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The Complexity of Mass Mediated Risk Discourses: A Conceptual Framework for Studying Issue Attention to Science and Technology

1. Introduction

The central research question of the paper is why some risks gain a lot of media attention, while others never overcome the threshold of public awareness. The mechanisms influencing media attention are rather complex and generate unpredictable results. For example, researchers observe that social risk perception of low-consequence/high-probability risks and high-consequence/low-probability risks is not at the same level although it technically should be.[1] Furthermore, media attention follows its own rules and can gain surprising momentum in the coverage of one issue,[2] while other issues seem to be silenced.[3] This paper argues that to take account of the complexity of media discourses, existing approaches of ex-post explanation of attention cycles should be complemented by dynamic models and simulations which are grounded in complexity theory.

2. The Nature of Media Attention towards Scientific Risks

The most important reference model when studying the media careers of issues is the issue attention cycle as proposed by Downs and Luhmann in the 1970s.[4] Both authors distinguish different stages of development in the public's issue attention. After a la-

tent phase, where only insiders are interested in the problem, some issues break through to the public agenda. However, after a limited time span of media hype, the issue loses attention again and sooner or later disappears from the public agenda. The reason for their disappearance is seen in the limited carrying capacity of the media arena, due to the limited attention of the audience. Therefore, issues and issue sponsors are constantly competing for public attention.[5]

Numerous researchers have grounded their empirical research on this ideal type model of issue careers.[6] Results show that the proposed pattern of media attention can indeed be found empirically. Media attention to scientific risks is not steady, but often follows inherently dynamic waves of ups and downs. Even the coverage of long-term risks is not sustained at high levels for a longer time span.[7] Besides showing that real issue careers of some risks occur,[8] researchers also note that other risks happen to be entirely overlooked by the media.[9] Vasterman even states that real media hypes are only exceptional.[10] This view is affirmed by findings, which show that media attention to scientific risks[11] and to science and technology in general is rather low.[12] The main interest of researchers therefore lies in explaining, when, why and how an issue makes the breakthrough to the public agenda. It is widely accepted that media risk discourses neither correspond necessarily to scientific and expert assessments of risk nor to objective real-world criteria.[13] Consequently, the mass media are discussed as one important station in the social amplification of risk.[14] The following mechanisms and factors explaining issue careers are derived from a literature review:

- *Momentum:* Researchers explain media hypes by self-reinforcing effects through inter-media-agenda-setting,[15] and by the effects of key events, which decrease attention thresholds for following similar events.[16] Saturation effects are mostly explained by issue competition and the limited carrying capacity of the media arena.[17]
- *External factors:* News selection theory and agenda-building approaches contribute important variables to the explanation of issue careers: (1) events, (2) issues, (3) frames and (4) social actors.[18] News selection criteria are the link between these variables and the resulting issue careers: the higher the news value of an event or an issue, the more dramatic the applied frame and the more polarized the actor constellation, the higher is the chance for media attention. The interest of individual or collective sponsors to place an issue on the agenda or to silence the issue is also critical.[19]

Thus, so far researchers contribute to explaining issue careers by isolating certain factors or mechanisms and trying to determine their power of influence. Most of the studies focus on only one or a few cases to give an ex-post explanation of the occurrence of an issue career with quantitative or qualitative methods. Studies comparing several issues are rare,[20] so are studies, which transcend description, e.g. by using explanatory statistical time series analysis.[21] Furthermore, studies often stop at the point of showing which variables are influential, but do not explain, how the numerous variables interact. To realize this endeavor, dynamic models are required, which

overcome the restrictions of linear regression models and are able to simulate the interplay of factors and mechanisms.

3. A Complexity Perspective on Mass Mediated Risk Discourses

Since the beginning of the 1990s, complexity research has developed from its roots in physics, mathematics and information science to an interdisciplinary approach for studying the behavior of complex systems.[22] Today, also economists and social scientists are heavily interested in the computational methods developed in this research tradition, because social systems are by definition complex systems.[23] Miller and Page define complex systems as follows: (1) Complex systems are characterized through the interconnectedness of their components. In contrast to only complicated systems, the *web of connections* between the components is decisive. Thus, the removal of only one component can have substantial effects on the behavior of the whole system. (2) Complex systems are subject to dynamic *change induced by choices* of their agents. These agents are able to process information from the environment, and they are able to adapt their actions to a change in that information. (3) Complex systems often are composed of *heterogeneous agents*. This means that agents have differing traits, which can lead to stability or instability of the system depending on the type of feedback loop by which the agents are connected.[24] The following concepts of complexity theory are very useful to the understanding of public issue careers.

3.1. Non-linearity

Mathematically, complex systems are defined as nonlinear systems, which are characterized by dynamic, often chaotic and unpredictable behavior.[25] Small variations in the state of the system at one time can result in very large changes to later states of the system.[26] However, nonlinear systems mostly do not behave completely chaoticly, but also show elements of order. This is why complex systems are located between order and chaos.[27] As has been shown in the previous section, media attention towards scientific risks is highly non-linear with unpredictable ups and downs in coverage. Nevertheless, media researchers have been able to identify repeated patterns of issue attention, the so-called issue attention cycle. Therefore, public issue attention ranges between order and chaos, which requires also non-linear models for its description and explanation and questions the use of simple linear regression models.

3.2. Emergence

Another important concept is emergence, a term for the phenomenon of interactions among components producing higher-level patterns. These patterns have new characteristics, which require new categories for description.[28] To generate those higher-order regularities, simple rules and local interactions at the lower level are often sufficient. For example, simple pair interactions between birds lead to the emerging V shape of a bird flock.[29] The higher-level patterns emerge from the bottom up, "… without any central planner or top-down programming".[30]As the V shape of a bird flock, the issue attention cycle can be seen as an emergent pattern, which results from many local interactions of agents. Our research question, therefore, focuses on the

simple or complex interaction rules, which are able to generate an issue career in media coverage.

3.3. Heterogeneity of Agents

The actors in the media arena, which produce issue careers through their interactions, are heterogeneous in their attributes, goals and strategies. First, media actors (e.g. journalists) have to be distinguished from other societal actors (e.g. politicians, companies, associations),[31] which have been called sponsors in the literature.[32] Media actors differ for example in political orientation,[33] and journalistic self-concepts, which may influence the attention thresholds for certain issues.[34] Important differences of sponsors are resources (e.g. money and power) and status (e.g. prominence and prestige), which influence their access to the media arena.[35]

3.4. Interconnectedness of Agents

The heterogeneous agents are linked together by a web of connections. Because some agents are more powerful and have more resources than others, this web is characterized by asymmetries and dependencies. For example, the mass media depend on established political actors as news sources.[36] On the contrary, outsiders like social movements are heavily dependent on mass media attention to achieve their goals, but do not have the same access to the media arena as established actors.[37]

3.5. Self Organization and Feedback

As there is no top-down planner, agents organize themselves by adapting to each other's behavior and to changing environmental conditions. Agents are interlinked by positive and negative feedback loops. While positive feedback leads to instable, explosive behavior of a system, negative feedback serves to balance the system to equilibrium.[38] Positive feedback loops are also at the heart of the phenomenon of media hypes. Media and societal actors observe public communication and adapt to it in the way that media coverage on an issue leads to even more coverage. This principle may explain the effects of inter-media-agenda-setting and key events

4. Methodological Prospects: Agent-based Modeling

Complexity research scholars have developed several computational modeling and simulation methods, because analytical mathematical methods often are not appropriate to model and analyze complex systems.[39] Among these methods agent-based modeling (ABM) is a technique, which is especially well suited to explore complex social systems.[40] Agent-based models mainly consist of the following components:[41]

- *Agents:* These are relatively autonomous software objects with defined attributes and goals. Agents are able to use information from the environment or other agents to choose their actions.

- *Environment:* Agents interact with each other in a virtual environment, which can be a topographic space, a network or an abstract knowledge space.
- *Rules:* Agents process information and choose actions according to defined rules.

The most important advantage of ABM, compared to other modeling and simulation techniques, is the possibility to model dynamic processes as well as heterogeneous, adaptive, and interacting agents. Therefore, it is a powerful instrument to model processes of emergence and to experiment with virtual societies: "In particular, once we specify an agent-based object model and find that it leads to a coherent macrophenomenon, we have thereby found at least one set of microconditions that is sufficient to generate the macro-observations."[42] These insights are important steps in the development of theories. However, the models of course have to be subject to empirical validation.[43]

ABM is a promising technique also for the analysis of media attention cycles to scientific risks. An ABM model of a virtual media system with media actors and sponsors as interacting and adaptive agents could yield important insights. Through computer experiments with changing parameters and sensitivity analyses, one could find out which of the proposed variables and mechanisms in the literature would suffice to explain the emergence of an ideal type issue cycle on the macro level and, thus are really crucial. Unfortunately, media attention cycles have not been in the centre of interest of social simulation research so far. However, interesting studies can be found

in the close field of opinion dynamics, where researchers simulate, how opinions are formed in a population.[44] Although these models have quite a different scope, they show that ABM can be applied meaningfully to analyze mediated risk discourses.

4. Conclusion

The main argument of the paper is that a complexity perspective on media attention cycles could theoretically and methodologically enrich research on media attention towards scientific risks. First, it has been argued that the current state of research needs to be advanced by dynamic models. Second, it has been shown that the characteristics of scientific risk discourses can well be described in terms of complexity research, namely nonlinearity, emergence, heterogeneity, interconnectedness, self-organization and feedback. Finally, it has been explicated that with ABM the complexity approach also offers a suitable modeling and simulation technique for research on complex social systems, and thus also for analyzing and explaining issue careers of scientific risks.

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