Please don't aim for a highly cited paper

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Citation-based metrics are important in determining careers, so it is unsurprising that recent publications advise prospective authors on how to write highly cited papers. While such publications offer excellent advice on structuring and presenting manuscripts, there are significant downsides, including: restrictions in the topics researched, incentives to misconduct and possible detriments to motivation, innovation and collegiality. Guides to writing highly cited papers also assume that all citations are equal, ignoring new directions in bibliometric research identifying 'quality' and perfunctory citations. Rather than pursuing citations, with the uncertainty about their significance and the potential negative consequences, authors may fare better by following evidence from several disciplines indicating that persistence, a focused research program, good methodology and publishing in relevant journals are more important in career development and disciplinary influence than the odd star paper. Research administrators could encourage such steps by considering innovative new multivariate assessments of research productivity, including assessing social impact.

Keywords: citation, quality citation, motivation, misconduct, innovation, highly cited

Introduction

Increasingly, researchers find their track records under scrutiny as supervisors and funding agencies seek the most successful groups to fund, or individuals to reward with appointments, promotion, tenure or prizes (Corsi, D'Ippoliti & Lucidi, 2010; Oswald, 2010; Teixeira *et al.*, 2013). Consulting the citation records in major databases is a more rapid and cheaper way to make such assessments than through peer review (Hodge & Lacasse, 2011; Buela-Casal & Zych, 2012), so citation profiles are increasingly important in determining careers (Calver, 2013; Calver *et al.*, 2013a; van Wesel, Wyaat & ten Haaf, 2014).

One must publish to be cited, so it is unsurprising that the valuable guides to scientific writing and publishing from experienced authors, editors or teachers (e.g. Glasman-Deal, 2010; Cargill & O'Connor, 2013; Tress, Tress & Saunders, 2014) have been joined by a new category of advice – how to write a highly cited paper (Pyke 2013; 2014). While both traditional and new guides share concerns for excellent presentation, sound scholarship and clarity of style, encouraging people to aim consciously to write highly cited papers is concerning for five main reasons: (i) it narrows the scope of research undertaken or published; (ii) the focus on reward may reduce intrinsic motivation, innovation and true collaboration but encourage mistakes and misconduct; (iii) despite substantial research, the significance of citations remains controversial; (iv) empirical evidence from several disciplines indicates that persistence, research specialisation, good methodology and publishing in germane journals are most important in developing a career and influencing a discipline, not the occasional highly cited paper; and (v) the convenience of citation counting may impede development or adoption of innovative new multivariate assessments of research productivity, including evaluation of wider social impact.

Narrowing research scope

The topic and the type of study are important predictors of citation potential, so choosing a topic is a key part of

advice on writing highly cited papers (Pyke, 2013; 2014). Taxonomists, for example, have vented their frustration regarding belittling of their important work on the basis of the low citations it attracts (Valdecasas, Castroviejo & Marcus, 2000; Valdecasas, 2014). Their specialised subject matter is of immediate interest to just a few experts (Ebach, Valdecasas & Wheeler, 2011), although it subsequently underpins (without citation) diverse areas of biological inquiry (MacRoberts & MacRoberts, 2010). The same is true of many areas in mathematics (Adler, Ewing & Taylor, 2008), some medical specialities (van Eck *et al.*, 2013) and numerous applied disciplines where the significance of work comes not from academic citations but from influence on practitioners (Shewan & Coats, 2006; Jones, 2007; Calver, Lilith & Dickman, 2013b). In contrast, hot topics and reviews are more likely to attract citations (Davis *et al.*, 2008; Davis, 2009; Teixeira *et al.*, 2013), as are positive studies (those supporting the hypothesis tested) (Falagas & Alexiou, 2008; Song *et al.*, 2010; Jannot *et al.*, 2013). Keeping good company may be important too: papers with many authors or at least one highly cited author attract more citations, which is why it is necessary to control for the number of authors in some bibliometric studies (Calver & Bradley, 2010).

Thus authors hungry for citations will neglect some fields or topics, regardless of their potential merit, in favour of the fashionable or the review, preferably written with many influential colleagues. They certainly won't tackle '... areas of public interest where little research is being done' (Martin, 2012, p. 168) and will probably have less time for applied research or engaging the public (B. Martin, 2011). A narrowing of research diversity is as valuable to scholarship as atherosclerosis is to the cardiac patient, yet one follows citation hunger as surely as the other follows a fatty diet.

Focus on reward

Intrinsic motivation, or the desire to complete a task for personal satisfaction rather than external reward (Cerasoli, Nicklin & Ford, 2014), may be at risk when the focus is on an external outcome or reward, such as high citations, rather than the process of conceiving, implementing and communicating a good study. Some empirical studies and meta-analyses of relationships between external rewards and intrinsic motivation find a reduction in intrinsic motivation when rewards are offered (e.g. Ryan & Deci, 1996; Deci & Ryan, 2013; Green, 2014). Others do not (e.g. Eisenberger & Cameron, 1996; Reiss, 2005). Nevertheless, even critics of negative links between external rewards and intrinsic motivation accept that rewards depress intrinsic motivation when the task is interesting, the possibility of reward is known in advance and the likelihood of reward is ambiguously connected to performance (Cameron, Banko & Pierce, 2001). This matches aiming for a highly cited paper because the research is interesting, authors know that citations may follow, but even good work may only receive modest citations (Valdecasas *et al.*, 2000; Shewan & Coats, 2006; Jones, 2007).

Critiques of using rewards as motivation also note that while they may increase basic productivity, innovation may decline (but see Curran & Walsworth, 2014 for suggestions that the type of reward may be important in determining whether or not it encourages innovation). It may be better to use tried and true methods in case the new approach fails, or people may simply be so busy chasing the reward that they do not consider an alternative approach (Ariely *et al.*, 2009; Webb, Williamson & Zhang, 2013). Charlton (2008) speculated that science in the UK is undergoing just such a process, with a preference for more productive 'normal science' over less productive but potentially more ground-breaking 'revolutionary science.' In academia, the problem may be compounded by a preference for the tried and true at the grant application stage (Martin, 2000) or in editorial process with publications (Horrobin, 1990). Surprisingly, mistakes may actually increase when the focus is on the outcome rather than the process, a phenomenon well documented in declines in athletic performance under pressure (DeCaro *et al.*, 2011).

True collaboration may suffer too, because genuine collaborative relationships may be replaced by a 'contrived collegiality' in which there is uncritical acceptance of striving for an external goal or meeting an external agenda (Boocock, 2011). For example, in 2007 the UK began planning its first iteration of the REF (Research Evaluation Framework) for evaluating research in higher education, with a strong emphasis on citations. Several senior academics predicted that authorship practices would shift to the disadvantage of junior researchers. Specifically, junior researchers would be excluded from secondary authorship on group publications so that they could later cite those papers without a penalty for self-citation for the senior colleagues on the original papers. On the other hand, senior researchers were predicted to form 'citation clubs', in which they agreed to cite each other's papers for mutual benefit (Corbyn, 2008). Citation clubs are already documented at the journal, if not the individual, level (van Noorden, 2013).

These examples fulfil predictions that obsession with numerical assessments rewards aggressive, acquisitive and exploitative behaviour (Lawrence, 2002).

Finally, a conviction that success is 'deserved' may tempt authors into misconduct to gain the reward, just as an athlete may rationalise doping (Martinson, Anderson & De Vries, 2005; Fanelli, 2009; Deci & Ryan, 2013). Thus 'Excessive focus on building publication records may lead to over-bias towards choosing high-impact journals for publication, violation of publication ethics, and unbalanced development of writing skills' (Cheung, 2008, p. 41). Buela-Casal (2014) argues that excessive concern with research status and associated marketing meet the criteria of a psychological disorder, manifesting in behaviour such as fraudulent misrepresentation of research data or bibliometric profiles, personal belief in such misrepresentations, and an obsession with self-image.

What does a citation mean?

Critiques of simplistic citation analyses highlight numerous biases and unchecked assumptions, some of which remain unaddressed (Appendix 1). Furthermore, in some fields citations correlate significantly with peer assessments of impact or influence such as prizes and awards, but in others they do not (Bergsma, Mandryk & McCalla, 2014). This calls into question their validity as measures of quality.

More recently, bibliometricians note that not all citations are equal, even leading to the farcical situation where a non-existent paper is cited frequently because authors have copied a referencing error (Dubin, 2004). Not so farcical are examples where misrepresentation of what was actually written or echoing a fallacy by not checking the original promulgates misinformation (Wetterer, 2006; Wright & Armstrong, 2008). These problems may be common. In the field of marine biology one in four citations was found to be ambiguous in relation to the statement it was supposed to support, offered no support at all, or was empty (a reference to a secondary source) (Todd *et al.*, 2010).

A recent review claims that between 40 and 80 per cent of citations are inessential or perfunctory. The authors then suggest a framework for identifying influential citations on the basis of repeated use in one paper, similarities between the citation title and the title or sub-sections of the citing paper, the context of the citation in the paper (noting any descriptors such as 'important', 'baseline', 'key' etc. or whether the citation appears alone or in a series), and the location of the citation in the paper (Zhu *et al.*, 2014). Bergsma *et al.* (2014, p. 35) also claim significant improvement in assessing an author's influence by replacing citations with multivariate data including 'novel social, linguistic, psychological, and bibliometric features.' Applying methods such as these may reduce the value of some highly cited works such as reviews relative to empirical papers making original contributions. They would also threaten questionable practices such as the boosting of citations by commissioning opinion pieces that offer extensive opportunities for the self-citation of authors and journals (Heneberg, 2014).

Overall, striving for a highly cited paper is not necessarily the same as aiming to produce influential work. To use an analogy from novelists, Harold Robbins may have sold more copies than William Faulkner or Ernest Hemingway, but Faulkner and Hemingway have surely had a greater influence on modern literature.

Lessons from successful researchers

Commentaries by authors on their highly cited papers nominated interest from the scientific and lay communities, novelty, utility to broad audiences and significance in addressing an important or fundamental problem as key reasons for the high citations. The categories were not mutually exclusive, so authors often referred to more than one (Small, 2004).

However, significant influence on a discipline is more likely to follow from consistent performance over a career, not one star paper. In ecology, such influence correlates strongly with research specialisation, a focused body of work (not necessarily on a fashionable topic) and publication of good papers in germane (not necessarily highly ranked) journals (Parker, Allesina & Lortie, 2013). In this context, it is worth noting that the citation gap between elite journals and the others is declining (Acharya *et al.*, 2014). Padial *et al.* (2010) further stressed the value of innovation in ecological papers. Hermanowicz (2006), in a survey of physicists, found that the top-ranked quality for success was persistence in the face of difficulty or publication rejection. This is echoed in the case of ecology by Cassey and Blackburn (2003, p. 375), who found that 'publication success and manuscript rejection are not strangers', and in psychology by Douglas (1992), who claimed to have received up to three rejections for every highly cited paper he published. To all of these can be added the blessings of Lady Luck, because of '... the key role that error, chance or accident can sometimes play in scientific endeavour' (Campanario, 1996, p. 20).

Innovations in research assessment

Citation counting for research assessment is attractive to research administrators because it is speedy and offers the illusion of objective numbers (Adler *et al.*, 2008), despite the problems reported (Appendix 1). This may restrain support for the more challenging approach of allowing individuals or organisations undergoing evaluation to demonstrate the impact of their work beyond bibliometric indicators. Possibilities might be changes in professional or government practice as a result of research (Witten & Hammond, 2010), publishing in local languages rather than English to reach regional communities or practitioners (Adler & Harzing, 2009), or online readership/download statistics where readership may be more important than citations (Bollen *et al.*, 2009).

Several major initiatives are attempting just such broad assessments. For example, STAR METRICS (Science and Technology for America's Reinvestment: measuring the effects of research on innovation, competitiveness, and science) focuses on a wide range of results and impacts from federally-funded US researchers (Largent & Lane, 2012). In Brazil, the Lattes Platform takes a multivariate statistical approach to evaluate the broad impact of Brazilian researchers (Araújo *et al.*, 2014). In Europe, the Social Impact Assessment Methods through Productive Interactions (SIAMPI) project is a broad-based initiative involving contributors from The Netherlands, Spain, France and the UK. Its goals include assessing the social impact of research and providing granting bodies with diverse data on the effectiveness of their activities (Molas-Gallart & Tang, 2011; Spaapen & van Drooge, 2011). Innovative online resources are also growing. Examples include: Metrics from Scholarly Usage of Resources (MESUR), Standardised Usage Statistics Harvesting Initiative (SUSHI), Shared E-Resource Understanding (SERU) and Counting Online Usage of NeTworked Electronic Resources (COUNTER) (Pesch, 2011). These suggestions are difficult and possibly expensive (B R Martin, 2011), but the alternative is a simplistic, restricted assessment of the value of research to the community (Lane, 2010; Lane & Bertuzzi, 2011).

Assessment

While some assert that 'Writing highly cited articles is an important goal for scholars' (van Wesel *et al.*, 2014, p. 1602), aiming for a highly cited paper concentrates on an outcome, not the process of doing good research and disseminating the results. As Douglas (1992, p. 405) noted cynically: 'In any event, if you were to set out in cold blood to write a highly cited article, your best bet would be to devise or revise a paper-and-pencil test of personality or motivation, improve on a commonly used method, coin a snappy new word or phrase, or think of a new way to apply statistics.' With no intent at cynicism, van Wesel *et al.* (2014, p. 1612) advise: 'If scholars or their institutions want to contribute to scientific literature, and to be seen to contribute, and if they wish promote (sic) their individual and collective reputations in rankings and evaluations, they need to be aware of how the invisible hand in science works, and how it can be influenced. Form and style also influence how well individual scholars and their institutions fare in the global competition that scientific publication has become.'

Such an outcome-driven approach reduces research diversity, encourages selfish behaviour or even misconduct, conflicts with empirical evidence about what practices are most likely to lead to a strong and lasting influence and might hamper the uptake of innovative new methods of assessing the significance of research, especially efforts to assess social impact. It leads to complaints that '... dodgy evaluation criteria such as impact factors and citations are dominating minds, distorting behaviour and determining careers' (Lawrence, 2007, p. R583) and that research rankings based partly on citations are '... causing biomedical scientists to focus more on their careers and less on understanding nature and disease' (Lawrence 2002, p. 835). Valuable points about style and crafting a paper can be taken from advice on writing highly cited work (Pyke, 2013; 2014; van Wesel *et al.* 2014), but there are dangers in moving beyond that to selection of research topics on the basis of citation potential. Surely, one should advise authors to aspire to influencing their discipline through quality work rather than writing a highly cited paper – with all the uncertainty about what a highly cited paper actually means.

Research administrators might also consider the advantages of more broad-based methods of research assessment, heeding the call of 'The San Francisco Declaration on Research Assessment (DORA) (http://am.ascb.org/dora/) to '... consider the value and impact of all research outputs (including datasets and software) in addition to research publications, and consider a broad range of impact measures including qualitative indicators of research impact, such as influence on policy and practice.' Such a focus on the broad impacts of research would assist authors in shifting their emphasis from the 'hot topics' that feed citation hunger to a wider range of problems of social, political and environmental relevance.

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Appendix 1. Criticisms of citation analysis taken from MacRoberts and MacRoberts (1996), together with responses in bibliometric research.

Criticism	*Response*
Authors do not cite all their influences	The criticism that authors cite only a fraction of their influences in their papers remains unanswered, while the range of reasons other than influence for choosing a citation is growing. These include, amongst others, availability (Harnad *et al.*, 2004), personal contacts (White, 2001), and a preference for secondary sources (MacRoberts and MacRoberts, 1996).
Citations are biased	It is acknowledged that, for a range of reasons, authors cite selectively, introducing bias (Song et al., 2010). The possibility of replacing citations selected by authors with others based on electronic assessment of publication similarity ('virtual scientometry') is possible but challenging (Amancio *et al.*, 2012).
Secondary sources are preferred	Reviews attract disproportionately high citations (Davis et al., 2008; Davis, 2009, Teixeira et al., 2013), so the reviewer takes credit really due to the authors of the primary papers. The trend for reviews to receive disproportionately more citations is so well established that it is controlled in citation-based studies (e.g. Calver and Bradley 2010).
Informal influences are uncited	Informal influences may be noted in acknowledgements or 'personal communications' but not a full citation, which means that they earn no credit.
Citer motivation is unknown	It is recognised that citation is not simply an acknowledgement of credit – many factors influence the choice of citations in a paper. Journal restrictions on the number of citations allowed in a paper is one good example! Another is the pressure editors may place on authors to cite papers from particular journals (Yu *et al.*, 2014).
Citation rates vary between disciplines	There has been much work on addressing this, particularly in relation to journals, through indices such as SJR[1] and SNIP[2]. Nevertheless, fine-scale differences in citations can exist between sub-fields (e.g. the higher citations for basic medical research as opposed to clinical medical research – Opthof, 2011; van Eck *et al.*, 2013, or variations in citation rates across subdisciplines in mathematics – Smolinsky and Lercher, 2012).
Self-citation	This is recognised as excessive (Aksnes, 2003), with options to exclude it provided in some databases.
Audiences vary between disciplines, but are generally unknown	There has been much work on addressing this, particularly in relation to journals, through indices such as SJR[1] and SNIP[2].
Some sources are traditionally not cited	It is acknowledged that some types of information are traditionally uncited (for example, floras) (MacRoberts and MacRoberts, 2010).
Ignorance of the literature	It is acknowledged that the literature in many fields is so vast that an exhaustive review cannot be undertaken, so relevant papers may be missed from ignorance.
Data are biased	Bibliometricians acknowledge that databases are selective, so citation performance may vary depending on the one used (Jacsó, 2008).
Databases have technical problems	Despite the best efforts, there are errors in databases (Leydesdorff, 2007). Bibliometricians offer advice on tracking down orphan references (references with no master records in a database) and stray references (that cannot be linked to the master record in the database because of errors by the citing authors), but such errors may exert an unknown influence on citation analyses (Jacsó, 2008).

1 SCImago Journal Rank (see Colledge et al. 2010 for further explanation)

2 Source Normalised Impact per Paper (see Colledge et al. 2010 for further explanation)