and measures are highly controversial. This is partly due to the fact that in the face of growing public interest, scientific discourse is increasingly held in the public sphere. In addition to the political and economic exploitation of scientific knowledge, the uncertainty, conflict nature and value orientation of this knowledge increasingly enters the public consciousness. Climate change is a global problem and was only transformed into an important item on the political and public agenda by politically interested scientists. The declared aim of climate scientists is to mobilize citizens to adopt a climate-friendly lifestyle and actively search for information on the subject. At the same time, they regard mass media coverage on climate research as sensationalist, abridged and distorting.

Climate research is highly mediated and has evolved according to the technological media change. Climate research experienced an immense upswing with digitalization and the development of increasingly more powerful computers [Stehr and von Storch 2010, pp. 5–10]. The complexity of combinable data is dependent on the performance capabilities of computers. In this regard, however, climate science has increasingly moved away from the basic principles of an exact science because, since the 1990s at

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the latest, it has tended to focus less on concrete empirical observations and measurements and more on models, scenarios and computer simulations [Conrad 2008, p. 127]. Computer science or simulation science entails a new type of knowledge production [Gramelsberger 2010], and the uncertainty of knowledge grows with this simulated nature [Petersen 2006]. The contradiction between scientific self-conception of the pure, i.e. exact physics, and the (social) constructive element of computer models was already postulated by Hans von Storch in 1996 [p. 85]. This is the level of interactive communication. Mediated interpersonal communication is, however, what has enabled major international climate research projects in the first place. And yet the use of new media is not without risk, as 2009's "Climategate" showed. Mass communication and mediated interpersonal communication are commonly linked to climate scientists because they communicate more over blogs due to dissatisfaction with journalistic coverage. To a large extent, climate research conceives of itself as a post-normal science [Krauss, Schäfer and von Storch 2012].

Post-normal science [Funtowicz and Ravetz 1993] is a special process for the production of new knowledge and the (at least temporary) creation of institutions that produce this knowledge. In contrast to the "scientific revolution" as a type of mutation [Kuhn 1962], the origins of this scientific change are not located within science but rather outside of science in a "post-normal situation". Post-normal situations are crisis situations with a high degree of complexity, great uncertainty and strong interest from different groups; they are loaded with values and produce considerable pressure to make decisions or take action. These crisis situations can no longer be processed in the scientific field. Therefore, transdisciplinary institutions have been entrusted with the task of developing problem-solving strategies that, at the same time, represent a new knowledge. Post-normal research fields are, for example, technology assessment, risk research, environment, climate change, health, reproductive medicine or genetics.

All of these research fields are, at the same time, policy areas. The transdisciplinary institutions form a new social field in which representatives from science, politics and interest groups meet. For science it is especially important that the "relevant peer community", which is responsible for evaluating quality, is extended beyond the boundaries of a particular scientific community to an "extended peer community" in which citizens participate in the negotiation and assessment processes. Indigenous knowledge, i.e. non-scientific, traditional knowledge of laypeople, is not necessarily regarded as the same as scientific knowledge in post-normal science, but is rather an important part to consider in the production of knowledge. Post-normal science is intended as a complementary concept to conventional, disciplinary science and has the task of generating in-depth, expert knowledge that is combined in new ways by post-normal science, i.e. it can be placed in a larger context. Post-normal science has a particularly strong bearing on the public. New media play an important role, too. Extended peer communities receive far greater reach and power through the Internet [Funtowicz and Ravetz 2003]. As part of the participation, negotiation and review processes migrate more and

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more into the new media, such that extended peer communities are now regarded to a large extent as online communities. Cross-field communication has changed, and scientists no longer behave merely as advisers but also as political agents. According to Peter Weingart [2001], this change can be attributed to three interfering processes: (1) the scientification of public policy, (2) the politicization of science, and lastly (3) the mediation of new relations between politics and science, meaning the influence of mass media on science and politics or their adaptation to the rules of the media field. This leads to a blurring of the boundaries between the social fields, science, politics and media. Furthermore, all potential impacts of Krotz's three mediated forms on the four forms of scientific communication, which are shown in Table 2 can be observed in climate research as an example of post-normal science. This contradicts the state of research on conventional science and demonstrates that, in addition to the technical progress in terms of media change, a general socio-cultural change is also responsible for the change in scientific communication. By this is meant society's demands on science and the framework conditions made available to it. This change affects not only the constitution of the scientific field, but also its positioning in the overall social space and its relationship to other social fields such as politics, economy and journalism, as was explained using the example of post-normal science.

Conclusion: Complexity and dynamic as features of field-specific mediatization

In this article using the example of scientific communication, field-specific mediatization was conceived as a result of the interplay between field logic, individual *habitus* and media change. However, the social field is still divided into sub-fields (disciplines, institutions), each with their specific logic. In addition, science interacts with other social fields and the environment of the social space. Thus, communicative and socio-cultural change can be understood as a complex dynamic system [Mainzer 2004] in which the individual elements are interdependent (Figure 2).

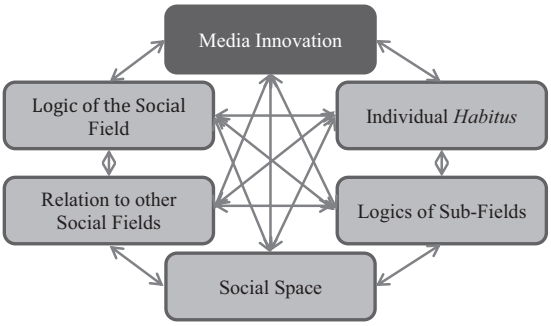

Figure 2. Elements of field-specific mediatization

Source: Author's own study.

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These elements can be applied to science. The most important consequence of the interaction between media change and socio-cultural change on science is presumed to be a partial communicative and social delimitation. Both the differences between the forms of scientific communication as well as the boundaries between science and the overall social space on the one hand, and between science and other social fields on the other hand, are becoming blurred. Informal scholarly communication is becoming public, and public science communication is becoming less formal. Overlaps are emerging. These overlaps and delimitations do not refer to the entire scientific field but rather operate in post-normal science in sub-areas or, at least for now, only on the periphery. The number of agents and their heterogeneity are growing in these overlaps. In addition to technical progress, a general socio-cultural change is responsible for the change in scientific communication, which is caused by (1) the changing conditions in the overall social space (e.g. an economization of the scientific field due to the increasing importance of external funding) and (2) the interaction of individual agents and the scientific field. Traditional, disciplinary science continues to be found in the scientific field alongside post-normal science, but the change here is slower. Established communicative structures and disciplinary field logic are resilient. Traditional science is not affected by delimitation but remains a relatively independent field, and relatively independent sub-fields of disciplines are found within in. External and internal communication continue to be distinct, but are, nonetheless, mediatized by new science media. This mediatization affects formal scholarly communication through (public science) mass communication and newly legitimated publication media and practices (e.g. online publications, open access), as well as through mediated interpersonal communication in the publication process. Informal scholarly communication is affected by mediated interpersonal communication (collaboration) and interactive communication (knowledge production). The degree of mediatization varies according to discipline and then again by status group or generation. The development from conventional to mediatized scientific communication can be represented in a model (Figure 3).

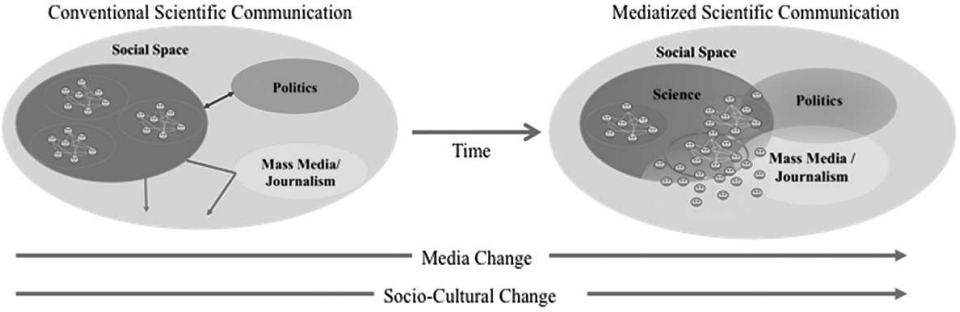

Figure 3. Mediatized scientific communication

Source: Author's own study.

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It remains to be answered why Web 1.0 applications have prevailed across the board in the science system as opposed to Web 2.0 applications. Until the opening up of the Internet in 1990, new media technologies had, for the most part, been developed in the scientific field. A structural homology existed between new media, their communicative possibilities and the field logic within science, the scientific *habitus* and scientific practices. The new media were not only exclusive to science (plus administration and military), but were rather oriented to scientific needs. Innovation was welcomed as a driver of the structurally stabilizing progress and was naturally incorporated into the communicative practices because it brought, for the most part, relief to the usual, established practices and procedures. With the release of the Internet for commercial use in 1990, scientific exclusivity came to an end. Further developments had their origins outside of science (e.g. Weblog 1997, Google 1998, Wikipedia 2001, Second Life 2003, Facebook 2004 or Twitter 2006) [Ruttimann 2006]. Social media are, therefore, structurally alien to the scientific field and were not designed with regard to scientific practices. While the blogosphere of post-normal climate scientists corresponds to their special relationship with the public and their intrinsic motivation, agents of conventional science remain in their field and leverage social media in their repertoire only reluctantly as a reaction to social pressure (requirements for transfer and popularization). Most science blogs are, therefore, not by individual scientists but rather communication organs from scientific institutions, where special outreach and scientific PR structures are created to meet these new social demands on science without putting a strain on the individual scientists. How scholarly communication will transform when the digital natives born in 1980 and later move into decision-making positions in the scientific field over the course of the generational change remains an exciting research question for the future, as their *habitus* departs significantly from the *habitus* of the previous generation due to the capital mixture of private media socialization and traditional scientific socialization.

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