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Article

Science journalists' selection criteria and depiction of nanotechnology in German media

Lars Guenther and Georg Ruhrmann

ABSTRACT: For lay people, mass media are the main source of scientific information; that is why science journalists' selection and depiction of scientific issues is an important field to study. This paper investigates science journalists' general issue selection and additionally focuses on science journalists' depiction of nanoscale science and technology and its related scientific evidence (certainty/uncertainty of research findings). Face-to-face interviews with science journalists (n = 21) from different German media channels were conducted. The results show that the professional role conception, personal interest, news factors and organizational processes mainly influence the selection of science journalists. Overall, journalists have increasingly positive attitudes towards nanoscale science and technology. But results indicate that the coverage of scientific evidence differs according to the science journalists' focus on beneficial or risky aspects of this emerging technology: journalists stress scientific uncertainty predominantly when discussing the risks of nanoscale science and technology.

Context

Science journalists play a leading role in science communication; they have the objective to convey results of scientific research to the general public and present them in a way that it can be understood by non-experts.[1] There has been an overall increase in science coverage in German media.[2,3] However, journalists can only cover some topics out of a variety of different scientific issues. Their decision about what to publish is influenced by *selection criteria.*[1,2,4] While there is some research tailoring assumptions of general journalism theory to science journalism, it is still unclear which selection criteria are guiding science journalists the most in selecting scientific issues. That is why this paper applies assumptions of the *Gatekeeping theory*[5] and Weischenberg's[6] *Onion Model* ("Zwiebelmodell")[7] to investigate science journalists' selection criteria.

It is important to answer the question of the most significant selection criteria in science journalism, since mass media depictions of such issues are the main source of information about science for the lay audience,[8,9] which is one reason why the media are perceived as particularly influential with new issues, such as the coverage of *nanoscale science and technology* (NST).[10-12] Journalists' perceptions of their reporting

on NST, especially regarding the scientific uncertainty of NST-related research findings, are the second central focus of this paper with NST *depiction* seen as one specific type of science coverage. This study is among the first to investigate journalists' perceptions of their NST reporting.

Journalistic selection of scientific issues and the depiction of NST

Science journalists' selection criteria

Journalists are confronted daily with a high number of possible issues from various sources,[4] *selection criteria* help them to select what topics will be presented to the public. Media are interested in stories that affect people,[13] but their attention is limited. For instance, science sections of newspapers and magazines only include a few pages.[1] Journalistic selection criteria are a research field that already gained some attention in general journalism theory. However, a systematic analysis of such selection criteria for science journalism is still missing. Conventional views on journalism theory can be tailored to science journalism, with validating general journalism theories for science journalism.[2]

The theoretical approach applied here is based on Gatekeeping[14,15] and visualized with the help of Weischenberg's[6] Onion Model (compare the selection-part of figure 1). In the following paragraphs, the main assumptions of the different influencing levels on the journalistic selection provided by Gatekeeping will be introduced sequentially.[16] They will be extended to research results of previous investigations on selection criteria in science journalism. There are five levels to study in terms of Gatekeeping, all of which influence journalistic selection: individual factors, communication routines or practices, the organizational level, the social and institutional level, and the social system level.

At the *individual level*, models of thinking and characteristics of the individual such as the journalists' professional role conceptions are of importance[14,15] in questions of the selection criteria. Personal interest on an issue can be significant for science journalists when selecting issues: White[17,18] already pointed out that Mr. Gates selected and rejected stories because of personal evaluations and judgments. Among other things, science journalists' medical expertise and interest in medicine is one reason for the dominance of medical coverage in science sections in Germany.[19] Next to personal interest, the professional role conceptions of science journalists are important at this level. Such role conceptions are one field of research that already receives some attention: according to Weischenberg, Scholl and Malik[20] and assumptions of general journalism theory, professional role conceptions can be divided into different roles: information providers, critics and entertainer/service provider. For the field of science journalism, there are some initial results: science journalists tend to see themselves predominantly as information providers, less dominantly as critics and even more rarely as entertainers/service providers.[21-23] For Shoemaker[14], such roles lead journalists

to evaluate the worthiness of news differently; hence, these role conceptions can be perceived as a selection criterion.

Communication routines or practices are a set of impartial rules; such routines can be medium specific, with television (TV) journalists more frequently identified to reject news items lacking good visuals than non-TV journalists.[14] This was also found for science journalism: science TV journalists reported that what they cover mainly depends on whether they can find appropriate visual materials.[24] But not all routines are medium specific: restrictions like time and limited space can guide journalists in their selection of issues.[14,18,25] "Stories have to be written in hours, and sometimes within 10 or 20 minutes if a deadline is looming."[26] Furthermore, in terms of Gatekeeping news values are understood as working rules which guide the choice of selection. "Some messages are clearly more newsworthy than others, and the more newsworthy a message is, the more likely it is to pass a news gate."[27] In German research and according to Schulz[28] there is a distinction between news value and news factor: news factors can be seen as particular features, attributed to an event that lead journalists' selection. Depending on combination and intensity of news factors an event gets a certain news value influencing the journalistic decision on selection or non-selection.[29] Galtung and Ruge[30] were the first to specify characteristics that increase an event's chance of selection; they identified twelve news factors (with sub-factors).[31] But, among other things, these news factors are limited to the reporting of foreign affairs.[32] The identification of news factors in science journalism is a recent field of research.[9,13,33,34] Badenschier and Wormer[2] interviewed five science journalists; factors like range (number of affected people), relevance to the public, unexpectedness and composition (variety of issues) were highly ranked by the interviewed journalists. However, initial results also show that the identification of news factors in science journalism is a research field that deserves more attention.

At the *organizational level*, characteristics such as organizational hierarchies, organizational size and socialization like norms and values of the organization (e.g. the media company) are of importance.[14,15] Hence, the selection of a scientific issue also depends on editorial processes such as the science journalists' professional relationships with both other journalists and news editors.[34] With respect to the hierarchies, the editorial department and ultimately the chief editor has the position to decide which issues should be covered and which should not; they can act as a strong selection criterion. In most media companies the agenda is set by news conferences, this is also true for science journalism.[13] Clark and Illman[4] furthermore explain changes in the number of scientific topics within the *New York Times Science Time* section over time with shifts in the size of the section and relate this finding to the organizational level.

Science journalism, like journalistic work in general, is also influenced by factors located outside of media organizations, at the *social institutional level*.[15] Such factors are sources, public relations (PR), audience perceptions, and the coverage of other media. Firstly, what comes to attention by the media is strongly influenced by the sources the (science) journalists use to obtain information about (scientific) issues.[14,35] A survey among science writers in the UK revealed that they use peer-reviewed journals such as *Nature* or *Science* as the main sources of their stories.[13,36] Attending a

scientific conference or individual contacts can also be an important source of a scientific news story.[9] Secondly, especially in times of economic pressure and declining numbers of published units, the editorial staff is reduced; and the influence of PR on journalistic coverage is increasing, even in science journalism.[25,37] For instance, materials provided by PR can additionally guide the journalistic selection. Besides sources and PR, thirdly, audience perceptions are also located at this level: nowadays coverage of science tends to be more entertaining and understandable as it is focused on the needs of the audience,[33] that is why perceptions of the audience are a strong influencing factor on journalistic selection.[34,36,38] Fourthly, the coverage of other media can also be influential in leading attention to certain topics in science journalism.[14,39]

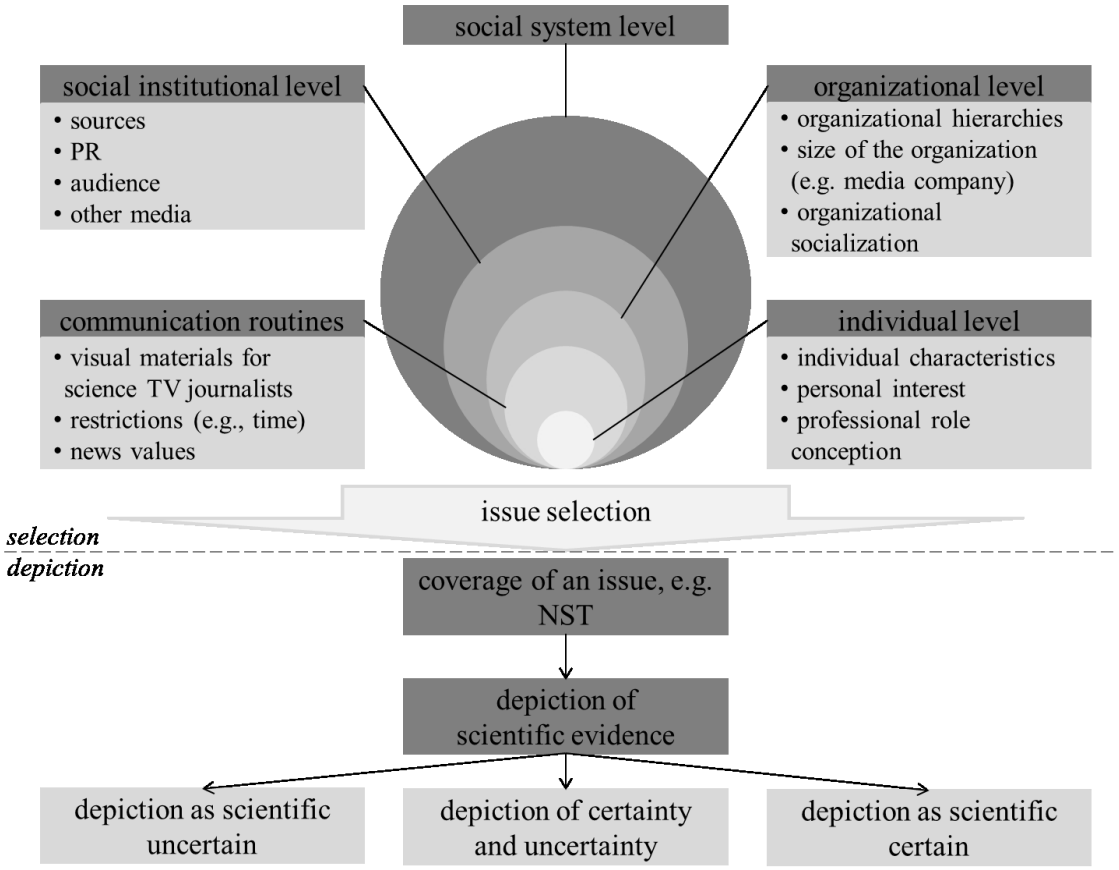

Figure 1. Theoretical model: science journalists' selection criteria and their depiction of NST and its scientific evidence. ***Notes.*** The figure represents two parts: the upper part is focusing on the journalistic *selection* whereas the lower part focusses on journalistic *depiction*.

At the last level, the journalistic decision which issues to select is influenced by the *social system level*. But since this paper exclusively investigates the German context, the investigation focusses only at the four levels mentioned before. As can be seen by the theoretical approach, a high amount of influencing factors at different levels can be

identified. However, it is still unclear which factors affect the work of a science journalist the most. Therefore, we ask:

> *Research question 1: what are the most common factors influencing issue selection for science journalists?*

Journalists' perceptions of their depiction of NST and its related uncertainty

While the first part of this paper focused on science journalists' selection criteria, the second part concentrates on the way NST and its related uncertainty is specifically *depicted* (compare the depiction-part of figure 1).

To date, there have been few investigations of journalists' perceptions of NST and its coverage. Ebeling[39] conducted interviews with eight finance and science journalists, and found that these journalists focus more on applications than on definitions when reporting on NST. Generally, journalists perceive their coverage of NST issues to be on a low frequency level. For instance, one of the five journalists interviewed in a study by Wilkinson et al.[40] reasoned that NST is under-represented in the media because of the high uncertainty of this research field.

Due to the lack of research on journalists' perception of NST and their coverage of this issue, we can additionally refer to content analyses of NST coverage.[40-44] These studies show journalists to have a positive attitude toward NST because the coverage provided is highly positive. While researchers observed an increase in reporting on NST-related issues during the early years of coverage on this technology, the level of reporting has declined in recent years. In general, news coverage mainly focused on opportunities and benefits, but not on risks. Based on initial findings and the lack of studies surveying science journalists, we are interested in:

> *Research question 2: how do science journalists evaluate NST and their reporting on this issue?*

When journalists report on NST, facts on *scientific evidence* of this emerging technology are of high importance for the public, as research on risks associated with NST has just begun and knowledge about NST is still perceived as incomplete by scientists.[45] Scientific uncertainty is central to science, with scientists trained to develop research questions, fill research gaps and tolerate acceptable levels of statistical errors.[38,46] However, to cope with uncertainty, journalists make selective use of scientific claims.[47] They tend to have an image of themselves as translators of scientific knowledge to the public[38], using different coverage styles to cope with different levels and types of uncertainty.[35,39,46-48] Firstly, they can downplay uncertainty, presenting scientific findings as unambiguous and uncontested; which means as certain. This can be accomplished by leaving out methodological information that is too complex for the audience. In contrast, journalists can attract attention by hyping uncertainty, playing up knowledge gaps or caveats. Scientific controversies help to fuel scientific uncertainty; single-source stories or a lack of context can also produce scientific uncertainty. Lastly, journalists can present scientific information accurately.

Scientific uncertainty of NST-related research should be particularly emphasized by the media as this technology is characterized by incomplete knowledge on health and environmental risks. However, results of content analyses on NST reporting show different results. Dudo et al.[49] found that "the uncertainty theme was, for all practical purposes, absent from nanotechnology news coverage." Anderson et al.[50] stated that NST coverage is characterized by a "mixture of strong optimism in relation to the benefits of nanotechnologies combined with concerns about the risks and uncertainties about possible benefits or risks." Due to these different results and a lack of surveys paying attention to science journalists, we ask:

> *Research question 3: how do science journalists judge scientific evidence in the field of NST and what impact does this have on the way they report on NST in the media?*

Method

Participants

In order to answer the research questions, we conducted qualitative, semi-structured, face-to-face interviews with German science journalists (n = 21). In line with prior research on perceptions of NST coverage,[39,40] participants were selected on the basis of different criteria: we e-mailed 25 science journalists who had recently reported more than once on NST in print or on TV.[51] Potential participants were informed about the research project and 21 of them agreed to be interviewed. Their ages were between 31 and 63 (M = 44; SD = 8.7). Fourteen of them were male. The sample was highly educated, with thirteen participants holding a university degree and six more holding a doctoral degree. Considering the fact that different media outlets have different audiences,[4,13] and to get a more detailed view, the sample consisted of journalists from different media channels: seven science TV journalists from the most important German public channels (ARD, HR, WDR, SWR, BR, 3sat, and NDR), six journalists from the most important daily newspapers (*Frankfurter Allgemeine Zeitung*, *Frankfurter Rundschau*, *Süddeutsche Zeitung*, *taz — die Tageszeitung*, *WELT*, and *ZEIT*), five journalists from monthly science print magazines for a general audience (*P.M. Magazin*, *natur+kosmos*, *Bild der Wissenschaft*, and *Spektrum der Wissenschaft*) and three journalists from a weekly news print magazine (*Focus*). The sample consists of twelve specialized science journalists working in the science departments of their media company and nine specialized science journalists working as freelancers. Five of the latters work in the media companies, four of them work from home.

Semi-structured interviews were conducted in person by a trained researcher from a German university at the offices or homes of the journalists between February and April 2012, in eleven different German cities. Interviews took approximately one hour with the semi-structured format allowing for follow-up questions based on participant responses. Interviews were tape recorded with the participants' consent and fully

transcribed afterwards. Data extracts have been anonymized to protect participants' confidentiality.

Measurement

The semi-structured questionnaire contained open-ended questions and was divided into two parts, with the first part focusing on how participants generally select science issues, and the second part focusing on NST coverage. At the end of the interviews, participants provided sociodemographic information.

Related to the first part, dealing with science journalists' selection criteria, the questionnaire contained open-ended questions based on the different Gatekeeper-levels.[14,15] Furthermore, the questions were based on research results already outlined in the theoretical part.[2,4,9,20-24,34,36,38,39] Regarding the *individual level* (as stated before, sociodemographics were assessed at the end of the interviews) and the professional role conceptions, we asked: "What is the main target you keep in mind when you report on scientific issues?" Regarding the *communication routines or practices level* and to assess news values we asked: "What characteristics does an event need to get selected for your general science coverage?" Science journalists working for TV were asked one additional question related to the importance of visual materials: "For you as a science TV journalist, how important are visual materials when you select a science issue?" To get insights into the *organizational level* we asked: "Think of your professional and personal acquaintances: which people influence your selection of an issue and how do they influence you?" Since the *social institutional level* includes a high variety of factors and we are interested in the most important ones, we further asked: "What other criteria can influence your selection of science issues?"

Regarding the second part, dealing with NST coverage, the questionnaire included questions on basis of the research findings of surveys paying attention to science journalists[39,40] and content analyses.[40-44] To assess perceptions of NST coverage, the journalists were asked: "How important is it to report on application-related aspects of NST?" and: "How do you personally evaluate NST?" To assess the relevance of NST in science media coverage, the participants were asked: "How important is NST as issue for your media company?" and: "How often do you report on NST?" To learn more about the perceptions of risks and benefits, the participants were asked: "Think about your coverage up until now: what risks or benefits of NST did you cover?" The participants' perception of the uncertainty of NST was assessed with the question: "How do you judge research findings in the field of NST?" and their reporting on scientific certainty or uncertainty of the issue was assessed by asking: "How did you recently report research findings of NST, as rather certain or rather uncertain?"

Analysis of open-ended questions

A qualitative content analysis was conducted on interview data. Transcripts of the interviews were the coding unit of the content analysis; two trained coders worked on the transcripts. Coding book categories were developed inductively from a sample of

answers, with categories emerging from the interview data.[34,39] Categories were open to further extractions at every stage of the coding process to "[encourage] the researcher to constantly revisit and revise assumptions and coding terminology."[52]

For the first part of the questionnaire (selection), the content analysis revealed selection criteria on science journalists' decisions according to the different Gatekeeping-related levels: professional role conceptions, news values, the importance of visual materials for science TV journalists, and the influence of professional and personal acquaintances related to the first three Gatekeeping-levels. Answers corresponding to the *social institutional level* were divided into subcategories: sources and situational factors.

For the second part of the questionnaire (NST depiction), the data was coded regarding the importance of NST in news coverage and the relevance of NST as an issue in science media. Benefits and risks of NST-coverage were subcategorized into different risk and benefit domains. Finally, the content analysis measured statements concerning the scientific evidence of NST-related findings. Answers significant in regard to every category were extracted subsequently.

Results

Selection criteria in science journalism

In order to answer research question 1, which is interested in the most important criteria influencing science journalists' issue selection, results shall be introduced according to the levels outlined in the theoretical part (compare figure 2). They will be summarized in the conclusion section.

At the *individual level*, fifteen science journalists stated that their work is influenced by their personal interest in issues. For instance, an editor from a daily newspaper said: "To be honest, a lot is influenced by my subjective perception and really, issues should meet my personal interest to be selected."[53] Furthermore, at that level we were interested in the professional role conceptions of science journalists. We asked participants to state the targets of their communication when reporting on science; answers were classified with respect to the main statements. Eighteen science journalists aimed their coverage to be a fact-orientated and neutral reporting of science; this result is related to the role of the information provider. For instance, a science TV journalist put into words: "We are not making science TV for academics, but for the average science TV viewers." Those journalists identified as information provider also had the aim that their audience comes to own conclusions: "To inform the reader and let himself decide what he has to think. That's the job of a journalist: to report on things and thereby also to be as objective as possible", said a journalist working for a monthly print science magazine. Seven participants wanted their recipients to get a more critical view regarding science issues, comparable with the role of a critic. A science journalist from a weekly news magazine said: "Public consciousness is one of my concerns. Awareness among the public that you have to worry about new technologies and that

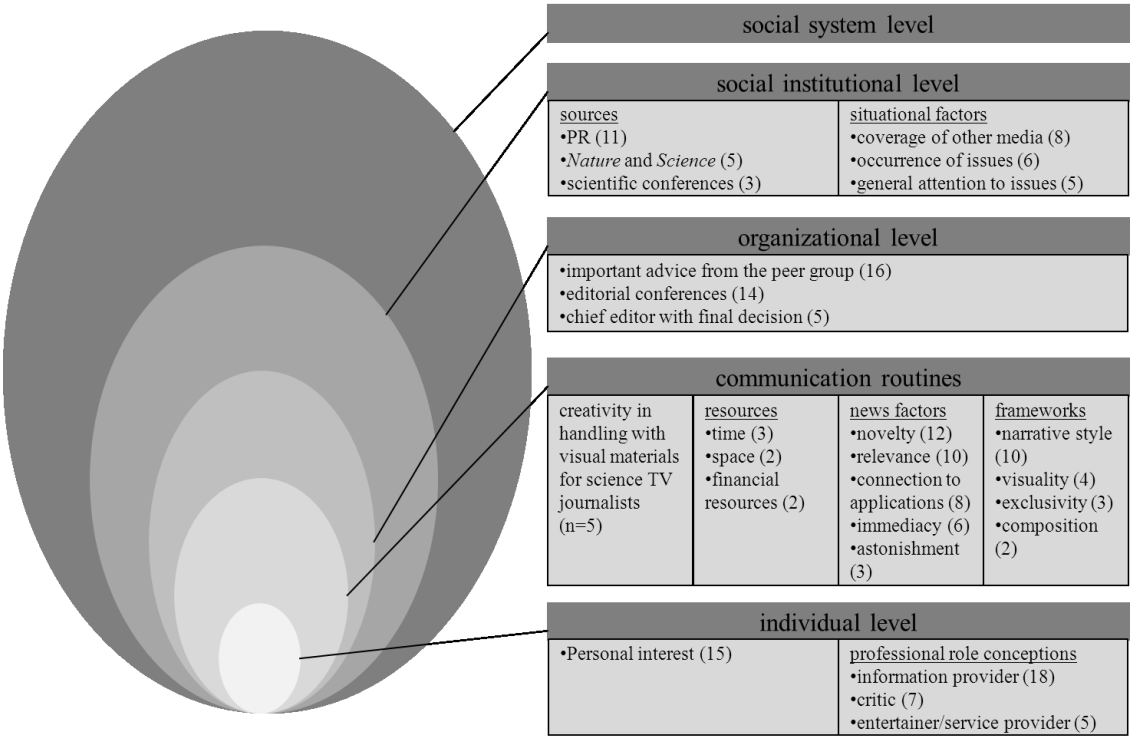

Figure 2. Main results of the science journalistic issue selection according to the different levels provided by Gatekeeping theory. ***Notes.*** Numbers provided in brackets show the frequency of the named items. This model is a summary of the main results of science journalistic issue selection. Science journalists are influenced by various factors at different levels (Gatekeeping).

research is needed to be better informed about risks." Furthermore, five of the science journalists wished their reporting to show visions and arouse curiosity, which is comparable with the role of entertainer/service provider. A science TV journalist stated: "We want to arouse curiosity for new technologies. To some extent we certainly also want to inform the public, but of course within our typical TV format. We are in the middle of the entertainment section in the evening, so we need to entertain the people." A journalist from a daily newspaper said: "We are not a professional journal, our science pages are supposed to produce entertainment and fun out of science."

At the *communication routines or practices level* there are some medium-specific differences. But science TV journalists' issue selection did not depend on the availability of appropriate visual materials as much as was anticipated; only one journalist said that it is not possible to select an issue when there is no appropriate visual material. Conversely, five journalists said that creativity is necessary to make issues become news. "You have to be creative. I never neglected an issue because I did not know how to put it into pictures." Hence, creativity seems to be a stronger factor than visuality. At this level of analysis, a few journalists considered resources like time ($n = 3$) or space ($n = 2$) required to cover stories (i.e., length of articles or TV clip), and the financial resources available ($n = 2$). This is one influencing factor which is not specific to the type of media the journalists work for. Journalists in this sample realize that their resources are limited: "If you select a certain issue, you are also not-selecting

other issues," said a daily newspaper journalist. Furthermore, we were interested in news factors of science journalism. Twelve participants said that issues have to be new to be selected for coverage. One freelancer from a monthly science print magazine emphasized: "Issues always have to be new. As a freelancer you can never propose yesterday's issues to your chief editor." Ten of the study participants mentioned audience relevance as a selection criterion for their coverage. One science TV journalist said: "If the issue I select is not relevant for my audience, they just take the remote control and switch over to another program." Another important factor mentioned by eight participants is connection to applications. Six participants took into account the immediacy of an event, others felt that issues need to be an astonishment (n = 3). What we identified is that next to news factors of science journalism, the participants in this study named factors that cannot be defined as news factors, but are important selection criteria as well. Hence, we would like to expand the *communication routines or practices level* to a category we define as *frameworks*. Ten participants said that they predominantly select issues when those issues are suitable to give them a narrative structure. A science TV journalist explained: "The issue should contain a narrative component. […] It is not about Scientist A, his research, what he exactly did and what he found out. This would be boring for the audience. Instead of that, the issue should fit into a shape that gives scientific facts a story, a narrative style. It is like in the past, when scientific content was told in tales among the public to help them to gain and maintain knowledge." Other factors influencing selection on the category we define as frameworks included visuality (n = 4), exclusive nature of the story (n = 3) and composition (variety of issues in one media outlet) (n = 2).

The next level important for this investigation is the *organizational level*. We were interested in the professional (in comparison to the personal) relationships science journalists have with their editors and other journalists. Fourteen interviewed journalists said that every issue they want to cover is discussed in editorial conferences, and sixteen got important advice from their peers. Only five participants stated that the final decision is made by the chief editor. In comparison, personal acquaintances are a less important factor, with only four participants taking them into account.

For the *social institutional level* and the high amount of possible influencing factors, we asked the science journalists to state other criteria that come to their mind having an influence on their issue selection. We classified answers in relation to their main statements: (1) sources and (2) situational criteria. Sources were mentioned as influential selection criteria: for eleven journalists PR is the key to their. Further, five participants said that articles in journals such as *Nature* or *Science* were main sources, additionally three of the science journalists listed scientific conferences as important source. Some science journalists mentioned situational factors like the coverage of other media (n = 8), occurrence of an issue (e.g., lots of people get sick when winter starts) (n = 6), or the general attention to issues during a certain time (n = 5) as selection criteria.

Journalists' perceptions of their depiction of NST and its related uncertainty

The second part of the questionnaire focused on the depiction of NST as a particular issue covered by science journalists. Research question 2 asked how science journalists evaluate NST and their reporting on the issue. Overall, the science journalists interviewed in this study stated strong positive views on NST (n = 16); or were in the middle between positive and negative views (n = 5). Thirteen participants agreed that for them NST is a media issue of minor relevance. Only five participants rated this issue as being of average importance, and only two of them ascribed high importance to this issue for their coverage.

If NST is selected as an issue in the media, reference to applications is urgently necessary (n = 6) or at least important (n = 13) for most participants. Only two participants stated that basic research, with no reference to applications, dominates how they cover NST-related issues. One journalist from a weekly news press magazine summarized this as: "We only pick this issue if there is a certain reason. A good reason is a research result directly combined with consumers." One journalist from a monthly science print magazine highlighted the fact that: "Readers want to know if nanotechnology helps against sunburn. […] That is important for them, as it would be important for me as a reader. They do not want to know if researchers found or created even smaller particles just because they are smaller than everything before."

Content analyses revealed higher frequencies for coverage regarding the benefits of NST, as opposed to its risks. Our interviews showed: if journalists report about risks, coverage mostly focuses on medical (n = 17) or environmental (n = 7) risks. In contrast, benefits are illustrated with improved product characteristics (n = 13), or medical (n = 10) and environmental (n = 4) opportunities. Most participants considered their coverage to be balanced (n = 8), or supposed that benefits outweighed risks (n = 8). Fewer journalists (n = 5) reported that they pay more attention to risks than to benefits.

Research question 3 asked how science journalists judge scientific findings in the field of NST and how that influences their coverage. Ten participants mentioned in their interviews that research in NST is still just beginning; previous research findings are, therefore, perceived as incomplete by seventeen participants. A daily newspaper journalist said: "I have not yet talked to a scientist who has told me that every research finding in this field is certain." Despite this uncertainty, some journalists feel comfortable expressing certainty in terms of specific applications (n = 10), indicating that perceptions of uncertainty associated with NST are widely based on what specific topics journalists cover. For some journalists, the development from research to consumer products is atypical. A TV journalist explained that: "At first people were investigating in laboratories, suddenly there were the first consumer products, and after that risk analyses were conducted."

With respect to their own reporting on NST, nine journalists perceived their coverage of research findings in the field of NST as predominantly depicting the scientific uncertainty. Six participants reported to make a distinction between uncertain and certain findings; and six participants perceived that their media portrayal of the issue is depicting certainty.

While we could find no differences in the reporting of uncertainty concerning the different media channels, this was not the case when comparing the coverage of scientific evidence to the coverage of beneficial or risky aspects of NST. Journalists whose coverage mainly focused on risks associated with NST perceived their coverage of research findings to be more depicting uncertainty than those reporting benefits as well as risks, who perceived their coverage of findings as sometimes depicting certainty and sometimes depicting uncertainty; they also differed from participants whose coverage focused on benefits, and who perceived their reporting of findings as more depicting certainty. Hence, the depiction of scientific evidence correlates with the focus on risks or benefits of the news coverage (see table 1).

Risks vs. benefits	Journalists predominantly perceived their NST reporting as depicting scientific		
	uncertainty	certainty and uncertainty	certainty
Journalists perceive their coverage to focus on risks	5		
Journalists perceive their coverage to be balanced	3	5	
Journalists perceive their coverage to focus in benefits	1	1	6
Total	9	6	6

Table 1. Frequencies of journalists' perceptions. ***Note.*** Blank cells represent zeros. This table shows the distribution of frequencies journalists stated according to their reporting on risks/benefits and the scientific evidence of NST.

Conclusion

This paper concentrated on two aspects important for science communication: selection criteria in science journalism and the depiction of NST and its scientific evidence.

Science journalists can only cover some topics out of a variety of issues; *selection* criteria help them to make decisions. The results in this study base on qualitative interviews but they provide insights into the most important selection criteria of science journalists, by using different influencing levels related to Gatekeeping[14,15] (and visualized with the help of Weischenberg's[6] Onion Model as can be seen in figure 1) to give a systematization of selection criteria in science journalism. For the journalists interviewed in this study, factors influencing their selection of science issues predominantly included their perceived professional role as an information provider, and their own personal interest in issues (both *individual level*), the fact that events need to be new and relevant (news factors at the *communication routines and practices level*), and organizational influences like the discussion of issues in editorial conferences and the work with other science journalists (both *organizational level*, compare figure 2). That issues need to be new is one fact that has already been identified by researchers: "News by definition is something the reader doesn't already know — if they did, it wouldn't be new."[54] However, the identification of news factors in science journalism is a research field that still deserves more attention. Researchers

agree that issues need to have some kind of relevance to the audience,[2,33,34] but besides this finding, the identified news factors are quite different. We strongly suggest researchers to better separate between characteristics of an event (news factors) and other influencing factors. In this paper, we summarized some of these factors under the category of frameworks, including the possibility of giving a story a narrative style, visuality, exclusivity and composition (e.g. issue variety). According to the results of this study, personal interest and the science journalists' identification as information provider, are also supported by other research results, both in general journalism theory and science journalism.[17–19,21,22,23] The processes within the journalistic organization, such as the work with other journalists and editors, are one field of research that needs more attention in the future. According to the frequencies provided, other aspects on the selection process were of minor importance; although we strongly believe that influencing factors such as resources should be important for all science journalists, but if they are asked in an open-ended question, this is one factor which is not that apparent to them. Overall, the data did not show differences between the specific media channels the journalists were from.

This study was explorative in nature, interviewing only 21 journalists, all of them working in Germany. On the basis of promising findings, we propose developing a standardized questionnaire to be tested it in a representative sample. Such a survey can reveal the most important selection criteria of science journalists and ask — in relation to the influencing factors detected in this study — how much they impact the selection choice of science journalists. Cultural differences in selection criteria might be detected if this study would be repeated in different countries; with the help of that approach the *social system level* of Gatekeeping[14,15] can also be included.

With respect to a specific *depiction* of one issue, NST is central for this study; with this paper among the first to investigate journalists' perceptions of this issue. The same is true as for selection: qualitative interviews are a first step to get insights into this field of research. Although science journalists in this study in general reported increasingly positive attitudes toward NST (in line with results of analyses investigating their coverage[40–44]), they perceive an urgent need for more risk analyses. That is why the majority of participants reported findings in the field of NST as uncertain — against Dudo et al.'s[43] finding that the uncertainty theme is absent in NST coverage. Data verify that journalistic perception of uncertainty varies according to the topics they cover. Those journalists reporting on the risks associated with NST predominantly perceive their coverage of research findings to be depicting uncertainty, while those reporting on a range of NST-related issues perceive their coverage is depicting certain and uncertain aspects in different areas. Those participants who put their main emphasis on the beneficial aspects of NST perceived their coverage of findings to be depicting certainty.

Hence, the results show that journalists in this sample, in relation to the topics that they cover, gained an evidence-based judgment of NST, differentiating between degrees of certainty and uncertainty. However, only some of them stress the scientific uncertainty of this technology in their coverage, which is mostly in the field of risk analyses. But coverage with a dominance of linking scientific uncertainty with risks is

no proof of a transparent engagement with the public. The challenging task of promoting NST in a way that openly and transparently depicts uncertainty needs to be addressed by scientists, policy makers, and science journalists. Our results suggest a lack of coverage of scientific uncertainty as it relates to basic research, although scientific uncertainty is central to the field of science. Reporting more on this would educate the general public about the scientific process, promote the understanding of scientific work and help the general public to accept scientific uncertainty. This study indicates that the coverage of NST in Germany is not as balanced as it could be. Reporting focuses too much on application, which makes sense, given the fact that journalists attach primary importance to attracting their audience.[4,38] But applications can also contain levels of uncertainty.

Future research on NST and the depiction of scientific evidence should not only show that coverage styles of scientific evidence differ between science journalists, but also address the question why such differences exist. The results presented here show that their depiction can be related to the risky or beneficial aspects of this emerging technology but the sample used in this study is not representative and solely focused on NST.

Notes and references

[1] M. Schaefer (2011), *Science journalism and fact checking, JCOM* **10**(4): C02.

[2] F. Badenschier and H. Wormer (2012), *Issue selection in science journalism: towards a special theory of news values for science news?,* in S. Rödder, M. Franzen and P. Weingart eds., *The sciences' media connection and communication to the public and its repercussions,* Springer, Dodrecht, Netherlands, p. 59–86.

[3] C. Elmer, F. Badenschier and H. Wormer (2008), *Science for everybody? How the coverage of research issues in German newspapers has increased dramatically*, *Journalism & Mass Communication Quarterly* **85**(4): 878–893.

[4] F. Clark and D.L. Illman (2006), *A longitudinal study of the New York Times Science Times Section*, *Sci. Commun.* **27**(4): 496–513.

[5] "The gatekeeper concept [offers] communication scholars a framework for evaluating how selection occurs and why some items are selected and others rejected" (P.J. Shoemaker and T.P. Vos (2009), *Gatekeeping Theory,* Routledge, New York, U.S.A., p. 5). Based on Lewin (K. Lewin (1947), *Frontiers in group dynamics II. Channels of group life; social planning and action research*, *Human Relations* (1): 143–153), White (D.M. White (1964), *The 'Gatekeeper': A case study in the selection of news*, in L.A. Dexter and D.M. White eds., *People, society and mass communications,* Collier-Macmillan, London, U.K., p. 160–172.) suggested the flow of news events through channels with certain gates at which news events might or might not pass.

[6] S. Weischenberg (1994), *Journalismus als soziales System*, in K. Merten, S.J. Schmidt and S. Weischenberg eds., *Die Wirklichkeit der Medien. Eine Einführung in die Kommunkationswissenschaft,* Opladen, Westdeutscher Verlag, Germany, p. 427–454.

[7] The Onion Model is an onion-shaped illustration of an individual journalist within the media system.

[8] M. Ramalho, C. Polino and L. Massarani (2012), *From the laboratory to prime time: science coverage in the main Brazilian TV newscast*, *JCOM* **11**(2): A02.

[9] E. Weitkamp (2010), *Writing* science, in: M.L. Brake and E. Weitkamp eds., *Introducing science communication. A practical guide,* Palgrave, London, U.K., p. 79–104.

[10] E.A. Corley, Y. Kim and D.A. Scheufele, *Leading US nano-scientists' perceptions about media coverage and the public communication of scientific research findings*, *J. Nanopart. Res.* **13**: 7041–7055.

[11] S.S. Ho, D.A. Scheufele and E.A. Corley (2011), *Value predispositions, mass media, and attitudes toward nanotechnology: The interplay of public and experts*, *Sci. Commun.* **33**(2): 167–200.

[12] Nanoscale science and technology is seen as a highly funded and interdisciplinary emerging technology (A. Lorenzet (2012), *Fear of being irrelevant? Science communication and nanotechnology as an 'internal' controversy*, *JCOM* **11**(4): C04). It works on the atomic level, with a nanometer being one billionth of a meter long. This technology has become a part of people's daily lives with about 1,000 products derived from NST on the market; although the real potential of the technology is predicted to emerge over the next 10 to 50 years (A. Retzbach, J. Marschall, M. Rahnke et al. (2011), *Public understanding of science and the perception of nanotechnology: The roles of interest in science, methodological knowledge, epistemological beliefs, and beliefs about science*, *J. Nanopart. Res.* **13**: 6231–6244.). However, as applications expand, there is a growing discussion about possible harmful outcomes, with uncertainty surrounding the long-term effects of NST on human health and the environment.[11] Risks related to NST are invisible; especially with regard to whether nanoparticles are dangerous: There still exists considerably uncertainty whether nanoparticles can enter the body, as well as if they have damaging effects on cells and DNA.

[13] S. White, P. Evans, C. Mihill et al. (1993), *Hitting the headlines. A practical guide to the media,* The British Pychological Society, Leicester, U.K.

[14] P.J. Shoemaker (1991), *Gatekeeping. Communication Concepts 3*, Sage, London/New Delhi, U.K./India.

[15] P.J. Shoemaker and T.P. Vos (2009), *Gatekeeping Theory,* Routledge, New York, U.S.A.

[16] Studies never cover the full complexity of Gatekeeping in the communication process.[14] In addition to Gatekeeping, Weischenberg's[6] Onion Model differentiates four levels influencing the journalistic system: media actors, media productions, media institutions, and media systems. But since these levels represent journalists within the media system and not exclusively the journalistic selection of issues[6], this paper predominantly tries to explain science journalists' selection criteria with the help of Gatekeeping and uses the Onion Model to visualize the selection criteria. The Onion Model offers some advantages for this visualization: its clear structure can show how an individual journalist is influenced by close and peripheral levels, all of which include different selection criteria. The journalist is surrounded by these levels, some of them seem to be closer to him/her than others — this, however, does not implicate a stronger influence of closer levels than more periphery ones; due to the imagination of a person surrounded by different levels (or layers), the metaphor of the onion arose, with external layers encircling interior ones.[6] This visualization is also suitable for the Gatekeeping-levels[14] that can also be regarded as layers influencing each other, "ranging from […] the micro world of single people […] to the macro world of countries and continents" (see note 15, p. 31).

[17] D.M. White (1950), *The 'Gate Keeper': A case study in the selection of news*, *Journalism Quart.* **27**: 383–391.

[18] D.M. White (1964), *The 'Gatekeeper': A case study in the selection of news*, in: L.A. Dexter and D.M. White eds., *People, society and mass communications,* Collier-Macmillan, London, U.K.

[19] H. Wormer (2010), *Warum ist der Himmel blau? Wie die Massenmedien Wissensthemen aufbereiten und verbreiten*, in: U. Dausendschön-Gay, C. Domke and S. Ohlhus eds., *Wissen in (Inter-)Aktion. Verfahren der Wissensgenerierung in unterschiedlichen Praxisfeldern,* De Gruyter, Berlin/New York, Germany/U.S.A., p. 347–376.

[20] S. Weischenberg, M. Malik and A. Scholl (2006), *Die Souffleure der Mediengesellschaft. Report über die Journalisten in Deutschland,* UVK, Konstanz, Germany.

[21] B. Blöbaum, A. Görke, H. Hettwer et al. (2003), *Wissenschaftsjournalismus bei Regional- und Boulevardzeitungen. Befragung, Inhaltsanalyse und Ausbildungsperspektiven*, available at: http://www.bertelsmann-stiftung.de/cps/rde/xbcr/SID-7717A221-36579DD3/bst/Endfassung_RegionalStudie_pag_04-09-13.pdf (retrieved Jan 11, 2013).

[22] U. Stamm (1995), *Recherchemethoden von Wissenschaftsjournalisten und -journalistinnen*, available at: http://www.polsoz.fu-berlin.de/kommwiss/institut/wissenskommunikation/media/_stamm_fobe1.pdf (retrieved Jan 11, 2013).

[23] X. Wolff (2003), *Wissenschaftsjournalisten und ihre Verbände. Fragen zum Selbstverständnis und zur Einstellung zu Berufsverbänden. Eine Umfrage unter organisierten und nicht-organisierten Wissenschaftsjournalisten*, available at: http://www.polsoz.fu-berlin.de/kommwiss/institut/wissenskommunikation/media/wolff_fobe.pdf (retrieved Jan 11, 2013).

[24] J. Milde and S. Hölig (2011), *'Das Bild ist stärker als das Wort' - Selektions- und Darstellungskriterien von TV-Wissenschaftsjournalisten beim Thema 'Molekulare Medizin'*, in: G. Ruhrmann, J. Milde and A.F. Zillich eds., *Molekulare Medizin und Medien*, VS, Wiesbaden, Germany.

[25] H. Wormer (2006), *Selling science in a soap selling style?*, *JCOM* **05**(3): C03.

[26] S. White, P. Evans, C. Mihill et al. (1993), *Hitting the headlines. A practical guide to the media,* The British Pychological Society, Leicester, U.K., p. 13.

[27] See note 15, p. 51.

[28] W. Schulz (1976), *Die Konstruktion von Realität in den Nachrichtenmedien*, Alber, Freiburg/München, Germany.

[29] M. Maier, K. Stengel and J. Marschall (2010), *Nachrichtenwerttheorie,* Nomos, Baden-Baden, Germany.

[30] J. Galtung and M.H. Ruge (1965), *The structure of foreign news. The presentation of the Congo, Cuba and Cybrus crises in four Norwegian newspapers*, *J. Peace Res.* **2**(1): 64–91.

[31] For a critical investigation of these factors and a reformulation, see for instance Harcup and O'Neill.[32]

[32] T. Harcup and D. O'Neill (2001), *What is news? Galtung and Ruge revisited*, *Journalism Studies* **2**(2): 261–280.

[33] W. Göpfert (2006), *Wissenschaftsjournalismus heute*, in: C. Götz-Sobel ed., *Wissenschaftsjournalismus heute. Ein Blick auf 20 Jahre WPK.* VDI, Düsseldorf, Germany, p. 29–36.

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[36] E. Weitkamp (2003), *British newspapers privilege health and medicine topics over other science news*, *Public Relations Review* **29**: 321–333.

[37] W. Göpfert (2006), *The strength of PR and the weakness of science journalism*, in: M. Bauer and M. Bucchi eds., *Journalism, Science and Society*, Routlege, London, U.K., p. 215–266.

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[41] A. Anderson, S. Allan, A. Petersen et al. (2005), *The framing of nanotechnologies in the British newspaper press*, *Sci. Commun.* **27**(2): 200–220.

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[46] S.H. Stocking and L.W. Holstein (2009), *Manufacturing doubt: Journalists' roles and the construction of ignorance in a scientific controversy*, *Public. Underst. Sci.* **18**: 23–42.

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[50] A. Anderson, S. Allan, A. Petersen et al. (2005), *The framing of nanotechnologies in the British newspaper press*, *Sci. Commun.* **27**(2): 213.
[51] This study is part of a research project funded by the German Research Foundation (DFG) in the Special Priority Program "Science and the Public" (DFG-SPP 1409) in which a content analysis of the years 2010 and 2011 collected information about NST coverage and provided names of important journalists.
[52] J. Schneider (2010), *Making space for the 'nuances of truth': Communication and uncertainty at an environmental journalists' workshop*, *Sci. Commun.* **32**(2): 179.
[53] Original responses were given in German; they were translated by the researchers.
[54] E. Weitkamp (2010), *Writing science*, in: M.L. Brake and E. Weitkamp eds., *Introducing science communication. A practical guide.* Palgrave, London, U.K., p. 87.

Authors

Lars Guenther is a Ph.D. student and research associate at the Institute of Communication Research at Friedrich Schiller University in Jena, Germany, as well as a freelance journalist for several media companies. He has degrees in Communication Research, German Literature, and History, and his research interests include journalism, as well as science and health communication.
E-mail: lars.guenther@uni-jena.de.

Georg Ruhrmann is Professor of Communication Research at Friedrich Schiller University in Jena, Germany. His recent co-operations include the program "Science and the General Public" for the German Science Foundation (DFG), and the work for the Commission of Risk Perception and Risk Research of the German Federal Institute of Risk Assessment (BfR). E-mail: georg.ruhrmann@uni-jena.

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