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Frames of scientific evidence: How journalists represent the (un)certainty of molecular medicine in science television programs

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Abstract
For laypeople, media coverage of science on television is a gateway to scientific issues. Defining scientific evidence is central to the field of science, but there are still questions if news coverage of science represents scientific research findings as certain or uncertain. The framing approach is a suitable framework to classify different media representations; it is applied here to investigate the frames of scientific evidence in film clips (*n* = 207) taken from science television programs. Molecular medicine is the domain of interest for this analysis, due to its high proportion of uncertain and conflicting research findings and risks. The results indicate that television clips vary in their coverage of scientific evidence of molecular medicine. Four frames were found: Scientific Uncertainty and Controversy, Scientifically Certain Data, Everyday Medical Risks, and Conflicting Scientific Evidence. They differ in their way of framing scientific evidence and risks of molecular medicine.

Keywords
framing, molecular medicine, risks, scientific evidence, television coverage of science

1. Introduction

Contrary to trends in the US and the UK (Bauer et al., 2013; Williams and Clifford, 2009),[2] media coverage of science has increased in the past few years in Germany (Elmer, Badenschier and Wormer, 2008). Science journalism is the representing of research results, debates and discussions

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undertaken both within and outside the scientific community (Brechman, Lee and Cappella, 2009). Mass media are the main source of scientific information for the general public (Schäfer, 2012). According to a survey conducted by the European Commission (2007), more than half of German citizens are interested in coverage about scientific research, with television (TV) identified as the most popular and credible medium of information about science. In comparison to TV channels in other European countries, German TV channels offer the highest proportion of airtime for scientific information (Lehmkuhl et al., 2012). Although science TV programs are omnipresent in the German media offerings, they are a rarely investigated field of research (Schäfer, 2012).

One highly variable aspect of the media coverage of scientific information is how scientific facts and scientific evidence are depicted (Dudo, Dunwoody and Scheufele, 2011; Guenther and Ruhrmann, 2013; Olausson, 2009). Medical issues such as molecular medicine are among the most frequent issues in science coverage (Elmer et al., 2008). Research on scientific evidence and TV is sparse; initial results show that public perceptions of science can be influenced by the way in which scientific results are represented as certain or uncertain by TV programs (Retzbach et al., 2011). Journalists' reports on scientific evidence may also have an impact on the decisions that consumers make. How safe are therapeutic options based on molecular medicine? Do they have unknown or risky side effects?

This article initially analyses how scientific evidence of molecular medicine is publicly addressed in the media. The *framing approach* (based on Entman, 1993) is applied to measure the representation of scientific evidence of molecular medicine in science TV programs.

2. Scientific evidence and the mass media

Although laypeople depend on mass media information about scientific findings, they tend to become irritated when confronted with uncertain research findings and the risky consequences of future technologies (Peters, 2012). The public understanding of scientific information varies depending on, among other things, how scientific facts and evidence are introduced, explained and assessed in the mass media (Retzbach et al., 2011). *Scientific evidence* in the present study refers to medical, clinical evidence, for which *evidence* means proof or confirmation (Cooper et al., 2012; Jenicek, 2001).

Scientific knowledge and research are always associated with uncertainty; science is not simply the source of bare facts or transcendental truths about the world, but a source of evidence (Jasanoff, 2006). One basic characteristic of scientific knowledge is its uncertain, fallible and tentative nature. There are different degrees of scientific uncertainty with respect to how hypotheses are tested and what methodologies are used (GRADE Working Group, 2004). Scientific work is a context-specific, purposeful, and culturally embedded social enterprise in which human beings are engaged (Jasanoff, 2006); this engagement creates the potential for risks. Problems that arise from new knowledge, as well as from the consequences and applications of technologies, can then respectively (and simultaneously) also be assessed as risks (Gigerenzer, 2013). In this regard, scientific uncertainty with respect to newly discovered knowledge is increasingly part of news coverage (Nisbet and Scheufele, 2009).

Science journalists have the possibility to question the validity of findings; somewhat paradoxically, seemingly straightforward results can be the most provocative (Pellizzoni, 2003). This is because journalists require tentative and contradictory findings to construct narratives that engage the public. Journalists may also manufacture or imply scientific ignorance as a reflection of their own attitudes and interests (Stocking and Holstein, 2009). Weingart (2012) stressed that the different ways in which mass media and scientists communicate knowledge are strongly connected to the social organization of the specific knowledge producer and their public. Science journalists select events and developments that they consider to have both risks and benefits, engaging the interest of their target audience (Weaver and Bimber, 2009).

Initial surveys of science journalists have revealed that the representation styles of scientific evidence vary (Guenther and Ruhrmann, 2013; Stocking and Holstein, 2009): Sometimes the uncertainty of research findings is stressed to attract audience attention or create a controversy; in other cases, scientific findings are presented as more certain than they really are. For instance, Zehr (2000) found that uncertainty is central to coverage of climate change, but Olausson (2009, for climate change) and Dudo, Dunwoody and Scheufele (2011, for nanotechnology) showed an absence of scientific uncertainty in the media coverage of scientific issues. Furthermore, analyses focusing on evidence-based information, such as statistical or methodological evidence, showed that such information is widely absent from the mainstream media coverage (Cooper et al., 2012).

Journalists are especially attracted to scientific controversy, offering thorough assessments and evaluations (Weaver and Bimber, 2009; Zehr, 2000). "Scientific uncertainty can […] be appealing to journalists because it can be made to seem like controversy. Journalists are often seeking conflict – a story – and if a science story appears to involve controversy among scientists battling over the truth, that angle may be particularly appealing as news" (Schneider, 2010: 176). The journalists who cover and represent these controversies often fuel and encourage these conflicts. "In such a setting, journalists are invited to play a major role in constructing reality not only by the duelling scientists themselves, but also by journalistic practice, which recognizes the attractiveness of controversy as news and has cobbled together a variety of strategies" (Dunwoody, 1999: 61). When the differences of opinion that exist among researchers relate to economic, political or cultural topics, then a social controversy may arise. In such a case, politicians, economic actors and scientists will often enter into the debate on the social risks and possible ethical implications of the science in question.

For the reasons outlined above, questions of scientific evidence and risks are especially salient in fields that attract many people from diverse backgrounds. One example of such a field is molecular medicine (Ganten and Ruckpaul, 2007). This domain of interdisciplinary research was chosen for the present study because it offers a good perspective from which to show how scientific evidence is represented and risk is assessed in the media, due to its numerous high-profile uncertain and conflicting research findings (Swierstra et al., 2013). Molecular medicine is a scientific field that can be described as "evidence sensitive". Topics related to molecular medicine are publicly debated, especially with regard to possible harmful consequences.

Television science coverage is rarely investigated, and journalists have some freedom in how they communicate scientific evidence. However, there has not yet been any research on how scientific evidence and the risks of molecular medicine are depicted on TV. Therefore, the first research question of this paper is:

Research Question 1: How and to what extent do science TV programs report on the scientific evidence and possible risks associated with research in molecular medicine?

3. Framing scientific evidence

Representations of scientific certainty or uncertainty can be classified using the *framing approach*. In the following the approach will be introduced and how it is applied in the present study will be explained.

Frames "have at least four locations in the communication process: the communicator, the text, the receiver and the culture" (Entman, 1993: 52). Framing research draws on literature from several fields such as cognitive, constructionist, and critical studies (D'Angelo, 2002; see also Reese,

2010) stemming from sociology, economics, psychology, cognitive linguistics, and communication/media studies (e.g. Scheufele and Tewksbury, 2007). While Entman (1993) called for a paradigm to unify framing research, for D'Angelo (2002) this would not be desirable as he sees one major advantage of framing in the knowledge accumulation of different perspectives, a so-called "multiparadigmatic research program" (p. 871). The interdisciplinary quality of the field includes a diversity of approaches (Bowe et al., 2012; Reese, 2010). In fact, a lack of clear conceptualization and operationalization of framing has led to a high amount of framing studies that are distinctly different, with contradictory conceptual definitions of frames and framing (Scheufele and Scheufele, 2010).[3] Researchers doing framing analysis have to make some careful choices about the best point of entry to answer their very own questions at hand (Reese, 2010). According to Borah (2011) and her recent review on framing literature, the approach has its origins in two different fields as a sociological (Entman, 1993; Gamson and Modogliani, 1989; Goffman, 1974) and a psychological (Tversky and Kahneman, 1981; see also Scheufele and Iyengar, 2011) foundation can be identified. Their dual nature can be summarized as (1) frames in the news (sociological) and (2) frames in individuals' minds (psychological) (Borah, 2011).[4] This paper focuses on the sociological side, since it is interested in frames of scientific evidence within the context of molecular medicine in science TV programs as *one* example of frames in the news.

The research on so-called *media frames* also reveals different conceptualizations and definitions of frames when it comes to the question of how news stories are constructed and what processes shape this construction (see Borah, 2011). Van Gorp (2010) suggests that organizational, external, and source characteristics may influence journalists when selecting from their "repertoire of frames that can be useful to construct a news story" (p. 86). Gamson and Modigliani (1989) define frames as interpretation packages, as central organizing ideas that give meaning to an issue. They identify five framing devices that suggest how to think about an issue: metaphors, exemplars, catchphrases, depictions, and visual images. "Other devices that can be taken into account are themes and subthemes, types of actors, actions and settings […]" (Van Gorp, 2010: 91). A frame thereby is organizing and structuring work; hence, frames are more than just a topic of a news story (Reese, 2010). However, a high amount of definitions on frames does not automatically lead to an applicable operationalization of media frames (Kohring and Matthes, 2002; Matthes and Kohring, 2008). A detailed and widely accepted definition is given by Entman (1993): framing stresses certain aspects of reality and pushes others into the background – it develops a selective function in which attributes, judgments and decisions are suggested (see also Entman, Matthes and Pellicano, 2009). "To frame is to select some aspects of perceived reality and make them more salient in a communicating text, in such a way as to promote a particular problem definition, causal interpretation, moral evaluation, and/or treatment recommendation for the item described" (Entman, 1993: 52).

To measure media frames, for instance, Scheufele and Scheufele (2010) offer a distinction between qualitative and quantitative approaches. Matthes and Kohring (2008) also presented an outline of the empirical work done so far and raise concerns about the validity and reliability of content analyses that measure media frames. They offer their own way of measuring frames that is applied here and therefore explained in more detail next.

Matthes and Kohring (2008, see also Bowe et al., 2012; Donk et al., 2012; Kohring and Matthes, 2002) argue that a frame is a certain pattern in a given text that is composed of several elements; these elements are not words but previously defined components or devices of frames, such as the four elements offered in Entman's (1993) definition. These elements can be coded with several variables in content analyses; and these variables can be cluster-analyzed later on. "That means when some elements group together systematically in a specific way, they form a pattern that can be identified across several texts in a sample. We call these patterns frames" (Matthes and Kohring, 2008: 263). Such a pattern is identified as the product of the selection and construction of a journalist (Bowe et al., 2012); however, this operationalization has a text-framing orientation (Kohring and Matthes, 2002) and some advantages:[5] Frames are not pre-defined but measured with the help of operationalized frame elements, thus, this method improves reliability and validity of a content analysis and has proven to be "consistent and convincing" (Donk et al., 2012: 12).

Using the definition of Entman and the operationalization first offered by Kohring and Matthes (2002), media content like the representation of scientific evidence within the context of molecular medicine can be understood as a pattern in a given text and thus, typified with respect to relevant characteristics, the frame elements (Entman, 1993). Such a framing analysis allows recognition of the manner in which the scientific evidence of molecular medicine is perceived and contextualized in the media, leading to the second research question of this paper:

Research Question 2: What are the typical journalistic frames in which the scientific evidence of molecular medicine is represented in science TV programs?

Using molecular medicine to address our research questions is ideal, as this subject has a great deal of uncertainty and public interest, with active high-profile debates over areas such as the use of stem cells in research and stem cell therapy, cloning, genetic research and gene therapy, tissue engineering, and genetic diagnoses and therapies of cancer and other genetic diseases (Ganten and Ruckpaul, 2007; Gigerenzer, 2013; Swierstra et al., 2013). In the specific context of Germany, this paper has already outlined how TV is the main source of scientific information for the German general public (Schäfer, 2012), and that TV is considered both the most popular and most credible source of such information (European Commission, 2007).

4. Method

Sample

The sample of TV programs (n = 207) was obtained through a survey of every clip of molecular medicine broadcast by ten German science TV programs, between January 2008 and December 2009.[6] A list of keywords, developed based on the definition given by Ganten and Ruckpaul (2007), was used to identify relevant TV clips. The investigated TV clips represent a full sample of the coverage of molecular medicine in German science programs.

Data collection

Variables. We developed a codebook to measure variables related to both scientific evidence and frame elements. *Scientific uncertainty* was assessed via a category measuring different forms of scientific uncertainty: uncertainty of scientific results, uncertainty due to gaps in research, uncertainty due to missing data or scientific controversy, and conflicting results (Dunwoody, 1999; Retzbach et al., 2011). Opposed to this, we also assessed *scientific certainty* of research results. Another category measured the *scientific research process* such as research designs, test procedures, data representativeness, and statements about validity (Cooper et al., 2012). To include *non-scientific aspects*, the variables social problems and social controversies were coded.

Frames in this study were not measured directly, but as discussed earlier were coded within frame elements (Entman, 1993) via certain variables, allowing us to rule out subjective calculations and to increase the reliability of the content analysis (Matthes and Kohring, 2008). The four frame elements given by Entman are problem definition, causal attribution, (moral) evaluation, and treatment recommendation; all four had to be coded in each sample TV clip, with regard to scientific evidence. The four frame elements in this study were extended with variables referring to scientific evidence, because the presented analysis measures frames of scientific evidence within the context of molecular medicine.

Problem definition refers to the variables identifying relevant actors and topics (Bowe et al., 2012). It is a central aspect of an event that an actor has commented on (Matthes and Kohring, 2008). In the present study, problem definition mainly refers to scientific certainty or uncertainty. For example, scientists might advocate for additional research, while politicians might focus on the advantages to competition in molecular medical innovations. Such problem definitions are already objects of public attention (Gerhards and Schäfer, 2009), and journalists consider these problem definitions when constructing a narrative. To assess problem definitions in this study, the variables with reference to scientific evidence we mentioned before were used.

Causal attribution describes the causes and reasons given for a problem (Bowe et al., 2012; Donk et al., 2012). Journalists can publicly identify actors or situations as responsible for the uncertainty of a scientific topic, for example, ascribing uncertain research results to scientists' incorrect procedures. Causal attribution was assessed with regard to whether scientific uncertainty was reasoned or not, and if people or situations were held responsible for this uncertainty. Furthermore, we measured whether arguments were based on actors' experience or scientific research. Also variables according to different actors such as scientists, patients, politicians etc. were considered. Overall, the codebook measured 35 different groups of actors (383 actors in total) occurring in the 207 TV clips. Data were organized into the following categories:[7] scientists (69%), medical doctors and patients (42%), political actors (10%), and social institutions (5%).

(Moral) evaluation pertains to messages rating the functionality of the research finding, which usually implies a strong positive or negative judgment on the part of the journalist. It also refers to a problem's moral classification (Entman et al., 2009), which can be established explicitly by using evaluative words and terms. Journalists may paint scientific uncertainty in general as risky. For instance, the public's prior experience with scientific uncertainty suggests that the consequences of scientific uncertainty should be interpreted as a possible risk (Gigerenzer, 2013). To assess evaluations, the tenor of judgments (positive or negative) and the evaluation of benefits and risks were measured in this study.

Treatment recommendation is a complex element based on how journalists formulate solutions to the problems that they identify (Entman et al., 2009). For example, they may argue that new and more reliable cures could be discovered if more and higher quality research was being conducted in this field, or call for the support or abandonment of further research into a particular area. The solution can also be worded as a forward-looking prognosis (Matthes and Kohring, 2008). To assess treatment recommendation in this study, we assessed demands and solutions.

We used Holsti's reliability coefficient (CR) and Cohen's kappa ($\varkappa$) to measure inter-coder reliability[8] because both are widely used reliability coefficients, furthermore Cohen's kappa is able to accommodate more than two coders at a time.

Data analysis

We first created frequencies from the TV programs to determine how the relevant variables were distributed. In keeping with the methods first established by Kohring and Matthes (2002), we identified the frames of scientific evidence based on an explorative cluster analysis. We used the Constrained Cluster Analysis (CONCLUS) algorithm (Bardeleben, 1995). CONCLUS uses a hill-climbing technique that combines hierarchical and iterative clustering techniques based on maximum-likelihood estimations. Compared to the widespread WARD method (Kohring and Matthes, 2002), CONCLUS (1) minimizes the error variance in an explicit and reliable way, (2) maximizes the amount of explained variance of variables in an iterative way, and (3) realizes a valid statistical test on the number of clusters (Bardeleben, 1995).

As outlined before, in this study frames are understood as patterns in a text that are composed of several elements. When some of these elements group together systematically in a specific way, then they form a pattern that can be identified across several texts in a sample, a media frame (Matthes and Kohring, 2008).

The cluster centers for the individual clusters were determined such that the sums of the square distribution within the clusters were kept to a minimum (Bacher, Poege and Wenzig, 2010). This procedure places particular value on the developing of parameters to describe the clusters, for instance, homogeneity and consistence, variance/covariance matrices (Bacher et al., 2010; Bardeleben, 1995), and on testing procedures (identification of sub-optimal solutions, determination of optimal cluster numbers, etc.) that facilitate theoretical interpretation. This emphasizes the typification's status as a model. The cluster analysis included all frame-element variables,[9] which were coded as nominal variables with multiple categories.

5. Results

Regarding Research Question 1, descriptive data analyses found scientific problems to be the basis of 60% of all reports, whereas only 22% were based on social problems. One-quarter (25%) of the programs dealt with scientific certainty, and two-thirds (63%) dealt with uncertainty, showing the high variance in journalistic representation of research findings. In our data, uncertainty was reasoned in 40% of the cases; this uncertainty most often pertained to missing research results (22%), doubt over the application of experimental findings to humans (11%), or different interpretations of the data (8%). The research process was depicted in more than half of the TV clips: test procedures are mentioned in 44% of the sample's TV clips, research design is explained in 23%, number of studies performed is specified in 13%, and information on representativeness of research findings is present in 13%. The objectivity of results was only discussed in 4% of the sample. Altogether, nearly one-third (30%) of all science TV programs addressed either scientific or social controversies. Benefits (84%) as well as risks (71%) are also mentioned in most assessments of the consequences of the events and problems described.

To the question of *how* and *to what extent* (Research Question 1) science TV programs report on the evidence and risks associated with research on molecular medicine, we found that our sample of TV clips most often communicated about scientific problems, or focused on uncertainty and controversy. Social aspects were less frequently included in the science coverage on molecular medicine that we analyzed. Not all of the samples portrayed science as uncertain, and the discussion of benefits just slightly outweighed that of risks. Results presented here are evidence for a high variety in frequencies of the variables under investigation. These results lead us to wonder if these findings are rooted in different representation styles of scientific evidence in science coverage of molecular medicine, bringing up Research Question 2.

What journalistic frames are typical in representing scientific evidence within the context of molecular medicine? The variables mentioned above, representing the four frame elements, were clustered. Since neither the structure nor the number of frames was predicted in our chosen methodology, we conducted an exploratory cluster analysis. The ideal number of clusters was determined based on both content as well as statistical criteria. This model makes a four-cluster solution possible based on calculations of anything from a fifteen- to a two-cluster solution. Only a mild increase in the explained variation over the four-cluster solution was recorded in the scree test.[10] Altogether, the model that we chose explained a total variation of $\eta^2 = .31$, a good value.

Table 1. Lambda matrix.

Types	1	2	3	4
1	1.000			
2	–.302	1.000		
3	.198	.077	1.000	
4	.248	.138	.261	1.000

Table 2. Explained variance in the cluster analysis.

Variable	η^2	*F*-value
Social institutions as actors	.58	95.25**
Scientists as actors	.56	85.77**
Reasoned uncertainty	.50	66.85**
Negative tenor of judgments	.49	64.13**
Scientific uncertainty	.42	48.38**
Risk evaluation	.39	42.77**
Solution	.39	44.05**
Positive tenor of judgments	.36	37.14**
Medical doctors and patients as actors	.34	34.51**
Argument is experience	.30	28.45**
Profession of actor	.27	24.50**
Reasoned responsibility	.27	24.40**
Conflicting results	.26	24.19**
Benefit evaluation	.26	23.65**
Argument is research	.21	17.98**
Social problems	.20	17.33**
Depiction of the research process	.20	16.43**
Demands	.19	16.13**
Scientific problems	.15	12.27**
Political actors	.12	8.77**
Scientific controversies	.10	7.55**
Social controversies	.07	4.91*

Note: *p < .05, **p < .01.

The content as well as the consistency and the position of individual clusters also pointed toward a four-cluster solution. The present solution shows what that means for the cluster definition (see Table 1), shown here as a lambda matrix.[11] Given the multiplicity of variables that it accounts for, the somewhat greater affinities between Clusters 1 and 4, as well as between Clusters 2 and 3, nonetheless denote good results.

Table 2 shows how the variables contribute to cluster formation. They all show a significant degree of influence on cluster development, even if in distinct ways. Table 3 shows the means of the variables used in the cluster analysis.

The four clusters can be described as the following frames, including a representative example of each one.

Table 3. Values (z-means) of cluster variables.

Variable	Frame 1: Scientific Uncertainty and Controversy	Frame 2: Scientifically Certain Data	Frame 3: Everyday Medical Risks	Frame 4: Conflicting Scientific Evidence
Problem definition				
Scientific problem		−.38**	−.29**	.56**
Social problem	.43*	−.53**	.51**	−.28**
Scientific controversy	.60*			−.29**
Social controversy	.48*			
Scientific uncertainty	1.19**	−.34**	−.63**	
Research process depiction	.59**	−.33**	−.74**	.38**
Conflicting results	.65**	−.41**	−.54**	.47**
Causal attribution				
Reasoned uncertainty	.92**	−.50**	−.78**	
Reasoned responsibility	.77**	−.70		
Profession of actor	.33*	−.84**		.38**
Social institution as actor	.75**	−1.18**		.60**
Scientific actors	.41**	−1.21**	.28*	.64**
Medical doctors and patients	.42**	−.66**	.74**	−.37**
Political actors	.51*	−.41**		
Argument is experience	.66**	−.68**	.51**	−.30*
Argument is research	.37*	−.66**		.49**
(Moral) evaluation				
Benefit evaluation	.49**	−.80**	.38**	
Risk evaluation	.70**	−.72**	.63**	−.40**
Positive tenor of judgments	.84**	−.87**		
Negative tenor of judgments	.95**	−.69**	.60**	−.58**
Treatment recommendation				
Demands	.74***	−.50**		
Solution	.79***	−.96**		.28*

Note: *p < .05, **p < .01, ***p < .001.

Frame 1: Scientific Uncertainty and Controversy. With a consistency of C = .16, this cluster covers 19% of all TV clips sampled. It explicitly labels not only scientific uncertainty (74%) but also the scientific (60%) and social controversies (48%) associated with this uncertainty. Institutional and political actors held accountable for the debate frequently participate (75%). This cluster emphasizes the significance of social problems. The represented scientific uncertainty is essentially justified by the research process that is revealed, insights being based on personal experience (68%), or research (55%). The uncertainty is very often assessed as risks (80%). However, the benefits of the research are also mentioned comparatively frequently (65%). The reports include an above-average tendency toward positive as well as negative assessments. This model of reporting corresponds to a recently discovered type of science reporting in which a news story covers favorable and negative aspects (Jensen and Hurley, 2012). A representative example is a clip about the social repercussions and ethical implications of stem cell research, with politicians and representatives of other social institutions arguing with scientists. Both sides (positive and negative) are represented in this clip.

Frame 2: Scientifically Certain Data. This highly consistent type of TV science reporting (C = .52) made up 27% of all reports. This frame is characterized by its above-average frequency of depicting scientific certainty. This certainty, however, is neither justified nor discussed. Political, institutional and scientific actors, as well as medical doctors and patients appear less frequently than average. This frame primarily discusses current scientific events, as opposed to political or social topics. The actors responsible are never mentioned in this cluster. References to sources of scientific insight are similarly much more frequent than average. Assessments, demands or proposed solutions are generally absent, with reporting limited to conveying scientific facts. This type of reporting is not unheard of in earlier research on science communication (Stocking, 1999), but as most frame elements are empty in this cluster, it represents an incomplete frame. An example clip focuses on genes, discussing what they are, how they work and what current research in this area offers the public. Facts are depicted as scientifically certain, without controversies or discussions; the tone is neutral, without judgments or evaluations of risks or benefits. Clips such as this offer a purely descriptive overview of scientific facts and events.

Frame 3: Everyday Medical Risks. With a frequency of 27% and a consistency of C = .19, reports in this cluster also refer less to the uncertainty of research results than to social problems (43%). Medical doctors and patients are the most common actors, and their reasoning is primarily based on their own experiences. Such reports focus on risks with above-average frequency (76%). The tenor of the reporting is not balanced, but negative in the majority of cases (66%). Similar reporting models can be found in other studies on TV scientific communication. For instance, Lehmkuhl et al.'s (2012) results attest the existence of this type of science reporting. An example from our sample is a clip with a medical focus, documenting a case study of Alzheimer's disease. In this clip, the woman discusses how she deals with her disease and how she interacts with her medical team. So far, no therapy has helped, which is why the disease offers a high risk for the individual.

Frame 4: Conflicting Scientific Evidence. With a range of 27% (C = .31), reports in this cluster also tend to focus on scientific uncertainty (77%) or explain elements of the research process. The professions of actors appearing on screen are more frequently identified, and representatives of scientific institutions participate in 93% of all cases. On-screen actors are almost exclusively researchers (98%), with medical doctors or patients appearing relatively infrequently (23%). Research findings are the primary basis (61%) for arguments and insights, and risks are relatively infrequently addressed (25%). The tenor of the reports is only slightly negative (9%). Uncertainty primarily arises from conflicting scientific results, which journalists in this cluster discuss with above-average frequency. An example clip discussed promising therapeutic options using nanotechnology to fight cancer; these promising initial results are represented as addressing the uncertainty surrounding this new field of research.

To further illustrate the findings of this study (see Figure 1), the identified frames of scientific evidence within the context of molecular medicine are portrayed in a two-dimensional projection of the main components of the lambda matrix. The vertical axis (Dimension 1) refers to institutional communication about scientific evidence in the investigated TV clips; it represents the variables with the largest proportion of explained variance for the realization of the cluster solution. The horizontal axis (Dimension 2) represents the risk and benefit aspects of coverage. This dimension represents more appropriate variables with an equally large proportion of explained variance. Journalists in our sample more often concentrated on scientific evidence, demonstrating its uncertainty by depicting different recommendations, evaluations and meanings from the standpoint of

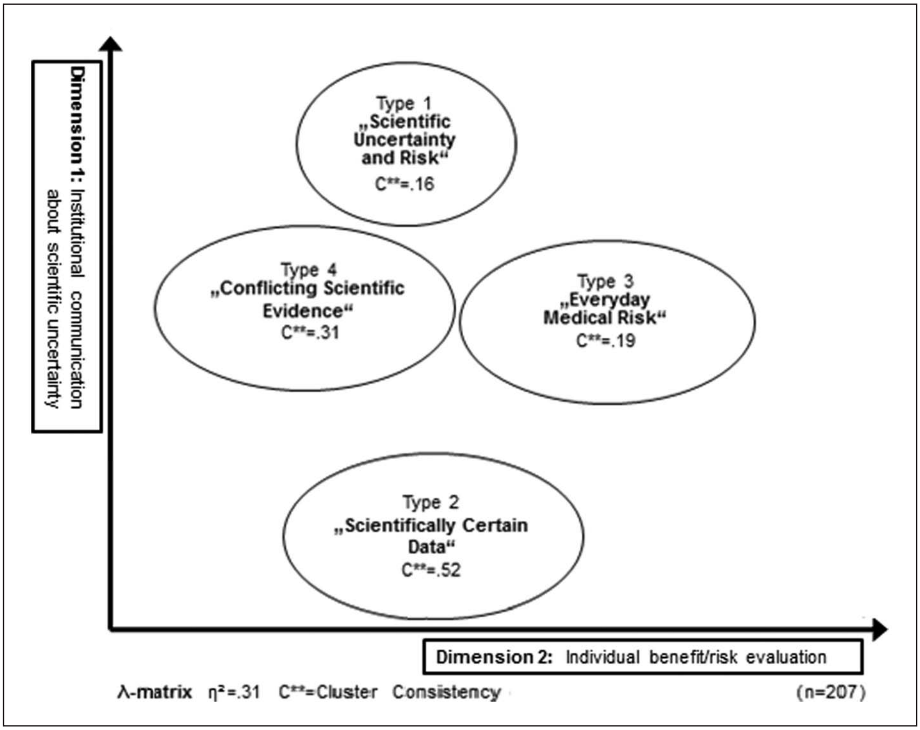

Figure 1. Cluster projection (*n* = 207).

different actors, conflicts and risks. The four identified frames denote the different ways that journalists handled scientific evidence.

6. Summary and discussion

Owing to a lack of research on the coverage of scientific evidence regarding molecular medicine, especially the coverage on TV, we conducted a content analysis, as we assume that the issue of the media's representation of scientific evidence will become more and more relevant for the general public in the future. There are different reasons for this assumption: (1) the increase in an explicit emphasis on scientific uncertainty and its social contextualization, (2) the occurrence of nuances in the media's representation of the issue, and (3) different consequences and effects on recipients arising from varying media frames.

(1) Overall, the communication of scientific certainty, uncertainty and risks is and will be an important factor for science coverage. We found that journalists' depiction of molecular medicine focused on several aspects of scientific evidence. This stress on the relative certainty or uncertainty of research findings and on research gaps was not seen in similar studies on other fields of science journalism (Dudo et al., 2011; Olausson, 2009). A socially contextualized public debate on scientific topics has arisen in recent years (Schäfer, 2012). Scientific controversies can be (re-)interpreted in accordance with the topics and interests of public social debates (Gerhards and Schäfer, 2009; Schäfer, 2009).

(2) Tentative scientific findings allow journalists to define, assess, morally evaluate and attribute problems. They do this by developing logical frameworks with particular rhetorical functions

or patterns of meaning, described in the present study as *framing*. A central finding of the present study was that the sample TV clips could be divided into four frames of scientific evidence. These frames were relatively homogeneous with respect to the four frame elements (Entman, 1993). Scientifically contextualized representations tended to have distinct emphases: Frame 2 (Scientifically Certain Data) and Frame 4 (Conflicting Scientific Evidence) can be distinguished from Frame 1 (Scientific Uncertainty and Controversy) and Frame 3 (Everyday Medical Risks), both of which focus on political and social risks. Frame 1 represents the most differentiated debate about scientific uncertainty and conflicting evidence. The two main axes of the cluster projection (see Figure 1) show an empirically reconstructed feature space for coverage of scientific evidence within the context of molecular medicine in the science TV programs. This feature space can differentiate more institutionally oriented science communication from assessments more focused on individual risk. The two dimensions represent a science journalistic coverage of scientific evidence which is able to put emphasis on different aspects: first, certain scientific findings are clearly distinguished from those with conflicting and/or uncertain scientific evidence. And second, the dimensions differentiate between institutionally communicated scientific evidence/risks and medical risks/benefits evaluated individually by doctors and patients. This raises the question of whether a largely science-dominated public communication is at least partly differentiated and transformed into a socially contextualized and journalistic communication about science. Especially in the US and Germany, there has been an intensive political debate about the risks of biotechnologies: "Monolithic positions in support of or opposition to genetic engineering dissolved into more nuanced controversy about the appropriate objectives of research" (Jasanoff, 2005: 5).

(3) The mass media's representation of the uncertainty of scientific results has also changed the way people now tend to interpret scientific knowledge (Retzbach et al., 2011); most of the public now consumes news about science with a measure of skepticism. For example, in Germany scientific breakthroughs in genetic cloning, as well as in agricultural and medical genetic engineering, have led to increased distrust of science and technology (Jasanoff, 2005). Additional research in the area of the present study should explore in what way and to what extent evidence-based TV reporting can change opinions or improve trust in science. This, however, will require additional research in combined media analyses and impact studies.

7. Limitations

As the first attempt to investigate the representation of scientific evidence on German TV in a detailed and empirical way, the present study has limitations. Indicators of the content analysis require further development, particularly regarding advanced theoretical and empirical analysis of the relationship between scientific uncertainty, risk analysis, and journalistic assessment. Journalists make risk assessments based on their perception of the selected evidence, and based on their assessment of possible risks and benefits given their organizational, social, and personal affiliations. The constructs used to operationalize this process should be refined and developed. We also recommend follow-up research and content analysis replication using additional indicators to more deeply explore scientific uncertainty. In our use of Entman's (1993) frame definition, we identified one frame per sample clip, which was sufficient for this initial study in which the goal was to measure the TV clips' representations of scientific evidence; furthermore this approach is in line with those of previous investigations (Donk et al., 2012; Kohring and Matthes, 2002; Matthes and Kohring, 2008). However, individual clips may contain multiple frames. We recommend that future studies make it possible for clips to be associated with multiple frames; for instance, according to every appearing actor. Identification of frames via cluster analyses should also recognize that some science TV programs represent a pure dissemination of facts that will not be argumentatively or rhetorically processed or addressed any further and will lead to few changes of opinion, knowledge, or attitude, if any.

Initial findings are based on molecular medicine only and should not be generalized. But this study is also a first step for further research on the general depiction of scientific evidence. A consonant coverage of issues related to scientific evidence can have an influence on audiences' understanding of science in general and molecular medicine in particular. The variance in the journalists' handling of scientific evidence in different frames may direct the public discourse of science issues.

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Notes

1. These authors contributed equally to this work.
2. Williams and Clifford (2009) state that in the US, the number of newspapers with regular science sections fell from 95 to 34 between 1989 and 2004. One of the main findings of Bauer et al. (2013) is that there is a perceived crisis among science journalists: Journalists in the US, Canada and Europe were more doubtful than their global colleagues that they will be working as science journalists in five years, and fewer of them recommended this career to young people (Bauer et al., 2013).
3. Furthermore, there is controversy regarding the similarities and differences between *framing, priming*, and *agenda setting* (see also Borah, 2011). For delineations see Scheufele and Tewksbury (2007), or Scheufele and Iyengar (2011).
4. The psychological foundation can furthermore be divided into *equivalency-framing* (Tversky and Kahneman, 1981) and *emphasis-framing* (such as episodic vs. thematic framing, or strategy vs. issue framing, see also Druckman and Bolsen, 2011; Scheufele and Iyengar, 2011).
5. For a methodological critique of this operationalization see Scheufele and Scheufele (2010).
6. We selected German science TV programs broadcast by the public networks ARD, ZDF, ARD-offshoot regional channels (MDR, BR, SWR, WDR) and 3sat. The only private channel in the sample was RTL2, since other private channels had no relevant material. TV clips in the sample are individual clips without moderator comments. Three clips appear twice because the public programs exchange their material with each other, but because different speaker texts were used, these three clips were included in the sample.
7. As one criterion for cluster analysis Matthes and Kohring (2008) mention that frequencies of variables need to be higher than 5%, otherwise "these variables will not contribute to the forming of clusters" (p. 268).
8. Finally, 20 TV clips of the science programs (10% of the sample) were randomly selected for reliability testing. Seven trained coders worked on the gathering of data. Cohen's kappa for the inter-coder reliability is for the formal variables $\varkappa = .98$ (identification of the science TV program, date of broadcasting, length of the TV clip). This is an excellent value and indicates a very good agreement (Wirtz and Caspar, 2004). The inter-coder reliability for the main variables which contribute to the cluster formation got the following values: social institutions as actors = .80; scientists as actors = .80; negative tenor of judgments = .65; risk evaluation = .72; solution = .67; positive tenor of judgments = .65; reasoned uncertainty = .54; medical doctors and patients as actors = .80; argument is experience = .69; profession of actor = .79; social controversies = .76; political actors = .80; scientific problems = .73. The value for the evidence-frame variables can be seen as acceptable or moderate due to high number of coders and a very complex

codebook (Wirtz and Caspar, 2004). We also used Holsti's reliability coefficient (CR) to measure instrument reliability (on average = .86) and inter-coder reliability (on average = .80) for ensuring our results.
9. It should be stated that clusters apply exclusively to the variable sets that are constitutive of them. But they, like frames, do not exist ontologically.
10. The η^2 scree test provides information about the appropriate number of clusters. This number is the point at which there is a clear increase in the explained variation. The delta η^2 test is a relatively strict test. It provides information on the increase in the explained variation between the $\langle k \rangle$ and $\langle k+1 \rangle$ cluster solutions. Delta η^2 must fall monotonically if $\langle k \rangle$ increases (see Bardeleben, 1995).
11. Cluster consistency is a measure of cluster homogeneity which is calculated as follows: con(k) = 1 - W(k). W(k) indicates the variance within a cluster: the lower W(k), the more homogeneous the cluster. The coefficient lambda shows the accordance between two cluster profiles relative to the profile similarity in all cases with a zero vector. Lambda should be as small as possible if the cluster is to be clearly discriminated (i.e. above average). The present solution is such a case. High positive values for lambda (maximum .45) show that two clusters are only artificially separated and actually form one cluster.

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