

Neglecting the Soul of Science: An Aristotelian Perspective on the Role of Citation Motivation
in Scientometric Analyses

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Abstract

This paper explores the history and theoretical frameworks of citation behavior in Scientometrics, and suggests the field begin to incorporate investigations of author motivations behind the citation process. Currently, scientometric analyses are grounded in the positivism paradigm and investigate the networks that comprise the structure of science, but not authors' decision-making processes regarding which papers to cite. Applying Aristotle's notion of matter and form, an argument is made that scientometricians are examining the *body* of science at the expense of the *soul*. Implications for empirical investigations are discussed, as well as recommendations for how to combine the Information Science sub-disciplines of Scientometrics and Human Information Behavior to explore the realm of science more holistically and completely.

Keywords: scientometrics, citation behavior, citation motivation, human information behavior

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For several decades, the Sisyphean task of establishing a unified theory of citation behavior has persisted, yet has also been largely abandoned (Cozzens, 1981; Cronin, 1981, 1998; Leydesdorff, 1987, 1998; Nicolaisen, 2003). In Scientometrics (often whimsically referred to as the science of Science), it is generally accepted that the motives to cite are grounded in normative, social, and symbolic reasons, and more often than not some kind of combination. Citation analysts investigate bibliometric networks, focusing primarily on the artifacts (e.g., documents) as the unit of analysis. This task has become easier with the advent of new technologies (e.g., VOSViewer, CitNetExplorer, Pajek, Gephi, etc.) which have the capability to take large datasets downloaded from the Web of Science (WoS) or Scopus databases, and in minutes construct co-author, co-citation, co-word, and bibliographic coupling networks in visually pleasing graphics.

While the author is a common unit of analysis in bibliometric studies (e.g., co-authorship network analyses), it should not be confused with what is typically understood as human data. In bibliometric research, a piece of information related to an author is typically a datum gleaned from a bibliography, rather than directly from the person (or people) who wrote the article specified in the related citation. Humans on the other hand, are rarely investigated with respect to citation motivation. In other words, the human (distinct from author) as the unit of analysis is becoming less common in citation behavior literature.

One could argue studying the science of Science is incomplete when the human aspect is ignored. As Cronin (1981) states, “To understand why an author cites in a particular way at a particular time we would need, to put it crudely, to step inside the author’s head” (p. 21).

Crudeness aside, this statement is accurate. To better understand the motive to cite, researchers need to investigate the motivations that drive citation behavior, and start stepping inside heads, so to speak.

Exploring citation behavior necessitates designing studies aimed at capturing human motivation, which are often small scale, painstaking, and require subjective interpretation. Scientometrics purists shy away from these kinds of studies in favor of focusing on the relationships between articles and across domains, which when isolated from the authors' motives have no inherent feelings or intentions. This methodological preference could be attributed to the sophisticated software and user-friendly bibliographic data mining techniques that are now available to researchers, or it may be due to the primarily positivist paradigm to which scientometricians typically align themselves. In all likelihood it is probably a complex combination of these and several other factors.

While Wouters (1999) suggests an endeavor to explain motivations behind citation to be a “dead end” (p. 211), this paper argues that such investigations are necessary to fully capture the entire story these networks have to tell us. One cannot dispute the watershed moments of establishing the Science Citation Index (Garfield, 1955a), or when we were first able to visually map WoS data with the click of a button. However, over time these analyses have become the primary focus of inquiry at the expense of understanding the motivation behind citation.

This paper is not a call for a reduction of scientometric investigations, co-citation analyses, or co-authorship network visualizations. These types of studies should continue with fervor, as they are critical in helping to understand the structure, growth, and development of scientific exploration through complex bibliographic chaining. However, when we consider Aristotle's conceptualization of living creatures as the combined facets of matter (body) and

form (soul), it is important to recognize scientometric analyses simply map the body of science. Without investigating the human motive behind a reference, we are neglecting the soul of inquiry.

Scientometrics and Aristotle De Anima

The curious reader may wonder how the ideas of Aristotle, one of the Western Intellectual Tradition's principal philosophers relates to the modern field of Scientometrics. Specifically, how Aristotle's interpretation of the soul could possibly apply to the primarily 21st century methodology of mapping scholarly landscapes. The connection between the ancient Greek metaphysician and the quantitative study of science lies in his dualistic views of body and soul.

Matter and Form

Aristotle believed a living creature was comprised of both matter (body) and form (soul). He elucidates this idea with an analogy involving an axe (Hicks, 2015). For the sake of argument, the axe is a living being. Its body would be comprised of wood and metal, yet the fact that it is made of wood and metal does not necessarily make it an axe or give it the capacity to chop. What makes the being an axe is its form, in other words, its soul. Once it loses its capability to chop, then it is no longer an axe and is simply comprised of its matter components.

Levels of Souls

In *De Anima*, Aristotle explains the capacity to possess a soul is not limited to sentient beings. He posits that there are different levels of souls appropriate to a creature's role in the biological hierarchy. The rational soul is the highest level reserved for entities that can think and rationalize, such as human beings.

Animals also have souls, but as they are limited to mobility and sensation and cannot

engage in higher order thought or rationalization, they cannot possess a rational soul. Therefore, animals are limited to what Aristotle classifies as a sensitive soul.

Finally, the lowest level is reserved for beings that cannot rationalize or move, yet are nevertheless alive in the traditional sense of the word. The vegetative soul is designated for flowers, trees, and all other flora. Plants can grow and reproduce but they cannot move or reflect on their thoughts, and therefore are still considered alive and capable of containing a soul (Hicks, 2015).

Aristotle and Scientometric Networks

Again, the curious reader may question how matter, form, and levels of soul apply to something as obscure and seemingly unrelated as say, a bibliographic coupling map. While most would agree that a co-citation network is not alive in the biological sense, an argument could be made that it does have form. Taking an Aristotelian approach, it is plausible to suggest these networks fall under the category of beings which possess a vegetative soul.

Although a bibliometric network is incapable of thinking, rationalizing, moving, or feeling, it is nevertheless dynamic. Networks change and reproduce, just like plants. With additional publications occurring every day, it is in a constant state of growth. When the network is fed more (i.e., when more citation connections are established), it grows more. In an abstract way, it is logical to presume these networks have souls, even if they are at the most basic level.

Assuming a network possesses a soul, the next step is to ascertain what constitutes its form. The matter is simple enough to identify. Depending on the type, networks are typically comprised of document citations, co-word occurrences, or co-author connections. Software tools like VOSViewer and Gephi allow us to reveal the structure of the body in ways that the field was seldom capable of doing in previous decades. However, these visualizations are simply

manifestations of matter, not form. The entities who give a network its form or its soul are the authors and researchers who generate the identified unit of analysis. In other words, the humans who make the decisions about manuscript language and bibliographic references are the ones who engender the shape and structure of a scientific landscape.

In different types of networks, the form is governed by the choices of an author or group of authors. In a co-word analysis, it would be the choice to use particular words or phrases in a manuscript. For co-citation networks it is the decision to cite article A over article B. In a co-authorship network, it is the selection of one or more partners for a project. These decisions are the essence of the network and they guide the form. In other words, if one were to retroactively imagine that the authors had made different decisions about phrasing or citations, then the network body would have resulted in a completely different structure.

Empirical Implications for Scientometrics Research Studies

Assuming in at least an abstract sense that citation networks are comprised of both form and matter, then the methodology of Scientometrics needs to be considered. Currently, the literature is dominated by bibliometric analyses in which the document is the unit of analysis (Bornmann & Daniel, 2008; Garfield, 1955a, 1998; Price, 1965; van Eck & Waltman, 2014; Waltman, 2015). Simply stated, the field is primarily focused on the body instead of the soul. What is needed is not necessarily a reduction in analyses of the body of science, but an increase in investigations of the soul to provide a more balanced panorama.

Studies of form will necessitate research questions aimed at citation motivations of authors, thus making the unit of analysis the human rather than the document. These investigations also require more subjective methods of measuring behavior, such as surveys and interviews. These research questions and methods pave the way for a sub-discipline comprised of

a significant overlap between Scientometrics and Human Information Behavior.

Before delving into the exploration of the soul of science, it is critical to consider current theories of citation behavior and devise research design methods to provide a richer and more balanced understanding of scientometric networks.

Citation Behavior Theories

As a result of over fifty years of asking questions about citation motivation, there are numerous citation behavior theories (Baldi, 1998; Cronin, 1998; Garfield, 1998; Gilbert, 1977; Nicolaisen, 2003; Small, 1978). The act of referencing has been explored from several perspectives and has resulted in a plethora of hypotheses regarding the reasons authors cite. The majority of these ideas have been compiled in various classification lists (Camacho-Miñano & Núñez-Nickel, 2009; Nicolaisen, 2004). This paper does not provide exhaustive coverage of citation behavior theory, but does discuss the three primary frameworks to which most perspectives align: normative theory, social-constructivist theory, and symbolic theory. Although, before exploring these theoretical frameworks, the historical foundation of citation motivation needs to be established.

The Functionalist Perspective

While there are three generally accepted umbrella categories for citation motivation theories, it is important to examine the historical background of this line of inquiry. The functionalist perspective was never substantiated as a bona fide theory (Cronin, 1998), but it did emerge as one of the most basic justifications for citing sources. Therefore, it is important to explore it first as the springboard for subsequent theories.

When scholars first began to inquire about citation motivation, the functionalist approach was naturally the first to emerge. This paradigm suggests the motive to cite stems from what

science traditionally considers to be the primary purposes of citation. That is, to support claims, define terms, refute a hypothesis, or provide historical context. When undergraduate students learn about citation and bibliographies within the context of a research methods class, they typically learn the functionalist approach.

Eugene Garfield, largely considered to be the father of Scientometrics was interested in the motivations behind citations. Although he is often lumped in with the normative theorists, he outlined fifteen reasons why authors cite. Some of his motivations align with the functionalist perspective:

1. To pay homage to pioneers
2. Giving credit for related work (homage to peers)
3. Identifying methodology
4. Providing background reading
5. Correcting one's own work
6. Correcting the work of others
7. Criticizing previous work
8. Substantiating claims
9. Alerting to forthcoming work
10. Providing leads to poorly disseminated, poorly indexed, or uncited work
11. Authenticating data and classes of fact, physical constraints, etc.
12. Identifying original publications in which an idea or concept was discussed
13. Identifying original publication or other work describing an eponymic concept or term
14. Disclaiming work or ideas of others (negative claims)
15. Disputing priority claims of others (negative homage)

(Garfield, 1965, p. 189)

While not an exhaustive list, Garfield's reasons are primarily functional. That is, they serve to gain some kind of insight into how researchers support their own claims by either identifying a key term, referring to a previously established method or tool, or providing alternative ideas that extend or refute earlier works. The exploration into functional citation motives laid the groundwork upon which scientometricians built subsequent theories and conducted preliminary investigations.

Normative Theories of Citation

The normative theory emerged in the early 1940's (Merton, 1942), and dominates much of the early history of citation behavior theory (Nicolaisen, 2004). What elevates it above a purely functional approach is the acknowledgement of science as a social system (Merton, 1973). Researchers quickly realized that the decision to cite one paper over another was rarely based solely on practical justification, but often included a sense of obligation to give credit to previous authors in order to replicate and extend their work.

Early papers in citationology have strong roots in this approach, focusing on the social system of science and how scientists govern themselves and their citations within that system. The main tenet of normative theory is that citations and references are related to the codified etiquette and standards of science (Garfield, 1955b; Kaplan, 1965; Merton, 1973). To put it simply, it suggests citations are primarily used to give credit where credit is due or to dispense rewards to colleagues (Kaplan, 1965). When scholarship is conceptualized as discourse or as a conversation, citations are considered to be "the socially appropriate cues or reinforcers of the narrative" (Cronin, 1998, p. 47).

Undoubtedly, the Three Tenors of this framework are Garfield, Merton, and Kaplan.

Garfield was discussed previously under the functionalist perspective, but he is often placed in the normative camp because his list of fifteen reasons authors cite includes some motivations that align more with a normative perspective. Specifically, reasons one and two which involve “paying homage” to pioneers and peers speaks more to norms and etiquette than say, substantiating claims or alerting to forthcoming work (Garfield, 1965). Therefore, it is safe to say Garfield has one foot in each camp, and much of his later contributions to this scholarly conversation were in line with Merton and Kaplan’s ideas (Garfield, 1979, 1998; Garfield & Merton, 1979).

Early on, Merton highlighted the social nature of science to be a system of debts and rewards (Merton, 1973), and citations were a “symbolic payment of intellectual debts” (Small, 2004, p. 76). In other words, if Researcher A builds their work off of Researcher B’s original paper, then Researcher A owes a debt to Researcher B. By citing the original work, A is rewarding B with a reference and paying off his debt. Therefore, science progresses forward based on these transactions in which references serve almost like currency.

Merton is credited with identifying the *Matthew Effect*, a phenomenon (named for a reference to a quote from the biblical gospel of St. Matthew) in which authors who are well established continue to receive recognition for contributions while those who have not yet made an impact in their field do not tend to receive credit (Merton, 1968).

Kaplan focused more on the norms of science than the debts and rewards aspects, but felt scientists’ behavior was unique when compared with other professions. Specifically, he identifies elements of communism in citation behavior, that the social nature of science means that everybody must contribute and therefore everyone receives equal credit (Kaplan, 1965).

As researchers continued to study citation behavior, another category of theories emerged

which retained the normative perspective's idea that science is inherently social. However, the focus shifted from explaining the practice through a monetary transaction system to a more subjective justification of using persuasion.

Social-Constructivist Theories of Citation

Social-constructivist theories are often seen as extreme and also important to distinguish from constructive theories (Moed, 2005). Any constructivist view of citation implies that an article's meaning is exclusively what an author interprets it to be. In other words, two authors may cite the same paper, but the meaning or intention of the reference may be entirely different across the two individuals, and the impact is constructed by the citing authors. This is different from a social constructive perspective, which simply "analyzes the social conditions and interactions involved in the publication process" (Moed, 2005, p. 213). This section focuses more on the social-constructivist theory.

The constructivist approach lends itself to Gilbert's theory that references are used solely as persuasive devices (Gilbert, 1977). Instead of putting the sense of reward in a citation to one's work, Gilbert posits that the reward is through "recognition for producing results that are seen as new, important, and true" (p. 116). The way an author gains recognition for their paper is through the audience (i.e., the readers), rather than another researcher who cites the paper. Therefore, it behooves the author to use citations as tools of persuasion instead of as a means to assign credit.

Nicolaisen (2003) attempts to migrate toward middle ground by taking a social collectivist approach to citation motivation. He suggests instead of focusing on an individual's private decision to cite or the intention to cite merely to persuade, the unit of analysis should be the social act of citing itself. Science is a collective institution in which decisions about which

theories, methods, and research questions are influenced by social factors. Studying the actions of the collective group will therefore allow researchers to investigate citation motivation in ways that do not need to be subjectively interpreted, as when studying intrinsic motivations.

Symbolic Theories of Citation

Small (1978) takes a radical new approach by veering away from examining citation motivation in the realm of the social system of science, and places the lens over how citations are used as representatives for concepts. This view suggests that authors do not use citations to pay off debts, nor to persuade readers necessarily, but to provide a sign-post for a given concept or context.

To delve into the idea of citations as concept symbols more deeply, consider the analogy of an image or symbol that is globally understood to represent a complex idea. For example, when most people see an image of the “peace” sign, they do not perceive it to be a circle with strangely arranged lines in the middle that look like a bird’s foot. Most people interpret it to stand for peace, harmony, or love, which are all fairly complex concepts. In other words, the image itself becomes a representative for the abstract idea. Similar parallels can be drawn from other symbols like the American flag, a black mourning band or badge, skull and crossbones on a bottle of bleach, or a Nazi swastika. Each of these symbols is used not to represent the images they depict, but to signal to the viewer a more complex concept or idea.

Similar to the American flag or a peace symbol, Small argues citations are used to represent main ideas presented in the original text. For example, say a physics student comes across an in-text reference that reads, “(Einstein, 1915)” in a paper. On its face, the citation is merely a brief string of text, but to the reader it represents Einstein’s entire Theory of Relativity, and therefore establishes the context for the article and the concept that is being used in a

specific paragraph.

The suggestion that citations are concept symbols for ideas rather than pieces of currency or persuasion devices, opens up an entirely new way to empirically study how citations are used by authors within the context of text, rather than in intrinsic motivations that are prone to subjective interpretation. Both Small (1978) and Nicolaisen (2003) attempt to remove the exploration of citation motivation out of the internal realm of the individual, and place it in an environment that is arguably more accessible to empirical study.

There are numerous theories and frameworks on citation motivation spanning from the 1940's to present day. While they are not exhaustively covered in this paper (see Bornmann and Daniel (2008), Camacho-Minano & Nunez-Nickel (2009) or Nicolaisen (2004) for extensive literature reviews), most tend to align with one of the three main categories of normative, social-constructivist, or symbolic frameworks.

Empirical Methods for Investigating Citation Behavior

Now that the background of citation behavior theories has been established, it is important to discuss how to empirically investigate this phenomenon. If we are to get inside the heads of authors to investigate the rationale for citations, then researchers need to utilize appropriate methods for exploring citation motivation.

This section outlines recommended techniques for other kinds of human information behavior studies, including: surveys, interviews, focus groups, ethnographic techniques, and grounded theory (Case & Given, 2016; Savin-Baden & Major, 2013). Combinations of these methods can be used to answer research questions related to the private process of citation decision-making and complement traditional scientometrics studies.

In addition to enhancing bibliometric analyses with explorations into citation behavior, it

is important to consider the positionality of the researcher. Positionality statements have become more prevalent in qualitative studies (Greene, 2014), yet are virtually non-existent in quantitative studies (Jafar, 2018). If empirical investigations of citation behavior employ a more mixed method approach in the future, considering the positionality of the investigators may become an important factor when evaluating the nature of the study and its findings.

Surveys

Surveys are typically used to systematically poll samples using standardized questionnaires. Item types can range from quantitative Likert scales to open-ended qualitative responses. There are merits and limitations to different item types, but data from surveys tend to reflect individual perceptions and opinions of the respondent (Case & Given, 2016; Savin-Baden & Major, 2013).

Questionnaires used in human information behavior studies need to be tailored to the analytical approach of the investigation and the sample size (Case & Given, 2016). If the target sample is large, the Likert or multiple-choice option is recommended for large scale analyses. Digital surveys using programs such as Qualtrics or Survey Monkey allow researchers to collect and analyze data seamlessly. The inclusion of open-ended items in large samples does not reduce the quality of data. However, the researcher should consider the time cost to code and analyze responses and weight it against potential gains.

For smaller sample sizes, qualitative item types are encouraged in order to elucidate responses to Likert items. For example, a Likert item may ask a respondent's level of agreement on their past citation behavior with respect to perfunctory references. A follow-up open-ended question may ask the respondent to explain their answer by giving an example or describing the context in which that kind of citation was used. Surveys can be used in conjunction with other

methods, such as interviews or focus groups. Additionally, pairing a survey with bibliometric techniques such as an author co-citation analysis has potential benefits for establishing a more holistic picture of the network.

Limitations to survey methods include response bias and the ability to interpret rich meaning from more general item types. Some participants may be hesitant to admit the true reason for citing a source (Van de Mortel, 2008). One might endorse a response option indicating they chose to cite a source to support a theory or method, when in reality the reason for citing the source was to bolster a colleague's tenure application. Assurances of anonymity and confidentiality may mitigate these effects, especially in studies conducted within the scope of a single institution. Additionally, multiple-choice and Likert items merely scratch the surface behind authors' personal motivations to cite. However, data would provide more insight into the behavior than neglecting to investigate the construct at all.

Interviews and Focus Groups

Interviews and focus groups are conversational techniques used to capture personal perspectives or experiences from a participant's point of view (Savin-Baden & Major, 2013). The advantage of interview techniques is the high level of complex information collected. Semi-structured and unstructured interviews allow the interviewer to tailor questions and follow-up questions to the narrative of each participant. In other words, the contemporaneous nature of the asking and answering of questions (as opposed to the time delay of a survey) allows for adjustments that may glean more useful responses.

In establishing a rapport with participants, researchers may have a chance at capturing elements of the personal and private process of citation. One of the major critiques of exploring the motivations behind citation is that the process itself is completely internal to individual

authors. That is, unless one is using either Nicolaisen (2003) or Small (1978) as a theoretical framework. While data in this highly qualitative technique is typically limited to few participants, over time the themes from responses can be used to speak to various citation behavior theories. Additionally, they may be able to support or refute the findings from previous studies (e.g., Baldi, 1998).

Focus groups would be useful when looking at a specific discipline or department at an institution. Subject to the same limitations as interviews, the analysis is necessarily both meticulous and subjective. Although, the opportunities to capture the group dynamics of a department or discipline as well as citation rationales would be boundless. Findings may be used to supplement bibliometric analyses such as co-authorship, co-citation, and co-word analyses. Specifically, those looking to explore research endeavors related to interdisciplinary studies and international collaboration.

Ethnographic Methods

Ethnography is a research approach with a wide variety of techniques. Originally used in anthropological studies (Vidich & Lyman, 2000), it is primarily employed to better understand the cultures and values of people using an observational approach. While perhaps not every ethnographic technique is suited to investigating citation behavior (e.g., ethnodrama comes to mind), some methods such as realist, auto, and duo ethnography may provide insight into citation motivations of particular authors, disciplines, or institutions. It is clear that when investigating the soul of science, ethnography has an unequivocal role.

Realist ethnography. Realist ethnography stems from the critical realism ontological approach. It is often used to examine social structures and their relationships with social actions (Savin-Baden & Major, 2013). The goal in using realist ethnography when investigating citation

motivation is to explain how the norms of attribution affect the decision to cite a particular article. This makes realist ethnography an ideal selection to study research questions related to the normative theory of citation.

Autoethnography. Auto and duo ethnography come from the constructivist paradigm. Autoethnography is used when a researcher wishes to explore their own experiences to make connections with a given social context (Ellis, 2004). It requires an immense amount of reflexivity and description of personal thoughts and interactions with others. When considering autoethnography, one is reminded of what Cronin said about needing to step inside the heads of others to understand why an author cites. It seems the easiest way to get inside of an author's head is to step inside one's own.

Duoethnography. If autoethnography is too far reaching, then duoethnography might be a more reasonable choice. Similar to auto, the duoethnography method aims to explain values and behaviors through reflection, but instead of through self-narrative, it is done through conversation with another and analyzing revelations through the process of discourse (Norris, Sawyer, & Lund, 2012).

Limitations. The limitations of ethnography lie in its subjectivity and potential for bias, especially when considering auto and duo techniques. The emotionally influenced data gleaned from ethnography studies may seem unconscionable to the generally positivistic paradigm of Scientometrics. However, when reminded that the objective is to explain the soul of science rather than the body, one may become more open to the idea.

Ethnographic techniques may become particularly useful when combined with a pure scientometric study (e.g., a co-citation analysis) to provide insight into both sides of the coin. The co-citation map demonstrates the answer to the “what” question, while the ethnography

sheds light on the “why” question.

Grounded Theory

Upon seeing grounded theory as the next recommended method for examining citation behavior, some researchers may shudder, or worse, roll their eyes. Classical grounded theory methods are bottom up approaches used to generate new theories from data (Strauss & Corbin, 1997). In a field which is littered with citation behavior theories and four decades of debate on establishing a unified theory, one might wonder why would a technique which results in the suggestion of additional theories be a prudent course of action. This is a fair question. In keeping in theme with the thesis of this paper, it is easy to forget that the goal is to explore the soul of science and the motivations behind a decision to cite.

Since so few studies have targeted the private and personal process of citing, the theories are manifestations of hypotheses with little data to back them up. In other words, most of what we believe we know about the decision-making that governs the referencing of sources comes from conjecture and indirect analyses of artifacts, not people (Bornmann & Daniel, 2008; Leydesdorff & Wouters, 1999). When the issue is framed in this way, it should become clear why grounded theory is a viable option to study the motive to cite.

In some ways, grounded theory is a kind of free for all for researchers to use whatever methods (within reason) deemed necessary to help the researcher generate a theory. This could mean a combination of interviews and ethnography, or a series of surveys. The goal is for a theory to “emerge from the data” (Savin-Baden & Major, 2013, p. 189), and that anything and everything must be considered data.

The limitations of doing grounded theory is that because the theory is generated, there is no foundation for it. One major criticism is the question as to whether the findings from a

grounded theory study can even be called theory. The recommendation for those who dare to take on a grounded theory approach to citation motivation is to establish a well-reasoned justification for it from the beginning. Many consider the technique to be one of the most misused approaches in qualitative research (Savin-Baden & Major, 2013). Therefore, it is strongly recommended the researcher carefully considers other approaches before ultimately deciding on the inductive messiness of grounded theory.

Positionality

Some may presume the purpose of this paper is to put forth an agenda to inject more qualitative methods into scientometric research. This is not the intention, either overtly or covertly. However, one cannot ignore the notion that approaching the empirical investigation of behavior and motivation necessitates some kind of subjective technique, which tends to fall under the qualitative umbrella. That said, the next recommendation for researchers who endeavor to study the soul of science is to consider positionality.

The necessity of a positionality statement in quantitative studies across all disciplines in science is generally accepted as unnecessary (Jafar, 2018), let alone in bibliometric studies. Scientometrics is perceived as a positivistic sub-field of information science, with calls for a more pragmatic approach when conducting empirical investigations (Hardeman, 2013). Researcher stance is rarely, if ever considered to influence the interpretation of findings in scientometric investigations. However, if the field goes forward with more mixed method approaches to study citation motivation behavior, researcher positionality may become more influential on conclusions drawn from ethnographic or grounded theory studies. It is recommended for researchers to consider their paradigm, stance, and positionality and evaluate how it may affect the interpretation of results.

Discussion, Limitations, and Future Directions

As a discipline, Scientometrics evolved primarily as a quantitative and positivistic enterprise. Even the etymology of the portmanteau has strong ties to a mathematical origin, with “scien-” originating from the Latin *scio*, or *to know*, and “-metric” derived from the Greek *metron*, which translates to *measurement*. Together these words denominate a discipline in which the primary goal is to statistically measure and map knowledge, or more specifically the structural makeup of academia through its literature and literati.

In 1963, Derek de Solla Price published *Little Science, Big Science*, a series of lectures discussing the role of science in society and how it may be measured empirically. In many ways, he was ahead of his time, imagining the capacity to map and statistically analyze science in ways that were not fully realized until nearly half a century later.

Price’s ideas had major implications for research evaluation and science policy, and relied solely on the quantitative measurement of scholarly literature through citations and co-author connections. The fruits of the progress have resulted in thousands of bibliometric indices used for evaluation (Todeschini & Baccini, 2016), a series of data mining and science mapping software that are becoming increasingly sophisticated in their capabilities (van Eck & Waltman, 2013), and an assembly of critics (MacRoberts & MacRoberts, 1989; Moravcsik & Murugesan, 1975; Murugesan & Moravcsik, 1978).

It seems highly unlikely that the human condition was considered when Garfield was inspired by the United States’ patent indexing system to create the *Science Citation Index* (Garfield, 1955a, 1964), or when Price was devising algorithms to determine the percentage of scholars who contribute to a field (Price, 1963, 1965). This is not a criticism, but an important fact to acknowledge when attempting to answer questions about not only the network structure of

science, but the factors which shape the network.

Limitations of the Aristotelian Approach

Aristotle's notion of matter and form is merely one lens through which to view the missing piece of Scientometrics. One might argue that as poetic as it sounds, science networks are not alive in a manner in which Aristotle's levels of soul would apply. Additionally, other cultures and even other Greek philosophers had different ideas about what substance makes up living beings. Applying another idea, such as Aristotle's mentor Plato and his tripartite theory of the soul with its logical, appetitive, and spirited components appears to have little relevance to the form and matter of science (Tschemplik, 2005). The response to these challenges is simply to say that the Aristotelian perspective presented here is used as a metaphor to help explicate a complex idea, and the reader should perceive it more as a tool for understanding than as a literal application of the theory.

Another limitation is that Scientometrics is more than a discipline, it is a methodology. Some may suggest that once a study deviates from a traditional bibliometric technique to incorporate say, a survey or an ethnography, it is no longer a scientometric investigation. Whatever the method is called or how it is carried out with respect to supplementing another scientometric analysis is not as important as addressing the obvious missing piece of citation motivation research. Those interested in this phenomenon may wish to call it Scientopsychology, or something catchy like Sci-Psych for short, and scientometricians can distance themselves from this line of inquiry if they wish. Again, the label is not as important as the research itself.

Future Research

Future studies should endeavor to explore the human side of citation and conduct investigations to answer the *why* and *how* questions, in addition to the *what* questions. The

strongest opportunity for research is to pair a bibliometric analysis with a complementary citation behavior investigation. One example could be an author co-citation analysis and a focus group using a sample of the authors whose citation data are included in the bibliometric dataset. These kinds of designs would provide a complete picture of what a network looks like and how the researchers' decisions regarding what papers to cite shaped that network.

As science continues to progress at an exponential rate, scholars can no longer ignore such a critical piece of the puzzle. Regardless of the metaphysical paradigm or methodology label, it is clear the gap exists. Scientometrics aims to explain the body of science at the expense of its soul. One of the main endeavors is to map scholarly landscapes. Therefore, the next logical step is to venture into the realm of human information behavior to expound upon this largely uncharted territory.

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