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The 'Economy of Memory': Publications, Citations, and the Paradox of Effective Research Governance

Abstract

More recent advancements in digital technologies have significantly alleviated the dissemination of new scientific ideas as well as the storing, searching and retrieval of large amounts of published research findings. While not denying the benefits of this novel 'economy of memory,' this paper endeavors to shed light on the ways in which the use of digital technologies may be linked to a distortion of the system of formal publications that facilitates the effective dissemination and collaborative building of scientific knowledge. Through combining three different strands of discussion that are often left separate – those pertaining to the cognitive effects of new technological memory systems, those pertaining to citation and

publishing practices, and those regarding the effects of formalizing modes of research governance – it is also shown that this distortion is not merely a consequence of technological developments alone. Rather, such a distortion is inseparable from and potentially aggravated by the spreading of increasingly dysfunctional, formalizing research governance mechanisms. It is argued that these mechanisms run the risk of fostering the proliferation of knowledge practices that are actually characterized by an increasing degree of superficiality as well as the strategic publication of research that is of a decreasing degree of originality. If left unaddressed, this may pose a serious threat to the efficiency and effectiveness of the formal record of scientific knowledge as a tool for the dissemination of original research. By extension, this may undermine the capacity as well as jeopardize the long-term sustainability of publicly funded research more generally.

Keywords

citation behavior, digital memory, electronic publishing, information overload, knowledge practice, redundant publication, research governance, research policy, research communication, scientific culture

1.) Introduction

This paper explores some of the ways in which the use of digital information repositories, and the related economy of memory, can be linked not only to an expansion but also to a distortion of the institutionalized type of memory system underlying and informing publicly funded research activities. In particular, such a system containing formal research publications has been crucial for the effective dissemination and collaborative building of scientific knowledge in the scientific community.[1] However, such distortion, I endeavor to show, is not merely a consequence of technological developments alone, but inseparable from and potentially aggravated by the spreading of increasingly dysfunctional, formalizing research governance mechanisms. In particular, I argue that these mechanisms run the risk to foster the proliferation of knowledge practices that are actually characterized by an increasing degree of superficiality as well as the strategic publication of research that is of a decreasing degree of originality. If left unaddressed, this may in the long-term pose a serious threat to the efficiency and effectiveness in which original research is disseminated within the scientific community, and by extension, may undermine the long-term sustainability of research more generally.

My discussion will be structured in three main parts. In the first part, a brief description of the communicative, epistemic and normative function of the institutionalized memory system of scientific culture is provided, as is a brief exploration of the notion of an 'economy of memory.' In addition, I also provide some clarifications concerning the conceptual background informing this study. In the second part, the focus is on exploring the ways in which this memory system tends to be actually used in current contexts to disseminate, search and build upon research findings, and on identifying and analyzing some of the distortion effects related to this use in particular. To this end, a range of recent empirical research concerning scientific publication and citation practices is consulted and synthesized, where this research by and large indicates that some of the knowledge and communicative practices of researchers have tended to become increasingly superficial and economical as well as more strategic. Finally, in the third part, the developments identified in part two are linked to the recent proliferation and (unintended) effects of formalizing, institutionalized governance systems shaping some of the epistemic and communicative practices of researchers.

[1] My use of the concepts 'science' and 'scientific' throughout this paper tends to be inclusive rather than exclusive, unless otherwise noted. Reflecting this more inclusive notion, some attention will be devoted to the social sciences (see, e.g., section 3.2). At the same time, the majority of examples used in this paper refer to the natural and technical sciences, for these are the domains where some of the developments to be discussed play out most strongly.

2.) The Institutionalized Memory System of Scientific Culture

The knowledge-system of modern scientific culture has historically evolved in a way that involves those research findings that are perceived as being particularly significant or controversial, and the related debates and discussions, sooner or later are stored in a more or less institutionalized and publicly accessible, permanent memory system containing published documents.[2] Such an institutionalized memory system provides a relatively comprehensive though selective, publicly accessible and accepted repository for and formal record of scientific knowledge, both past and present. This, it may be reasonably argued, is not only useful for the effective dissemination of new knowledge, but it also helps to facilitate, within the scientific community, the intersubjective examination and critique of novel or established methods, ideas, and findings. Furthermore, by virtue of its being a formal record of scientific knowledge, the same memory system arguably also acts as a potential safeguard against high levels of redundancy of research activities. Finally, it may also be argued that this memory system, in separating formal from informal representations of scientific knowledge, also fulfills some sort of quality control function.

At the same time, the institutionalized memory system of scientific culture also is crucial for the institution and perpetuation of the various norms guiding the formal communicative activities of the members of the scientific community. This applies most of all to the practical realization of what Merton has referred to as the 'ethos of science,' which demands that new scientific findings are openly shared within the scientific community (Merton 1973: 273-274). According to Merton, this is in recognition of the fact that those findings are the product of collaborative scientific activity and constitute part of a "common heritage" (Merton 1973: 273). This said, and relativizing Merton's somewhat idealizing depiction, the findings of a range of historical case studies also suggest that the very same memory system also has served, maybe ever since its own inception, as a forum for and site of various strategic activities, rhetoric or political ones for instance (see, e.g., Gilbert 1977; Gusfield 1976; Yearly 1981). For example, and closely related to its aforementioned quality control function, it has been shown that the

[2] The concept of 'scientific culture' is generally meant here to signify a specialized mode of collaborative cognitive practice aiming for the systematic development and critical examination of more or less rational forms knowledge – and which at the same time is a product of specific cultural and historical processes. For a highly instructive account of the emergence of scientific culture and that of its distinctive set of cognitive values in early modern Europe, see Gaukroger (2006). For a range of instructive case studies pertaining to the formation and historical development of scientific culture from the perspective of the sociology of scientific knowledge, see Barnes and Shapin (1979). In the context of such sociological investigations, considerable attention has been paid to the role that writing and the related practices, both epistemic and rhetoric, have played in the historical formation of early modern scientific culture (Bazerman 1981; Bazerman 1988, Part II; Yearly 1981). At the same time, focusing on more contemporary contexts of the production and dissemination of scientific knowledge, researchers have also extensively studied the epistemic and rhetorical use and usefulness of formal and informal textual practices and representations (e.g., Gusfield 1976; Gilbert 1977; Latour 1979; Knorr and Knorr 1978).

institutionalized memory system of scientific culture, in real-world scientific practice, also functions as a site for the strategic normalization of certain forms of scientific knowledge (see, e.g., Sismondo 2009), and for the exclusion of other forms accordingly.

In any case, in order to fulfill its apparent epistemic, communicative and normative functions (which at the same time make it a site relevant for strategic considerations), the institutionalized memory system of scientific culture has to meet a range of criteria. Let me mention three that I consider particularly relevant. First, this memory system has to be clearly structured as to ensure that relevant information (for instance, new and original research) can be easily identified and retrieved. Second, the content stored has to be widely, even publicly, accessible (that is to say, the content has to consist of formal publications). Third, there have to be some commonly known and accepted guidelines and mechanisms in place for selecting what is worthy, in terms of basic scientific standards, of being recorded and stored. Of course, such a system, despite its necessity, may have serious flaws. For instance, and in line what has been said above, it may be the case that the institutionalized mechanisms that are meant to safeguard the quality of the published content entering into its repository, may in reality involve a certain degree of bias, most of all, against research that conflicts with established, widely accepted scientific models, methods and assumptions, or that falls outside well-established domains of scientific knowledge.

I have noted previously that such an institutionalized memory system constitutes a *formal* record of scientific knowledge. The formal nature of such record is, however, inseparable from the fact that the documents contained in it "make representations of objects, actions, and knowledge" that are both publicly accessible and that endure beyond the confines of the concrete and often informal interactions of individual researchers and groups (Brazerman 1981; 362). In short, the establishment of a formal record of scientific knowledge presupposes, among other things, the existence of material-symbolic technologies that make it possible to store and represent complex information externally, outside of the biological memory systems of individual human agents (see Donald 1991). The long-term historical development of such technologies and that of its cognitive dimensions and effects in particular is as intricate as contested; and this is not the place to rehearse the major discussions and debates. This said, in line with the focus of this paper, one reoccurring train of thought is worth briefly elaborating upon here: The notion that particular symbolic technologies have contributed "to an immense expansion of knowledge available to the human mind" (Havelock 1982: 87).

The notion that particular symbolic technologies have contributed to the epistemic advances of the human mind is in many instances tied to the idea that such technologies, alphabetic writing for instance, have allowed for a more efficient "economy of memory" (Havelock 1982: 87). This

economization of memory is made possible by the fact that such technologies, in effectively externalizing memory, facilitate the reliable transmission of large stocks of knowledge, complex ideas and theories, for instance, across space and time, thus making possible not only the stabilization but also the accumulation of knowledge over generations (Donald 1991; also Goody 1977). It is argued that this partially abolishes the need for detailed, individual memorization, thus significantly reducing the cognitive costs associated with it, and ultimately releasing cognitive energies to be used elsewhere (see Havelock 1982: 87; for a critique, see Harris 1989). The point has been made that this effect is further increased with technologies such as the printing press that allow rationalizing the symbolic-technological process through which knowledge is externalized and transmitted.[3] The same can also be said about more recent digital media and information technologies, the development and common use of which is, even from a historical perspective, a very recent event, dating back only fifty to sixty years or so. These technologies, in line with the ever more increasing computational and storage capacities of digital media, have dramatically altered the scope and functionality of the external memory repositories available to human minds. Maybe most important in this context is that with and through the development and diffusion of digital media, it has not only become possible to externally store vast amounts of information in a manner that requires comparatively little effort and physical space, but such media also facilitate the rapid scanning, retrieval and dissemination of the stored information.[4]

Obviously, these recent developments have afforded significant opportunities to the knowledge-system of scientific culture. For instance, the development of tools that allow electronically accessing and searching published research findings has significantly broadened the range of available sources that researchers can potentially consult to inform and contextualize their own research activities (Tenopir, King, Edwards, and Wu 2009). Furthermore, electronic publishing, and open access electronic publishing in particular, also has demonstrated the capacity "to widen the global circle of those who can participate in science and benefit from it" (Evans and Reimer 2009: 1025). At the same time, however, and this is

[3] As Eisenstein observes in this regard, the use of print "made food for thought much more abundant and allowed mental energies to be more efficiently used" (1983: 259). Eisenstein (1979) goes on to argue that, from a historical perspective, this process of rationalization played a crucial role in the process that led to the emergence of modern scientific culture and thinking. This, she claims, is because the use of print led to a standardization not only of languages but also of knowledge, which in turn helped foster an epistemic culture that effectively relies on mutual criticism and collaboration.

[4] Shaffer and Kaput (1999) even go as far as proposing that the rapid diffusion of such digital media and technologies is synonymous with the evolutionary transition to a new stage of cognitive activity that they refer to as 'virtual culture.' Fundamental to this new cognitive stage is the accomplishment of the technological externalization of symbol-processing operations, which requires computational media that are inherently dynamic, that is, capable of changing their state, without the ongoing guidance from the operator (Shaffer and Clinton 2006: 287).

what I will be focusing upon in the following sections, the very same technological developments, in combination with recent shifts in epistemic and communicative practices, have also been creating a host of adaptive challenges for the scientific community pertaining directly to the proper use and ongoing usefulness of its formal record of knowledge.

Before further developing on this in the subsequent sections, some brief comments about the conceptual background of this study are in order. Broadly speaking, my research is informed by what one may refer to as an *ecological conception of cognition* (see Hutchins 2010a, Hutchins 2010b). Such conception is based on the recognition that the cognitive activity of human agents, in many of its real-world manifestations, constitutes a distributed and as such culturally and historical situated type of activity (Hutchins 1995; Hutchins 2010b; Kirsh 2006; Sutton 2006).[5] At least three types of the *distribution of cognitive activities* can be distinguished (see Hutchins 2010b). First, cognitive activities may be *distributed socially*, as in a group of individuals collaborating on solving a common problem. Second, cognitive activities may be *distributed spatially*, that is, they may not only be shaped by the activity of brains but also by a range of structures external to it.[6] Third, cognitive activities may be *distributed over time*, through the use of external memory devices, for example, which allow to store theories and ideas and to return to them at a future stage (Donald 1991: 316).

[5] What is meant by this is that the cognitive processes at play are functionally built upon and involve specific types of coordination between various cognitively efficacious elements such as minds, living bodies and a range of environmental structures, technological artifacts, for instance. Importantly, theories and approaches working with a distributed cognition focus are specifically interested in exploring the nature of the relations and dynamic interactions taking place between elements rather than these elements' inherent properties. This interest in relations and interactions explains their alignment with ecological approaches and perspectives (Hutchins 2010a).

[6] These may include spatial patterns, arrangements and representations (see Kirsh 1995), or a wide range of cognitive artifacts such as diagrams, pictures, books, or computers (see Hutchins 2001; Norman 1991); or even complex institutions such as universities and research institutes.

3.) Distortions of this Institutionalized Memory System

In what follows I explore how current tendencies in the epistemic and communicative use of the formal record of scientific knowledge imply a distortion of some of the well-established practices and institutionalized mechanisms that are meant to facilitate the effective conservation and dissemination of knowledge within the scientific community.[7]
The general backdrop for the analysis of these tendencies and the resulting distortions is formed by the transition toward 'big science' (see de Solla Price 1986), that is, by the rapid growth of the modern science system and its publication outlets and outputs. At the same time, the spread of formalizing regimes for the governance and evaluation of research appears to have seriously aggravated the distortion of scientific communication already caused by the growth of the science system. This will be discussed later in more detail in the section "The Paradox of Effective Research Governance."

In the following three sections, the focus is on the nature and scope of the distortion of two specific types of activities that are an integral part of the communication- and knowledge-system of scientific culture: Publishing and citing. The scrutiny of both types of activities, if considered within the context of recent empirical findings, provides illuminating insights into the ways in which some current forms of the use of the institutionalized memory system of scientific culture may in fact jeopardize this system's apparent function and functionality.

3.1.) *Redundant Publications*

It is a widespread assumption that the publication activity of an individual researcher or that of a group of researchers constitutes a relatively solid indicator for the extent to which new knowledge is produced and disseminated. At the very least, this notion has informed the formulation of a number of research policy and evaluation frameworks that are increasingly geared toward some sort of measurable research output and impact, in most cases relating to quantity of publications and/or citations (the latter being regarded as a proxy for impact).[8]
However, it also has been argued that the shift towards the use of metrics to evaluate research

[7] To clarify, my discussion concerning the distortion of the formal record of scientific knowledge is generally neutral with regard to the question concerning the validity of the "categorical distinction between genuine and distorted scientific knowledge" (Miller 2009: 261). This is in the sense that my discussion is primarily focused on elucidating the nature of the real-world processes that facilitate, shape and constrain the constitution, dissemination and reproduction of scientific knowledge, while refraining from making sweeping claims about the intrinsic nature and epistemological status of this knowledge itself.
[8] More recently, there has also been a trend emerging in some countries such as the UK toward developing and implementing more complex variants of impact that take into account the broader social and economic benefits of research. It is still too early to evaluate the feedback effect these new regimes of research evaluation have on researchers and their institutions.

has potentially had a range of inadvertent consequences, particularly if such metrics are used in an uncritical and superficial manner (Weingart 2005). For instance, it has been observed that the move to using metrics to measure research has led researchers to become increasingly strategic in maximizing their metrics (Bornmann 2011), and ultimately, has contributed to a 'paper inflation' clogging up the scientific communication system (Kostoff et al. 2006).[9]

A more scrutinizing perspective on the mechanisms of the publication game, let alone common sense, easily reveals, however, that the equation 'number of publications' = 'extent of original knowledge contribution' is indeed an excruciatingly simplistic one. One of the many reasons for this is the more or less widespread occurrence of a type of publication that, in terms of content, ultimately adds nothing new to the existing body of scientific knowledge. This may be publications that repeat findings already established and published elsewhere, and which thus offer content that is by and large redundant and which does not make a novel, original contribution to the domain of knowledge. These types of research publications are commonly referred to as "redundant publications" (see, e.g., Mojon-Azzi et al. 2004; Schein and Paladugu 2001).

Now, before briefly elaborating upon the underlying causes and motivations for redundant publications, two reservations concerning the status and role of redundancies in scientific publications are in order. The concept of redundancy, which was introduced as a technical term in the context of information theory by Shannon and Weaver (1949), is commonly used to refer to something in a message that is useless or unnecessary, that is, something that could be removed without detracting anything from that message. In some circumstances, redundancy may indeed fulfill a positive function, helping to ensure that relevant contents are received and remembered. For instance, one may argue that, in view of the ever growing amount of available published information, the multiple publication of a particular piece of research by a researcher or a group of researchers may be considered rational in that it may increase the chance that this research finds its audience within the scientific community. At the same time, however, the same behavior can be considered irrational from a more encompassing perspective, for it aggravates the general overload of the scientific communication system, thus making communication less effective. Arguably, too, some fields, those, for instance, that are of relatively heterogeneous nature as to methodologies, publication outlets, and targeted audiences, may have a larger scope and indeed need for redundancy in communication than

[9] It has been shown that such strategic authorship is particularly prevalent in those domains of scientific research that are not merely highly competitive but that also a have strong potential for commercialization. Striking examples are the medical and pharmaceutical sciences, where (academic) publication activities are in many instances organized by professional publication planners, and where the production and dissemination of research findings in academic journals are "ghost-managed" by commercial sponsors (Sismondo 2009).

others. And as one anonymous referee of this journal pointed out to me, it is also the case that in some social science disciplines with only comparatively limited core theoretical foundations (e.g., the field of management studies) that the reformulation and subsequent publication of already previously published ideas and results is a both common and accepted practice.

One can distinguish at least two types of underlying cause and motivation for redundant scientific publications.

First, redundant publications may be the result of deliberate strategic activities by researchers, where such activities are to some extent stimulated by governance practices focusing on and rewarding research output (see section "The Paradox of Effective Research Governance" for more detail). Authors knowingly publishing a paper that contains findings that are already published elsewhere is an instance of such a form of redundant publication. The proper term for such type of behavior is, of course, plagiarism. One commonly distinguishes in this regard a form of plagiarism where the work, ideas or findings of another person are reproduced without acknowledgement, and a form of self-plagiarism where an author reproduces in a publication significant amount of text he/she has already published elsewhere (see for a further discussion of the latter Roig 2005). A most insidious case of self-plagiarism is when an author knowingly publishes the same paper twice; this is referred to as "duplicate publication" (e.g., Kostoff et al. 2006) but, as a recent study has shown, it appears to remain a relatively scarce phenomenon, particularly in the social sciences and humanities (Lariviere and Gingras 2010).

A more inconspicuous and less clear-cut form of duplicate-publication comprises those publications that are presented by the authors as containing new, original research, while in truth being produced on the basis of a slight modification of some theoretical or empirical aspect of a paper published previously by the same authors. Such a modification has become relatively effortless to accomplish since the advent of electronic programs that allow to rapidly copy, edit and replace components of texts, and which also make it possible to easily transfer text material across different electronic formats. Another comparatively widespread and less inconspicuous form of strategically produced redundant publications consists in what is commonly referred to as piecemeal publications (also referred to as 'salami slicing'). The obvious aim of piecemeal publication strategies is to increase publication outputs, often to the detriment of the scope, depth and coherence of the published content. This is achieved through cutting down research findings, those resulting from a set of data collected through an experimental study, for example, or those resulting from a comprehensive conceptual analysis, into as many separate pieces as possible. The attempt is then made to publish these pieces in a number of different outlets. Piecemeal publication strategies, obviously, may potentially lead to a significant increase in the number of publications produced, and thus appear to signal an

increase in productivity. However, in regard to the efficiency and effectiveness, let alone the integrity, of research communication within the scientific community, the proliferation of such strategies has undoubtedly a detrimental effect.

Second, a significant proportion of redundant publications may also be the unintentional result of a lack of knowledge of the authors (and referees) over the existing and rapidly growing research literature in their field.

We are still lacking reliable data as to the extent to which redundant publications have come to distort the institutional memory of scientific culture.[10] The findings of a range of studies seem to indicate, however, that the problem of redundant publications is a relatively pressing and pervasive one, and that it is particularly so in the medical sciences. For instance, in a pioneering study Schein and Paladugu (2001) explored the extent to which the articles published in 1998 in three major surgery journals (*Surgery*, *British Journal of Surgery*, *Archives of Surgery*) constituted an actual or potential case of redundant publication. The findings are rather sobering. Out of the 660 articles Schein and Paladugu investigated, 147 (22.3%) papers were identified as potential instances of redundant publication. Out of these, twenty papers were categorized as dual publications (3% of total), 50 (7.6%) as potentially being dual publications, and 77 (11.6%) papers as piecemeal publications. Less drastic, but still striking are the findings of a study conducted by von Elm et al. (2004) concerning full articles referenced in systematic reviews in the field of perioperative medicine (anaesthesia and analgesia). The authors of this study found that 8.3% of these articles were duplicate publications, and that 8.9% of the data published in all articles was likewise duplicated. The authors also found that duplicate publications appeared "in journals with similar impact factors and were cited as frequently as main articles" (von Elm et al. 2004: 974).

From an overarching perspective, it is undeniable that redundant publications significantly add to the problem of 'information overload' already haunting researchers (see also the section *Information Overload and Changing Knowledge Practices*). Such information overload is the result of the more recent proliferation in the number of academic journals and electronically available publications, which, in spite of ever more effective online search mechanisms, seems to have made it increasingly difficult for researchers to easily identify, to contextualize, and in effect to build upon, some of the truly original research findings and unorthodox ideas contained in it (see Evans 2008). More bluntly put, redundant publications are wasting the time

[10] Thanks to the efforts of various researchers, there now exists a growing base of evidence concerning the scope of redundant publication in a range of scientific disciplines (e.g., Kostoff et al. 2006; Mojon-Azzi et al. 2004).

and effort of researchers, and they undermine both the effective dissemination and collaborative building of new, original forms of scientific knowledge.

The point has been made that the introduction of binding ethical guidelines and editorial practices that effectively stigmatize and respond to obvious attempts to strategically publish redundant material as well as other forms of plagiarism may help to ameliorate the scope of strategically redundant publications (see for related overviews, e.g., Enders and Hoover 2004; Long et al. 2009).[11] However, it should be noted here that such centralized measures are not only difficult to implement, but they ultimately also would not help to adequately address the problem of unintentionally redundant publication.

3.2) *Citation Practices*

It is one of the basic rules of scientific research that a piece of written research, in order to warrant publication, needs to be adequately situated within the existing research literature. Awareness of the existing literature, and of the decisive developments and discussions in a field, is signaled through the inclusion of a range of markers, most commonly, a combination of in-text citations and bibliographic entries. Such markers may also be used by authors to convey a sense of identity, e.g., the belonging to a specific field, group or paradigm. It has been noted that the use of citation is crucial for "the reaffirmation of the underlying norms of scientific behavior" (Kaplan 1965: 181), most of all, of those norms that are directly related to the aforementioned 'ethos of science' (Merton). However, the point also has been convincingly made that such use of citation is in actual practice often inseparable from uses of citation that are of more pragmatic or strategic nature. For example, Kaplan observes in his classic paper on citation norms that the primary function of citation appears to be that of a "social device for coping with problems of property rights and priority claims" (Kaplan 1965: 181). By comparison, Gilbert has proposed that citation is commonly used and useful as a "tool for persuasion," for example, to demonstrate the novelty of one's own research, or to support one's own argument through citing authoritative papers (Gilbert 1977; also Cozzens 1989).

At the present, in the natural sciences but also increasingly in other fields, (the number of) citations are widely considered to be a valid measure for the impact of the research published, that is, for the extent to which the published knowledge is received and built upon within the

[11] It has been recommended that such editorial practices ought to include the systematic use of already available technologies and forensic methods that assist in identifying redundant publications and reproduced or manipulated sets of data (see Errami et al. 2010; Marris 2006; Sun et al. 2010). An unintended effect of the use of such methods and technologies may, however, be a narrowing of the scope for legitimate and contained forms of repeating in a publication. Such forms may comprise, for example, publications by authors that have the purpose of situating their novel research findings in the context of their past research (and which thus involve some degree of repetition), or publications that serve the purpose of communicating research findings to different audiences.

scientific community. This has made citations a coveted currency among researchers and their administrators. The preoccupation with citation counts is to a significant extent an effect of the aforementioned fixation observed in many research governance systems and research institutions with using research metrics based on bibliometric data to evaluate both the impact and quality of research. As a matter of fact, this trend has for obvious operational reasons gathered significant momentum since the advent of electronic publication databases in the 1990s (Andras 2011: 90). There are many well-rehearsed problems associated with looking only at the number of citations a publication receives, and with using this number as a measure for determining research impact and quality.[12] Furthermore, as with any other evaluative measure used, citations are subject to the threat of game-playing, for example, through the effective organization of citations clubs and the use of strategic types of citation behavior more generally.

Despite all these problems, it cannot be denied that scrutinizing the citation activity of researchers may indeed provide valuable insights concerning the ways in which published knowledge is received and built upon within the scientific community. However, if one wants to use citation as an indicator for how knowledge is actually received and built upon, then analysis of the sheer number of citations received by publications and their clustering brings us only so far. What is rather needed is a complementary perspective on citation behavior that scrutinizes the actual citations themselves and the messages they convey, through studying the content of citations or the context in which they appear. This may include looking at whether the cited text is referred to in the citing text positively or negatively; whether the use of the citation indicates that a cited idea, concept or method has been thoroughly engaged with (and understood); and whether the cited idea, concept or method has been actually applied in the citing text. It goes without saying that such detailed, qualitative sort of citation research is both laborious and time-consuming, which may explain why it appears, compared to the vast number of purely quantitative citation studies, to be a relatively rare occurrence.[13]

[12] The problems associated with using, in various forms, (number of) citations as a measure of research impact, and even more so, of research quality are legion. For instance, it seems obvious that there cannot be any straight form of correlation between the number of citations and quality of the paper published, for the simple reason that, in some instances, and for some time after publication, a paper of a lower quality, e.g., one with a catchy title but little substance, or, a paper that offers nothing new but is published by an authority in the field, or even one that is just 'marketed' most effectively, are cited most often (see Andras 2011: 98). For a comprehensive discussion of (quantitative) forms of citation analysis, the construction of indicators, and of issues such as proper use of citation data in policy contexts as well as potential limitations of such forms of analysis, see Moed (2005). For a comprehensive overview of the state-of-the-art of citation analysis, including qualitative approaches, see Bornmann and Daniel (2006).

[13] See Bornmann and Daniel (2006, 50-58) for a discussion of various influential content- and context-sensitive citation studies and the taxonomies they employ.

The picture that emerges from the context or content sensitive citation studies undertaken in more recent times is not entirely clear-cut (see for a detailed discussion Bornmann and Daniel 2006: 50-58). The findings of some more recent studies seem to suggest that there by and large exists a close and epistemically sound relationship between citing and cited text in the scientific literature, which would support the view that a citation usually means that the cited text and its knowledge claims have been thoroughly engaged with and critically examined. The results of other studies suggest, however, that is not necessarily the case. Take the example of the study of Evans et al. (1990) concerning quotation accuracy in surgery journals, where major quotation errors were "assigned if the reference article failed to substantiate, was unrelated, or contradicted the authors' assertions" (Evans et al. 1990: 1353). According to authors of this study, who are all practicing surgeons, out of the fifty randomly selected articles they examined, a significant proportion (27%) contained a major error of quotation, something which, they claim, may indicate that some authors never ever read the sources they are citing (Evans et al. 1990: 1353). Even more strikingly, 48% of all citations examined proved to contain errors.[14]

Another, more recent example, this time focusing on the social sciences, is Andrew Abbott's study into how his book *The System of Professions* (1988) has been cited in the literature in the year 2008, and what these citations reveal about the actual transmission and reception of knowledge (Abbott 2010). The sample on which Abbott based his study consists of 105 articles composed by 193 authors, coming from a wide range of disciplines. Abbott's findings (2010: 181-183) appear to be striking: From his point of view, only 27 (25.7%) of the 105 articles he investigated really needed to cite his book. Out of these, Abbott claims, only 13 articles (12.3% of all articles) used his book in a manner that was central to their arguments, for things that had been central in the argument of this book, and got the argument of the book right in the process. While about 47 (44.8%) of the articles got the argument of the book by and large correct (value 5 or 4 on scale), 12 (11.4%) articles, he claims, got the argument utterly wrong. 24 out of 105 articles (22.9%) cited a particular page or set of pages of the book, while 42 (40%) cited the book as part of a parenthesized list, together with other references. Overall then, Abbott sums up, roughly 12% of the articles investigated by him used his book "centrally and correctly; another 13% did not use it centrally, but needed to cite it and cited it correctly; around 20% didn't need to cite it, but having done so, at least did so both substantively and correctly; (…); and about 10% cited it unnecessarily, trivially and incorrectly" (Abbott 2010: 182).

[14] These findings to some extent align with those of a similar study conducted by Eichhorn and Yankauer (1987) examining quotation and citation accuracy in public health articles**.** The authors of this study found that out of the 150 references checked, 46 (31%) contained some sort of citation error, and 45 (30%) some minor or major error of quotation.

Of course, findings such as the one presented by Abbott and by Evans et al. have to be taken with some caution. First, there undeniably always is a potential problem of bias when it comes to evaluating the correctness of the epistemic relationship between citing and cited text, particularly when, as in the case of Abbott's study, authors examine how their own work has been received. Second, it may be argued that the results of such more context- and content sensitive citation studies, due to their necessarily restricted sample size and scope, do not lend themselves to more generalizing conclusions. This said, there exists a growing body of empirical evidence from a range of large-scale quantitative studies concerning citation and reading behaviors that by and large appears to support the findings of the more selective qualitative studies discussed above. What these quantitative studies suggest is that the engagement of researchers with the available research literature has undergone significant change over the last few decades, becoming more economical and in effect superficial. One should note, however, that the results of these studies and the associated conclusions, while being to some degree related, are by no means unequivocal.

Take, for instance, the findings of a recent, comprehensive quantitative study conducted by sociologist James Evans (2008). In his study, Evans investigated how online access to ever increasing amounts of published information that is available online and thus easily accessible has transformed how researchers search and use the research literature. Using citation data from *Thompson Scientific*'s citation indexes comprising 34 million articles (from the sciences, the social sciences, and the humanities), their citations (from the year 1945 to 2005), and the period of their online availability (from the year 1998 to 2005), Evans claims that his findings show that the more journal issues and in effect more articles, old and new, were available online, the narrower the scope of articles cited became: "As deeper backfiles became available, more recent articles were referenced; as more articles became available, fewer were cited and citations became more concentrated within fewer articles" (Evans 2008: 398). On the basis of these findings, Evans suggests that, counterintuitively, the availability of more effective electronic search tools and thus of easily accessible online information may lead in actual practice not to a widening but to a narrowing of scholarship. Specifically, Evans proposes that the use of such electronic search tools may have induced some sort of 'herd mentality' in researchers, where a relatively small set of publications, with converging lines of research, is used as a reference and guide for discussion. As Evans comments: "By enabling scientists to quickly reach and converge with prevailing opinion, electronic journals hasten scientific consensus. But haste may cost more than the subscription to an online archive: Findings and ideas that do not become consensus quickly will be forgotten quickly" (Evans 2008: 398).

One of the problems with Evan's interpretation of his findings is, however, that the citation and reading activities of researchers, while being obviously to some extent aligned, may not necessarily be one and the same. Tenopir et al. (2009), for instance, claim that their own studies, based on a range of surveys conducted from 1977-2005, rather suggest that, contrary to Evan's claims, readings patterns may have been broadening since the advent of electronic journals, regardless of the factual narrowing of citation patterns. This said, the survey results presented by Tenopir et al. (2009) nevertheless supports the more general claim that, along with the shift from browsing the literature to automated searching over the years, the reading behavior of researchers has changed significantly. According to Tenopir et al. (2009), the major change has, however, been in regard to the average time that researchers dedicate to the reading of each publication, which, according to the results of their survey, has declined considerably, by around 35%, from 1977 to 2005. Somewhat putting Evan's conclusions into perspective are also findings presented by Persson, Glänzel and Danell (2004). Based on their study of all ISI indexed papers from 1980-2000, the authors identify a trend towards longer reference lists in published articles. This at the very least suggests that the trend toward citing an increasingly smaller sample of publications (from all available publications) is not as uniform and straightforward as Evans suggests. Yet another point of view concerning recent shifts in citation and reading activity is offered by Simkin and Roychowdhury (2005). These authors controversially claim that, based on the results of their quantitative analysis of the frequency of misprints in citations to twelve recently published, influential papers, potentially more than 70% of all articles cited in the scientific literature may never get read properly. The weak point of their research is, however, their assumption that the practice of the copying of a citation from a list of references, which they argue is the source of the recognizable repetitions of striking misprints in citations, is a strong indication that the cited paper has not been read. The obvious objection to this is that such patterns of misprints, while in themselves revealing, may reflect an increase in superficiality in referencing (e.g., through the use of the copy and paste function) and editorial diligence rather than a significant shift in reading patterns per se.[15]

Nevertheless, all the studies referred to in the above suggest in one way or another that there has been, with more and more published information becoming available and searchable, a decreasing level of engagement among researchers with the available research literature, if not in terms of scope, then in terms of thoroughness or depth of reading activity.

3.3) *Information Overload and Changing Knowledge Practices*

[15] For a relatively recent study exploring the scope of the problem of accuracy in referencing in the (medical-)scientific literature, see Sieber and Holt (2000).

In the preceding two sections, the findings of a range of isolated empirical studies have been drawn together to highlight some of the recent distortions of the institutionalized memory system of scientific culture, namely those that are related to publication and citation practices. In this section, I want to consider these distortions in the broader context of recent technological developments pertaining to this memory and the cognitive-ecological changes that can be associated with it.

As indicated earlier, in the current context, one of the fundamental problems of the institutionalized memory system of scientific culture appears to be that, at least since the modern transition toward 'big science,' the information contained in it, even within a specific field, has become so large that it is more or less impossible for researchers to identify and properly know all the relevant literature. This problem of information overload has been amplified by the advent and spread of electronic publishing, which makes research publications, present and past, more easily available and accessible. One of the most fundamental problems stemming from the drastic increase in available information is that it has made it increasingly difficult for researchers to easily identify what is truly original and groundbreaking research. One general behavioral response to the problem of information overload has been the increased internal differentiation of the science system (see Stichweh 1992). This process has resulted in the emergence of ever more scientific subfields with their own, specialized publication outlets, and as the other side of this coin, has increased demand for interdisciplinarity.

At the same time, in some disciplines and research areas particularly prone to information overload (the medical sciences, for example), researchers have started to resort to the use of tailored computer programs to cope with the quantity of published information available, and to identify gaps and patterns in the existing research literature (see Evans and Rzhetsky 2010). Similarly, recent years have also seen the emergence of 'collaborative' software platforms such as Mendeley, which in addition to their function as reference management programs, allow researchers to pick up large-scale statistical information about research trends (e.g., the most read papers in a particular field), and also to keep track of what other, individual researchers are reading.

However, even if such programs are becoming more powerful and also more widely used, one may wonder whether they ever will be able to adequately identify, from all the available data, those high-quality publications that contain truly original research. At the very least, the danger always remains that programs such as Mendeley, precisely because of the type of information they make accessible, will not only ease collaboration but at the same time also reinforce the aforementioned herd-mentality, leading to a streamlining of reading patterns. In any case, it

appears overall undeniable that in the current environment of academic research, despite the availability of more sophisticated literature search technologies, the effective identification of high-quality publications containing original research has become increasingly difficult to achieve. This is not only due to the dramatic increase in available literature, but also due to the fact that an increase in quantity of accessible, published information, and even more so that of redundant information, usually means that the quality of each publication is not increasing to a similar extent. As a matter of fact, quite often the contrary may be the case. Kirsh (2000: 24-25), for instance, proposes that, in fact, the recent increase in available and easily retrievable online information is characterized by an increasing gap between the exponential growth rate pertaining to all information available, and the linear growth rate of high quality information. Owing to this, he claims, "the individual cost of search for quality information" has increased significantly for researchers (Kirsh 2000: 24); with no search engine being available that is effective enough "to save us from having to browse dozens of useless papers in our effort to berry pick the best items" (Kirsh 2000: 25). Ultimately, Kirsh (2000) claims, such oversupply of information, and most of all, of low quality information, constitutes one of the main causes of the form of 'cognitive overload' that knowledge workers are regularly exposed to in their workplace.

Altogether, and taking into account the findings of the various studies rehearsed in the previous section, it thus seems as if the advent and spreading of electronic information storage, search and retrieval systems, and the accompanying proliferation of available information, have had rather ambivalent effects: The same technologies that have significantly broadened the range of available publications that researchers can easily retrieve and consult to inform and contextualize their own research activities can also be linked to a partial distortion of the use and usefulness of the institutionalized memory system of scientific culture. The discussed findings indicate that such a distortion is directly linked to increasingly cursory modes or habits of cognitive engagement among researchers with the available, formal record of knowledge. To some limited extent, these more cursory modes can be justified as adaption mechanisms that are necessary to cope with the new range of affordances offered and demands posed by the new memory storage and retrieval technologies. At the same time, however, the evidence presented also indicates that the emergence of a new 'economy of memory' in scientific culture – brought about by the expansion of knowledge repositories and novel literature search and retrieval mechanisms – has been accompanied by a worrying decline of seriousness in the ways in which publications are used to disseminate knowledge as well as in the ways in which this knowledge is received and built upon in the scientific community.

4.) The Paradox of Effective Research Governance

In the final part of this paper it is argued that one cannot properly understand the apparent distortion of the institutionalized memory system of scientific culture, in its cognitive - ecological and technological dimensions, if one does not also take into account the role of those governance systems and their defining mechanisms shaping some of the behaviors of researchers. The particular focus in this section is on the role and proliferation of those more explicit and formal governance mechanisms that are characterized by a large degree of formalization, standardization and institutionalization (e.g., research policies and research evaluation frameworks and the associated funding mechanisms). More specifically, it is claimed that some of these mechanisms have become increasingly dysfunctional in that they tend to encourage knowledge practices among researchers that are actually characterized by an increasing degree of superficiality as well as the strategic publication of research that is of a decreasing degree of originality and quality. Consequently, the same governance systems whose supposed purpose it is to make publicly funded research more efficient and effective paradoxically put at risk the efficiency and effectiveness of the formal record of scientific knowledge. By extension, these systems may undermine the capacity as well as jeopardize the long-term sustainability of publicly funded research more generally.

Now, it is well-known that the last decades have seen significant changes on the level of institutionalized research governance and evaluation systems: There has been a general trend (in some countries, the UK and Australia, for instance, more pronounced than in others) to gear those systems toward a stronger focus on tangible research outputs and performance targets such as number of publications, and to make use of metrics, in the context of citations, for instance, to evaluate impact. In many instances, the introduction of these evaluations is directly coupled to a significant shift toward performance-based research funding systems.[16] An important element of this latter shift is the transition toward project-based rather than recurrent funding systems, which in turn creates an increasingly competitive environment where the funding of research is at least partially made dependent on publication outputs of researchers. This obviously creates a strong incentive for researchers to publish, and to publish strategically.

On a societal level, such quantification and formalization of research governance instruments can be aligned with a broader organizational move toward replacing, in the context of public

[16] For an overview of how these developments play out in a number of countries, including the UK and Australia, see Geuna and Martin (2003). For more recent accounts of the situation in the UK and Australia and its perceived effects, see Adams (2009), Barker (2007), Gläser and Laudel (2007), and Lewis and Ross (2011). An instructive typological discussion of research governance systems and associated mechanisms along criteria such as degree of formalization, exogeneity of authority, strength and extent of enforcement is provided by Whitley (2011).

management and elsewhere, established, subsystem-specific modes of self-governance and evaluation (which are based on the local expertise of professionals) with more formal, standardized and 'objective' modes of governance (see Power 1997; also Schimank 2005).[17] Characteristic of this move is that the governance systems that are developed and implemented to define, monitor and audit performances tend to become increasingly self-referential, and ultimately self-enclosed. One of the important consequences of this shift is what one may refer to as a double process of managerial abstraction or disembedding (see Power 2005: 333-334). On the one hand, with regard to the entities whose performances are to be monitored and evaluated, there is a tendency to abstract from these entities' genuine role and their intrinsic structure and purpose; on the other hand, with regard to these entities' performance and its evaluation, there is a tendency to make "first-order questions of quality (…) subordinate to a logic of management system integrity" (Power 2005: 333).

In the case of scientific culture, such abstraction may prove to be costly for a number of reasons.

First, the inflexible use of standardized indicators such as citations or number of research publications to evaluate research performance, and the setting of stringent output targets may create among researchers an "excessive preoccupation with representations of performance and associated games" (Power 2005: 336). It is obvious that such preoccupations, apart being a waste of the individual researcher's time, energy and resources, over the long term, lead to a distortion of the publication and citation activities of researchers more generally, and ultimately, significantly add to the distortion effects of the memory system of scientific culture discussed previously. For instance, and as has been empirically shown in the case of Australia, a research governance and evaluation framework that is too one-sidedly geared toward quantity of output may lead to the proliferation of low-quality publications (Butler 2004; Butler 2003); and it may naturally also encourage those strategic forms of authorship that aggravate the problem of redundant publication.[18] All this leads to a further increase in the discrepancy between the growth rate of all available information and that which is of a high quality and relevance, and ultimately, makes the search for original, high-quality research more difficult and time- and resource-intensive. In this sense, one may say that research evaluation and governance systems that are too one-sidedly geared toward measurable outputs (as distinct from genuine quality outcomes), in potentially increasing the relative scarcity of high-quality

[17] One should note, however, that such a depiction is to some extent simplifying: In reality, the developments referred to are often characterized by intricate, sometimes contradictory shifts between differently articulated forms of autonomy (see Schimank 2005) and authority Whitley (2011).

[18] Butler's findings are undeniably telling, however, one should note that she, due to the large-scale quantitative nature of her studies, has to rely on a rather superficial measure of quality, namely citation impact.

information, further reinforce some of the problems that are created through the new technological media that are available for searching, publishing and disseminating research.[19] On this basis, the same systems, somewhat unintentionally, may actually make some of the crucial research activities such as the engagement with the available scientific literature less efficient, and other activities, most of all the dissemination of original research, less effective.

Second, the use of standardized indicators, e.g., citation metrics, is also problematic in that it provides a disincentive in engaging in such types of research that are of an original and risky nature, as such research is often cited with significant delays and thus, in a risk-adverse, output-focused environment, may attract less funding (Andras 2011).

Third, and maybe most fundamentally, such standardized and standardizing, output-focused research governance and evaluation systems are not mere reductionist "technologies of representation" (Power 2004: 778), but like any 'real' technology, also shape and to some extent adapt, in a manifest, enduring sense, the environment in which they operate. The problem with such systems thus is at least of a twofold nature. First, such systems, in being strongly geared toward metrics and measurable outputs, tend, as Norman notes in a different context, to "divorce themselves from the real world" and its cognitive complexities, instead dealing "solely with the products of their measurement" (Norman 1993: 15). Second, in actual practice, the very same systems, in structuring and constraining the environment in which researchers do their work, ultimately also tend to remake this environment so that it increasingly resembles its own, reductionist representation. Given this structuring, even materializing force, it may be no longer be merely due to purely operational reasons that the same period that saw the spreading of technologies that made possible the effective electronic storing and dissemination of published research, and which in the process made available a large body of electronic data, also saw a significant expansion in the actual use of formalized, standardizing systems to evaluate and steer research activities (see Andras 2011: 90).

Let me conclude with a brief summary and some reservations. It has been shown in this paper that the more recent development and use of powerful technological memory storage and retrieval systems has not only opened up immense opportunities for the dissemination and collaborative building of scientific knowledge but also, in terms of the efficiency and

[19] One should not forget here that ultimately, the *genuine quality* of published research can only be reasonably determined if taking into account the content and characteristics of the publication itself, rather than mainly focusing on the journal where it is published, or on the number of citations the publication receives. As Brenner aptly comments in this regard: "Before we develop a pseudo-science of citation analysis, we should remind ourselves that what matters absolutely is the scientific content of a paper and that nothing will substitute for either knowing or reading it" (Brenner 1995: 568).

effectiveness in which scientific knowledge is actually presented and received, has caused some significant distortions. At the same time, the argument has been made that such distortions are not mere side-effects following from the maybe too rapidly increasing scope and functionality of such memory systems, but are to a significant extent the result of the more recent expansion of dysfunctional governance systems shaping and constraining some of the knowledge-related activities of researchers.

Now, one thing that needs to be mentioned is that discussions that focus on and problematize recent developments always run the risk of idealizing the past. To clarify my own position then, I certainly do not hold the view that those types of distortions that have been discussed in this paper constitute a radically new phenomenon. Rather, it seems plausible to argue that such distortions, at least to some extent, have been part of scientific culture for a long time, and maybe ever since this culture's own inception. Yet at the same time, in view of the evidence presented, I suggest that it can be reasonably assumed that these distortions have increased in scale, and have begun to affect the dissemination and building of scientific knowledge in ways not seen before. Another thing I consider worth mentioning is that one should not underestimate the self-regulating as well as the arguably assimilative capacities of scientific culture. So far, the field of scientific culture, despite all its internal faults, irregularities, as well as its unsavory dependencies, has demonstrated a remarkable resilience in face of the external pressures and demands it has been exposed to, and this should give one some hope that this will continue to be the case.

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