Hype After Hype: From Bio to Nano to AI

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Nanotechnology stands out in two respects. Firstly, the technology is surrounded by hype, that is by excessive future promises and expectations, justifying funding programmes and driving financial, scientific, and innovative dynamics, followed by slumps of disillusionment and shifts away after promises and expectations have not been met [1, 2]. Secondly, no other technology before has received so much attention from the social sciences and humanities (SSH) proactively seeking to assess its ethical, political, and social implications while pursuing normative agendas aimed at fostering inclusion and participation, reflexivity and co-production, responsiveness and responsibility. Indeed, propelled by responsive policy language and generous funding in the USA, the EU, and beyond, nanotechnology became a laboratory for the experimentation with governance innovations advocated by the engaged research branches of the SSH. Among these, “public engagement” as a means of democratizing S&T innovation policy initially took the primary position. “Upstream engagement” [3] appeared as an early conceptual refinement calling for public engagement at early stages of S&T development. The SSH soon went further and proposed more comprehensive

concepts envisaging prominent roles for specialized segments of the SSH themselves, such as “midstream modulation” [4], “anticipatory governance” [5], and “constructive” or “real-time technology assessment” [6, 7].

This special section of *NanoEthics: Studies of New and Emerging Technologies* explores ideas arising from these peculiarities. Specifically, we suggest that technology hype, governance learning and reform processes, and SSH involvement are interconnected. In a sense, this is obvious since it was the dialectic of positive and negative expectations entailed by the hype that led technology élites to adopt a mode of governance that would integrate SSH expertise and experimentation with public involvement. Nanotechnology’s potentially “problematic” nature associated with concerns about negative socioeconomic implications and a looming public backlash such as that against biotechnology called for lessons to be drawn from the past and new, more cautious, and experimental ways of governance to be explored, which the SSH offered to scout out. In this context, it is important to note that this initial policy framing came from technology élites, not the SSH. In fact, the SSH hardly took any notice of nanotechnology in the 1990s [8, 9]. Hence, it was the policy framing SSH responded to, not the technology and its surmised social problems.

The less obvious relationship between SSH involvement and hype is one of isomorphism: just as technologists and technology advocates, policy makers and funders, visionaries, investors etc. have been

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caught up in the hype, so too do their ethical and reflexive counterparts, the SSH, each in their own ways depending on expected profits and risks. The former might aspire to gain competitive leads in technology innovation, markets, or geopolitics and, conversely, face the risks of falling behind in competitive dynamics, while the latter might see opportunities for normative policy reform, democratization of and gains in reflexivity in S&T governance [10]. For both, expected gains in reputation and influence in the respective academic fields are strong motives for involving themselves in a hype dynamic.

A look at bibliometric data supports what is obvious to those acquainted with the field — that the hype over nanotechnology, including the hype in the SSH, is long over. Figure 1 presents bibliometric data collected from the Web of Science (WOS) and Elsevier's SCOPUS based on key word research ("nano*" and "social"). The search yields a representative (though incomplete) record of the literature on the social aspects of nanotechnology, very broadly conceived, from its beginnings in the early 1990s through 2020. Purged of duplicates and articles of purely technical or scientific focus or marginal relevance, the sample consists of 1225 articles on social issues related to nanotechnology.

The graph does not display the diversity of this literature, its diverse normative and epistemic frameworks, and its range of fields, paradigms, and disciplines (to

be analyzed elsewhere). However, it clearly shows the cyclical character of an Issue-Attention Cycle [11] that would be expected in a fashion or hype dynamic [12]. What can be seen from the graph is that research on social and ethical aspects of nanotechnology has been on the decrease since 2014. Clearly, the SSH are well past the socio-ethical nanotechnology hype.

For a majority in the SSH, this carries the message of leaving behind a research field that has been examined extensively and moving on to new, promising horizons. However, a situation of hindsight also offers distinctive analytical opportunities. Reviewing a process in temporal depth helps one understand its underlying logic and dilemmas. As regards nanotechnology, conspicuous experimentation with new forms of normatively ambitious governance, combined with the involvement of the SSH, lends itself to an examination of the social logic of these new modes of governance. Why did it come to pass? To what effect? Have the calls for normatively ambitious governance models such as public engagement fulfilled expectations? And how have new forms of governance affected the SSH?

With regard to the first question it is widely acknowledged that the situational context of the late 1990s and early 2000s, notably the backlash against biotechnology, was a major reason for technology élites to seek a new governance approach to nanotechnology [13]. The controversy came to be seen as

Fig. 1 Temporal evolution

the result of a reductionist and arrogant approach to the public by the élites, with SSH acting as normative-interpretative intermediaries between the public and policy [14]. If mistakes were to be avoided, lessons had to be learned. Science and politics needed to “do it right this time” and open doors for public engagement and humble dialogue. Obviously, the public crisis around biotechnology had triggered a learning process and nanotechnology offered itself as an experimental field for governance innovations.

Furthermore, in the early 2000s a reformatory governance and policy discourse had already matured in the preceding decade. The SSH had gradually assumed roles in technology governance, initially in auxiliary functions, as observers of potentially “unruly” publics or observatories for future impacts, but also increasingly as policy analysts, commentators, and effective critics. Technology assessment, for instance, has its origins in the 1960s in the USA from where it spread and diversified into different national TA traditions; and potentially controversial technology

projects such as human genomics had seen the rise of special research programmes on Ethical, Legal and Social Issues (ELSI) or, slightly varied in the EU, Ethical, Legal and Social Aspects (ELSA). In this case, too, a discourse on governance learning unfolded. The conventional ELSI/ELSA approach was criticized for the passive and instrumental role assigned to the SSH, whereby technological trajectories were taken as givens to be dealt with rather than a matter of political choice. When the nanotechnology governance field emerged, both the drawing-lessons-from-controversy discourse and the ELSI/ELSA governance strand shaped the new governance of nanotechnology.

Figure 2 provides insights into how the academic debate evolved over two decades based on the development of a (by no means exhaustive) selection of key themes. Evidently, those themes which, initially, were key to the discursive construction of the field lost their significance over time. The theme of a looming public *backlash* against nanotechnology, the theme of *lessons* to be drawn from previous mistakes

Fig. 2 Selected themes. Temporal evolution

in the governance of S&T, and the *ELSI/ELSA* theme became steadily less important. Conversely, the theme *responsibility* gains in importance in the second half of the observation period, which mirrors the rise of Responsible Research and Innovation (RRI) as a guiding principle in the EU's eighth Framework Programme Horizon 2020 (2014–2020).

Figure 2 highlights key themes in the academic literature on social aspects of nanotechnology. Themes are identified based on information in titles, keywords, and abstracts. Trends in the roughly 20 years of academic nanotechnology discourse are presented by dividing the sample into quarterly periods of five years. Article counts until 2001 do not reflect any of these themes and are therefore omitted. The selected themes shed light on the evolution of the academic debate. More specifically, the observed patterns that are reflected by and in academic debate make sense on the assumption of social learning processes at the beginning and during the course of the observation period. The generalized concern among nanotechnology promoters of a looming public backlash against nanotechnology is a legacy of the preceding (bio-) technology controversies and the result of the élites' anxious desire to safeguard investments into the promising new technology. The same obviously applies to the logically and semantically linked “learning lessons” theme which, in making social learning an issue of academic debate, in a way mirrors such a process. Both themes were relatively important in the early phases of the academic debate and receded into the background during its later course. In the case of the backlash theme, this is arguably due to the fact that nothing comparable to a public backlash ever happened. In fact, with the only exception of France, nanotechnology never became particularly controversial. The generalized assumption of a threat to nanotechnology emanating from a discontented public turned out to be wrong, a fact not too often mentioned in the literature [15]. As regards the “learning lessons” theme, it soon became clear that the international wave of funding programmes for research on the social and ethical aspects of nanotechnology and the resulting wave of SSH studies on the subject could easily be interpreted as such learning processes, at least in terms of an extensive ethical debate, frequent social experimentation with public engagement policies and the mobilization of SSH expertise through funding and responsive policy language.

The *ELSI/ELSA* theme also shows an initial peak and descending pattern. Social learning seems to be at work again in several respects. As noted above, in an initial stage, the *ELSI/ELSA* strand was transferred (through learning) from earlier governance modes in genomics and biotechnology to the new nanotechnology field. The fact that the *ELSI/ELSA* terminology gradually faded over time allows several interpretations. For one thing, the pattern might result from the field's maturing, with demand for socio-ethical impact assessments becoming saturated over time. For another, the decline might reflect the displacement of *ELSI/ELSA* by new governance language which corresponds with SSH criticism of the terminology's normative shortcomings [16–18].

Indeed, in the 2000s, new governance language revolving around the term responsibility developed, mostly in the context of the nanotechnology field [19, 20]. As noted before, responsibility terminology found expression first in the USA then in EU policy language, with the later rise in academic attention paid to this terminology being largely due to the rise of RRI in the EU's Horizon 2020. One is tempted to surmise that, with the onset of Horizon 2020, the SSH hype over nanotechnology turned into a hype over RRI [19]. It certainly turned into the buzzword of the day [21].

Considering RRI's high profile, the SSH enthusiasm and buzz is more than understandable. A policy framework with the stated objective of aligning S&T innovation with broader social values, reflexively coping with uncertainty, ambiguity and ignorance in S&T innovation governance and fostering decisional criteria beyond market mechanisms and narrow risk-based regulation, appeared as a breakthrough in the S&T policy reform that the SSH have long been calling for. Significantly, with such a framework, reflexive governance no longer applied to the few selected S&T fields considered “problematic,” such as genomics and bio- and nanotechnologies, but promised to function as a generalized principle applicable to technological innovation across S&T fields. However, RRI had an expiration date. The following EU Framework Programme, Horizon Europe, shifted focus to innovation, inclusiveness, and participation and — to the concern and dismay of the RRI researchers whose numbers had grown sharply during Horizon 2020 [22] — took RRI largely off the funding agenda.

The focus of the call for the present special section was on the interconnection of technology hype, learning processes, and SSH involvement proceeding from the assumption that this interconnection, which became visible in the nanotechnology field, is and will be also operative in subsequent and future developments. In the meantime, new policy terminologies, or variations on old ones, and new technology hypes pervade the public discourse. A recent example of the latter is Artificial Intelligence (AI) where parallels to the discourses on nanotechnology can be observed. In the case of AI, prominent researchers and think tanks, for example, also warn against a public backlash if policy makers and funders fail to foster public support through public engagement [23].

In the first contribution to the special section, Frederick Klaessig expounds how the concept of the “technology trajectory” is predestined to simultaneously bridge disciplinary boundaries and conceptualize heterogeneous processes in disparate policy fields and over long-term developments through the key stages of policy making, regulation, and market adoption. Specifically, he uses the concept to draw lessons from nanotechnology and biotechnology to be applied to the hype currently surrounding AI. While admitting the tendency among technology proponents to make promissory claims to justify needed investment and the benign character of good faith exaggeration among peers, he stresses the need to counteract hype in the course of a technology’s development. According to him, the trajectory concept helps to identify, and possibly predict, the situations — markets, locations, or actors — in which such reality checks come to pass.

Jantien Schuijjer, Jacqueline Broerse, and Frank Kupper study the roles SSH scholars are taking on today in the public engagement field. Drawing on their experiences as SSH scholars in an EU-funded public engagement project on responsible nanotechnology, they add to the growing academic literature that deals with the problems SSH researchers face as they become integrated in S&T policy, research, and innovation projects. Regarding this special section, they respond to our question how new forms of governance have affected the SSH. The enquiry reflects dilemmatic consequences of the policy learning process that became so visible in the nanotechnology field and resulted in the expansion and experimental diversification of a new S&T governance regime. Now that SSH integration has become a common

element of S&T innovation, governance researchers, typically in early career phases, have to cope with the ambiguity of an academic mandate to research, be critical and inspire reflexivity, and somehow be helpful to S&T innovation projects while seeking to carve out a career or rather survival strategy in a structurally precarious segment of academia. The authors do so by proposing a systematization of five roles the SSH assume under such circumstances, discussing tensions and synergies between them and making a plea for role awareness, reflexivity, and the cultivation of new competencies among integrated SSH scholars.

In an invited contribution, Bernadette Bensaude-Vincent takes us to France. She responds to our question about the extent to which initial expectations regarding public engagement have been met. Having experienced outright fiascos with experiments in public engagement over nanotechnology and synthetic biology, France stands out in an international comparison. It seems that the polarity of an elitist, technocratic state and an “unruly” civil society that is so characteristic of France does not offer the best requirements for the ideals of deliberative democracy at the heart of the public engagement movement. Yet, as Bensaude-Vincent concludes, also from her insider experiences with the permanent stakeholder forum NanoRESP, there are spaces and arrangements that do render possible meaningful debate on nanotechnology. However, they come with reservations. These debates did not come about before the big controversies had faded away, and they remained debates among stakeholders rather than among the major public. She concludes that in France the ambitious ideal of co-production of science and society has given way to a more modest co-learning process between stakeholders. Compared with the initial SSH hype over public engagement, expectations need to be revised down to a realistic measure.

The responses to our call have been few and diverse. Considering our call’s broad thematic scope, this somehow fragmentary character may testify to the complexity of the topic and be due to the fact that the call came at a rather late stage in an academic field that moves at the same pace as the technological innovation race and the ever shifting policy language it depends on and critically reflects upon. The diversity, however, illustrates the intellectual opportunities offered by hindsight and historical perspective, which can yield new and broadly applicable

analytical approaches such as the technology trajectory approach. Specifically, it demonstrates the underexploited intellectual potential of investigating the SSH's increasing involvement and integration in S&T governance. This can take the form of critical self-evaluation or self-reflection among SSH scholars who share a broad normative consensus as in the contributions, but also conceptual approaches yet to be seen in future contributions questioning the SSH's evolving role as an active participant in S&T innovation governance.

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References

- Berube DH, Roco MC (2006) Nano-hype: The truth behind the nanotechnology buzz. Prometheus Books, Amherst
- Audétat M (2015) Sciences et technologies émergentes: Pourquoi tant de promesses? Hermann, Paris
- Wilsdon J, Willis R (2004) See-through science: Why public engagement needs to move upstream. Demos, London
- Fisher E, Mahajan RL, Mitcham C (2006) Midstream modulation of technology: Governance from within. *Bull Sci Technol* 26(6):485–496
- Barben D, Fisher E, Selin C, Guston DH (2007) Anticipatory governance of nanotechnology: Foresight, engagement, and integration. In: Hackett EJ, Amsterdamska O, Lynch ME, Wajcman J (eds) *The handbook of science and technology studies*. MIT Press, Cambridge, pp 979–1000
- Guston DH, Sarewitz D (2002) Real-time technology assessment. *Technol Soc* 24(1–2):93–109
- Schot J, Rip A (1997) The past and future of constructive technology assessment. *Technol Forecast Soc Chang* 54:251–268
- Bennett I, Sarewitz D (2006) Too little, too late?: Research policies on the societal implications of nanotechnology in the United States. *Sci Cult* 15(4):309–325
- Eisler MN (2013) "The ennobling unity of science and technology": Materials sciences and engineering, the Department of Energy, and the nanotechnology enigma. *Minerva* 51:225–251
- Macnaghten P, Kearnes MB, Wynne B (2005) Nanotechnology, governance and public deliberation: What role for the social sciences? *Sci Commun* 27(2):268–287
- Downs A (1972) Up and down with ecology. *The issue-attention cycle*. *Public Interest* 28:38–50
- Rip A (2000) Fashions, lock-ins, and the heterogeneity of knowledge production. In: Jacob M, Hellström T (eds) *The future of knowledge production in the academy*. Open University Press, Buckingham, pp 28–39
- Rip A (2006) Folk theories of nanotechnologists. *Sci Cult* 15(4):349–365
- Jasanoff S (2003) Technologies of humility: Citizen participation in governing science. *Minerva* 41(3):223–244
- Seifert F, Plows A (2014) From anti-biotech to nanowatch: Early risers and spin-off campaigners in Germany, the UK and Internationally. *NanoEthics* 8(1):73–89
- Balmer A, Calvert J, Marris C, Molyneux-Hodgson S, Frow EK, Kearnes M, Pablo Schyfter KB, Mackenzie A, Martin P (2015) Taking roles in interdisciplinary collaborations: Reflections on working in post-ELSI spaces in the UK synthetic biology community. *Sci Technol Stud* 28:3–25
- Rip A (2009) Futures of ELSA. *EMBO Rep* 10:666–670
- Zwart H, Laurens L, Van Rooij A (2014) Adapt or perish? Assessing the recent shift in the European research funding arena from 'ELSA' to 'RRI'. *Life Sci Soc Policy* 10:11
- Rip A (2016) The clothes of the emperor. An essay on RRI in and around Brussels. *J Responsible Innov* 3(3):290–304
- Shelley-Egan C, Bowman DM, Robinson DKR (2017) Devices of responsibility: Over a decade of responsible research and innovation initiatives for nanotechnologies. *Sci Eng Ethics* 24(6):1719–1746
- Bensaude-Vincent B (2014) The politics of buzzwords at the interface of technoscience, market and society: The case of 'public engagement in science.' *Public Underst Sci* 23:238–253
- Gerber A, Forsberg E-M, Shelley-Egan C, Arias R, Daimer S, Dalton G, Cristóbal AB, Dreyer M, Griessler E, Lindner R, Revuelta G, Riccio A, Steinhaus N (2020) Joint declaration on mainstreaming RRI across Horizon Europe. *J Responsible Innov* 7:708–711
- Cookson C (2018) Artificial intelligence faces public backlash, warns scientist. In: *The Financial Times* Sep 6th 2018. <https://www.ft.com/content/0b301152-b0f8-11e8-99ca-68cf89602132>. Accessed 31 July 2021

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