



Authorship order

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Abstract

Considering the fact that authorship order plays such a significant role as a basis for scientific merit, this paper looks into the practices of authorship order from a research ethical perspective. We conclude that there is a wide variety of practices and no common understanding of what the different authorship positions signify. Authorship guidelines do not provide much help. We recognize that, regardless of what system for valuing authorship positions is used, it will be misleading and unfair in most applications because relative contributions vary in ways that are not captured by fixed value assignments to authorship positions. In theory, assigning percentage figures reflecting the relative contributions of the authors would solve that problem, but we argue that such a scheme is not likely to work in practice. It can also be questioned whether relative, rather than absolute, contributions should be the basis for scientific merit. Contributorship is discussed as an alternative, but is recognized to be insufficient both in communicating absolute and relative contributions, as standardly used. However, there may be a way forward with contributorship, but then, the level of detail needs to increase considerably and its application be standardized.

INTRODUCTION

Publications in scientific journals play a central role in the communication of research. Publications also inform about who contributed to the research through the notion of 'authorship'. They are, therefore, central to a researcher's curriculum vitae (CV) as an indication of scientific achievement. However, authorship is not the only thing that matters in the CV – authorship order is another aspect of considerable significance to academic merit in many contexts. For instance, a certain number of first or last authorship positions on peer reviewed papers may be required in order to qualify for certain academic positions. In a survey to people who had recently defended their doctoral thesis in medicine, 61% responded that they regarded the handling of authorship order as 'very important', while 36% regarded it 'quite important'. Those who were more dependent career wise on their publications tended to care more about how authorship order

was handled (Helgesson, Juth, Schneider, Lövttrup, & Lynøe, 2018). This importance of the authorship position is acknowledged mainly because it signals the author's relative contribution to the work leading up to the paper (Tscharnkte, Hochberg, Rand, Resh, & Krauss, 2007; Wren *et al.*, 2007), a matter that may be genuinely difficult to settle as illustrated by this example: 'Which was the more important contribution: the construction of the apparatus, the Terabyte database software, the time-series analysis, the detection efficiency determination, the comparison with models or the actual drafting of the paper?' (Stubbs, 1997). Hence, it should come as no surprise that there may be considerable disagreement regarding this issue (Ilakovac, Fister, Marusic, & Marusic, 2007). In the era of 'publish or perish', researchers are, thus, not only struggling for co-authorships but also for good authorship positions on the papers they are co-authoring.

For an academic merit system to be workable and transparent, some clarity is needed regarding the meaning of different

Key points

- Authorship order is important as a basis for scientific merit, yet there is no common understanding of what different authorship positions signify.
- Regardless of what fixed values authorship positions are assigned, they will be misleading and unfair in many real-life cases.
- Assigning percentage contribution to recognize authors has been suggested, but this is not a feasible option for several reasons.
- Contributorship may be a solution to recognizing and rewarding authors, but it needs greater detail and standardization to be useful.
- The interest in authorship order illustrates how competitive and individualistic research has become.

authorship positions on a paper and how they are valued. In this paper, we will discuss the meaning and value of different authorship positions in various research practices and what would be a transparent and fair system to allocate authorship positions to participating researchers.

In what follows, we will argue that, regardless of what fixed values are attached to the different authorship positions, this will, in most cases, end up being misleading and unfair. The theoretically most appealing option to ascribe relative contributions, using percentages, does not seem feasible in practice. We will further argue that scientific contributions can be described in a more direct way; however, this solution does not address the problem of describing relative contributions. Finally, we reflect more broadly on the present strong focus on individual scientific contributions to research.

A VARIETY OF PRACTICES

Authorship order in research papers is handled in a variety of ways, with notable differences between different disciplines and often also between various groups in the same discipline or faculty (Brand, Allen, Altman, Hlava, & Scott, 2015; Wager, 2007). In some academic fields, not least in the humanities, single authorship is still the most prominent practice. In that case, there is no need to consider authorship order. Single authorship usually appears in research areas where working alone is perceived as the default practice. This does not mean that research is carried out in total isolation. Rather, it means that receiving constructive comments from colleagues at various stages of the research process is not taken as a reason to include these commentators in the authorship list. Instead, they may receive an acknowledgment. This has, for instance, long been the practice in philosophy (Helgesson, 2011), in combination with the practice of writing a

monography for the PhD thesis. This tradition might seem entirely unproblematic from the perspective of authorship and authorship order, but that is correct only if no helping hand ever is unjustly denied a co-authorship based on substantial contributions (Helgesson, 2011).

As soon as there are research collaborations, the issue of how to order the authors arises (Zuckerman, 1968). Here, some fields, particularly economics, mathematics, and the social sciences (American Mathematical Society, 2004; Marušić, Bošnjak, & Jerončić, 2011; Waltman, 2012), have traditionally handled authorship order by putting names in alphabetical order based on the surnames. Usually, there is an implicit assumption that authorship position does not signify anything specific about the contribution as all authors contribute equally. It may also be perceived as too difficult, or pointless, to identify the contributions from different participants in tight collaborations where the different contributions are intertwined with those of others – for instance, in mathematics (American Mathematical Society, 2004). However, if there indeed is a perceived view in a specific case that the contributions were not equal, then with such practice, this has to be accounted for elsewhere as it cannot be accounted for by authorship order.

In medicine and the natural sciences, there are typically, although not always, several co-authors on papers. In some collaboration – for instance, in particle physics and genome sequencing – it can add up to considerable numbers (Castelvecchi, 2015; Venter *et al.*, 2001). In both medicine and the natural sciences, collaboration can take different forms, ranging from tight collaboration in fairly small groups to extensive collaboration including several research groups working apart, contributing with their special knowledge to a project headed, and quite often fully understood, by merely a subset of the total number of researchers involved. Here, it cannot always be assumed that all authors contribute equally, and therefore, the need is greater to identify the relative contributions. Often, special significance is attributed to the first and last positions (Walker, Sykes, Hemmelgarn, & Quan, 2010). When this is the case, there is a tendency to interpret the last position as being held by a senior author or supervisor (Marušić *et al.*, 2011). But this varies. In a *Nature* paper, it is suggested that ‘Biologists tend to place a supervisor or lab head last in an author list; organic chemists might put him or her first’ (Nature, 2006).

A ranking order of authorship positions used widely in medicine and the natural sciences is as follows, starting with the most important/valuable contribution and ending with the least: first, last, second, third, fourth, and the rest ending with second to last. However, this ranking of authorship positions is not systematically applied, not even in fields where researchers generally agree on the above significance of the order. Our own experience from many years of teaching and discussing with doctoral students, their supervisors, and researching colleagues is that large collaborations, such as large EU projects, are frequently mentioned as an exception. Here, positions at the beginning (say, the first two or three) and towards the end (say, the last two or three) may be considered the most important, while the bulk of middle positions

are taken to be of less relative significance, showing a more limited relative contribution (although it may still represent a considerable contribution). Others consider the first and the last position as particularly important while considering the remaining positions to signify an equal contribution, which is taken as a ground for listing them alphabetically. Sometimes, the last position is the least valuable, and sometimes, the next to last is thought to be the third best. In addition to these accounts, authorship order may also be interpreted in ways that do not relate to relative contributions, such as a top position of the paper (often the last) being reserved for some high-ranked member of the research group, department, university faculty, or the like (Strange, 2008).

Yet others do not think that authorship order communicates anything of importance and, rather, see the appointment of corresponding author as identifying the author who has given the greatest relative contribution to the paper. For others, being the corresponding author is work for the junior scientist in the group so that the others do not have to deal with the tedious administrative task of submitting the paper. Who is junior and senior can also be signified interchangeably by being put first, second, or last, depending on group traditions.

As these large variations exist in how to understand various authorship positions, a reader of a CV cannot be sure to make the right interpretation of the relative contributions in the listed papers exclusively based on the authorship positions (Kosmulski, 2012). To be sure what the authorship positions mean in different papers, additional information is needed, such as 'For this paper, being the outcome of a large EU collaboration, the second to last position is one of the most important positions of the paper, identifying one of the senior and leading researchers of the collaboration' or 'In this paper, my second to last authorship position is to be understood as identifying me as the author who has given the least significant contribution to the paper'. As such, information is lacking in scientific publications, Tschamtké *et al.* (2007) are correct when judging that the 'interpretation of author sequence can be like a lottery'.

VALUING RELATIVE CONTRIBUTIONS

It is one thing to rank different authorship positions (and assign them to the collaborators in relation to their relative contributions) and another to understand more specifically what relative values the different positions signify in relation to the overall contribution to the paper. Our experience is that the evaluation of a specific authorship position is perceived by most researchers as quite vague, and most researchers seem aware that the relative contributions may vary greatly between collaborations such that, sometimes, a few researchers contribute most of the input to a paper, while at other times, the burden might be more equally distributed.

A normative ambition with valuing scientific contributions in collaborations is that the contribution should be assigned a proportionate and fair share of the overall value of the publication.

What this amounts to may indeed be difficult to determine; for instance, amount of time put into the work would not be an adequate measuring rod as what matters is the work done and not the hours it takes doing it (the slower \neq the better). How to compare work with the conception and design of the study to carrying out interviews, analysing responses to questionnaires, or writing up the first version of the paper are examples of difficulties that need to be handled in order to be able to estimate the relative value of different contributions. Such problems, real as they might be, will be left aside here. In what follows, we will assume that such comparisons can, in fact, be made in order to focus on how they can best be expressed.

A general point to be made about valuing different contributions is that, to the extent that there is a specific understanding of the relative values tied to different authorship positions, this interpretation will, in most cases, be misleading when comparing it to what actually took place. For instance, say that most of the value is assigned to the first authorship position, while any other position is considered as far less valuable; based on the assumption that this reflects relative contributions, this idea of relative values will be fair only to the extent that the collaboration actually looked like that (i.e. the first author did most of the work, while the other co-authors contributed little), while it will be unfair and misleading in all other cases. To take a real-life example, the medical faculty of one university in Sweden has, in the context of bibliometric-based distribution of faculty funding, given the following specific interpretation of the various positions: the first authorship position is assigned 40% of the total value of the paper, and the last position is also assigned 40% of the total value, while the remaining positions of the paper is considered to make up the remaining 20%. That is, if five authors contribute to the work, their relative contributions will be valued 40, 6.7, 6.7, 6.7, and 40%. This is fine and well each time this valuation reflects the actual relative contributions and misleading and unfair in every other case. Consider a case where five authors have contributed almost equally, say 21, 20, 19, 19, and 21%. This will then be valued as 40, 6.7, 6.7, 6.7, and 40%, which seems highly questionable if the idea is to be valued in relation to relative contribution. Note that the point about the problem of attributing fixed values to authorship positions is general and not dependent on the peculiarities of our two examples – that is, for any fixed attribution of value to authorship positions, this will be misleading every time the actual relative contributions deviate from the fixed attribution. This does not mean that all fixed value attributions are equally (un)reasonable. Attributing fixed values of authorship positions as 35–10–10–10–35 (percentages) is probably more likely to be in line with actual cases of collaboration than, say, a 47–2–2–2–47 distribution (at least if the collaboration is voluntarily chosen by all parties).

A way to avoid the fixed values problem is to use the ranking of positions without specifying any further how contributions relate to each other. The downside of this solution is that it solves the problem by introducing obscurity.

As the first and last positions are often given special weight, disputes about authorship order usually concern these positions.

Shared first and shared last positions have become a way to solve some of these conflicts, especially when three or four researchers have made important contributions of more or less equal value and considerably more than remaining co-authors. (Note that there is a risk that this opportunity is exploited as a means to provide more collaborators with top merits instead of focusing on what is a fair distribution of scientific credit. If misused, it would mean a deflation of the value of the contributions of those who actually contributed more. We have seen a paper with six authors all claiming a kind of primary authorship, with three authors sharing first position, two sharing the last, and the sixth in the middle as the appointed corresponding author!)

WHAT DO AUTHORSHIP GUIDELINES SAY?

The most acknowledged international authorship guidelines, the Vancouver rules – or, more formally, the *Recommendations for the conduct, reporting, editing, and publication of scholarly work in medical journals* – issued by the International Committee of Medical Journal Editors (ICMJE), do not say anything about the attribution or interpretation of authorship order in their latest version (International Committee of Medical Journal Editors [ICMJE], 2017). Previously, the only comment regarding authorship order stated that 'The group should jointly make decisions about contributors/authors before submitting the manuscript for publication. The corresponding author/guarantor should be prepared to explain the presence and order of these individuals' (ICMJE, 2008).

There are similar statements from All European Academies (ALLEA) and the Council of Science Editors (CSE). The latter mentions that much 'has been written about the meaning of each place in the byline listing, particularly among the first 6 authors' but is content with stating that the 'order of authors in the byline is a collective decision of the authors or study group. Disagreements about author order should be resolved by the authors before the article is submitted for publication. [...] Authors should not expect editors to become embroiled in disputes among authors over name placement in the byline' (Council of Science Editors, 2012). Similarly, ALLEA writes that all authors should 'agree on the sequence of authorship, acknowledging that authorship itself is based on a significant contribution to the design of the research, relevant data collection, or the analysis or interpretation of the results' (All European Academies, 2017). In addition, the American Medical Association has issued guidelines. They describe how authorship order should reflect the relative contributions while adding that the last position may sometimes signify seniority (American Medical Association, 2007).

To summarize, no specific guidance is given in these guidelines as to how authorship order ought to be handled. Considering its career importance, and therefore its potential for disagreements within research groups, it could be argued that this silence in research ethical guidelines on how to handle authorship order is both remarkable and regrettable.

IS THERE A FAIR SOLUTION?

As noted above, the general flaw with fixed values on authorship positions is that the valuations will be incorrect in most cases. It therefore seems that the solution will have to involve a determination of the value of relative contributions that is not dependent on any fixed scales. This could be accomplished by adding further information about each author's relative contribution or by simply describing the input made.

Could precision be accomplished by percentages stating how much each author has contributed? On the face of it, this seems to be the most justifiable approach as each co-author would get exactly the credit he or she deserves instead of being assigned to some predefined category. However, such a model would not be particularly realistic in practice. First of all, and as mentioned above, it would, in most cases, be extremely difficult to determine the relative value of different contributions, especially when they are different in kind – as when comparing design work with data collection or data analysis (Stubbs, 1997). And should a greater responsibility in putting the paper together, being the corresponding author, or function as a 'guarantor' count at all, and if so, how much? In practice, it would be very difficult to determine what relative value to ascribe to each author's contribution, and it would most likely be the cause of endless disputes. The very human tendency to overestimate one's own contribution relative to others, sometimes called the Lake Wobegon effect – here meaning authors' proneness to report their own contributions as greater than they are – can contribute to this (Hornburg, 2018). If such self-serving bias occurs, which seems likely considering the many confirming experiments performed on the phenomenon (Dance, 2012; Hoorens, 1993; Myers, 2005), there would simply not be enough percentages available to accommodate the estimations made by each individual. There would be a considerable risk that researchers end up putting more effort into authorship disputes than into research with such a system to determine authorship order, which is why we disagree with this approach (suggested, e.g. by Clement, 2014; Tschamtké *et al.*, 2007; Verhagen, Wallace, Collins, & Scott, 2003).

There is also a more principal objection to the 'percentage solution', which is relevant to the other solutions discussed above as well, and that is that it can be questioned whether merit should be put in terms of *relative* contribution to papers at all. The obvious alternative would be to derive merit based on *absolute* contribution, regardless of how much everyone else contributed. With this idea, 20 hr of hard work in the lab would be valued the same in all papers instead of being valued differently depending on how much work the collaborators put in.

In the late 90s, an approach that would avoid valuing the contributions in relation to each other and expressing them by authorship order was suggested by several academic authors (Rennie, Yank, & Emanuel, 1997; Smith, 1997). Their solution was, instead, to just describe the contribution of each collaborator involved in the paper. Such an approach still finds support, and the so-called CRediT taxonomy has been worked out to assist in ascribing *contributorship* to researchers by specifying

kinds of contribution in quite some detail (Brand *et al.*, 2015), an initiative that has gained some ground (see <http://docs.casrai.org/CRediT>). Several journals have introduced the practice of asking the collaborators of submitted papers to specify their contributions to the paper, which increases the transparency of the collaboration. However, we have, so far, not seen any journal that has explicitly replaced authorship (and the associated possibility to put an emphasis on the order of authors) with contributorship. Not valuing relative contributions is still compatible with listing authors, of course, but that would mean, first, that a cut-off point for authorship is still maintained (unless all contributors are listed as authors) and, second, that authors need to be listed alphabetically to show that relative contributions have not been considered when ordering them (perhaps this also needs to be explicitly stated to avoid misinterpretation).

It can be argued that using contributorship and avoiding the problem with authorship order altogether is the right way to go. Arguably, the valuation of the different contributions can wait until it matters – for instance, when it is time to apply for a position or to have a research application evaluated. This may seem even more appealing when considering that the value of the contribution may vary depending on context. For example, anyone looking to hire someone to manage a lab would put more value on that kind of experience – and some contributions, important at the time they were made, might lose value, such as having carried out computer programming with what is now outdated software. It might be worth underlining that this exemplified way of valuing research contributions does not essentially concern the value of the contribution to the published research (as this value does not depend on events occurring after the research is performed) but, rather, the estimated future usefulness of being able to make such contributions. However, that is how merits are normally used (this is what makes them interesting to an evaluator), even when they are considered to reflect the value of the contribution to some effort of the past.

Contributorship as presently used does not, however, provide a solution to the problem of identifying and valuing either absolute or relative contribution. If three contributors are all described as ‘having participated in the design of the study’, they may, in fact, have pitched in very differently, varying from just suggesting a couple of useful ideas to spending much time and providing a lot of intellectual input drawing it all up. Consequently, contributorship, as most widely used presently, does not solve the very problem that gave rise to the practice of designating significance to authorship order (Sauermann & Haeussler, 2017); in fact, it even says very little about absolute contribution.

However, there is considerable room for improvement as the major present flaw is that the descriptions given in most cases are too uninformative. If some tool, such as the CRediT taxonomy (Brand *et al.*, 2015), would be more systematically used to help structure descriptions of contributions, the information contained in contributorship statements would increase considerably. Perhaps the CRediT taxonomy could be developed further, partly by adding to and further describing the

contribution types listed. Based on this point, adjustment to different research areas would be adequate; for instance, while programming, calibrating technical devices, and statistical analysis are highly relevant for some research areas, it is definitely not so for others. Perhaps another dimension should be added to the taxonomy as well, containing a description of the size of each contribution. It could, for instance, contain three levels, where the meaning of each level would be described in the taxonomy. Sufficiently developed, a structured system for describing contributorship could perhaps inform about both absolute and (indirectly) relative contributions to a reasonable degree, as suggested by Frische (2012).

CONCLUDING REMARKS

To summarize, authorship order on published papers plays a significant role as a basis for scientific merit. However, there is no common understanding of what the different authorship positions signify. Even within a research field, authorship positions may be assigned different values in different papers due to differences in the context of where the paper was produced. This means that a CV, in principle, may not be complete with merely a list of publications – a complementary explanatory list of the meaning of the authorship position in the different papers may be required in order for the reader to be able to interpret the authorship positions accurately. Authorship guidelines provide very little help when it comes to designating meaning and value to different authorship positions. A general problem of using authorship positions as a means of estimating relative contributions is that, regardless of what system for valuing authorship positions is used, it will be misleading and unfair in most applications because relative contributions vary in ways that are not captured by fixed value assignments to authorship positions. In theory, assigning percentage figures for each paper reflecting the relative contributions of the involved authors would be optimal in this regard, but such a scheme would fare much worse in practice both because of the inherent difficulties in assigning these percentages with the required precision and because there is a considerable risk that it would make way for much more infected disagreement over relative contributions than with present practices. It can also be questioned whether scientific merit should rest on relative contribution rather than on what they, in fact, have contributed. As we observed, contributorship is another way of communicating contribution to research studies, but it does not presently solve the problems of communicating the absolute or relative contributions of different authors. However, it can be made more useful by becoming more detailed and more systematically applied, for instance, by taking its starting point in some established taxonomy for describing different kinds of contributions.

At this point, we should perhaps take a step back and reflect on the further implications of making estimations of relative contributions of collaborating researchers. We have discussed the point of doing so but have, so far, said nothing about its

relevance to science, neither in terms of what it contributes to scientific progress nor in terms of what it does to the sense researchers might have of science as a collective endeavour. To focus on authorship order, as a reflection of relative contribution, is to take an individualistic and competitive outlook on science. Maybe we need more of a collective ethos as Robert Merton stressed long ago (1973) in his discussion of 'communalism'. Today, science has a strong individual component to it, but at the same time, there is a strong movement towards social accountability and making science with and for society (European Commission, 2018). It might, therefore, be timely to link the question of how to deal with authorship and contributorship to the present discussion of 'open science' and, again, stress the importance of collective endeavour, responsibility, and recognition for scientific papers. The wish to differentiate how much you and I contributed could then, ideally, be replaced by giving (more mature) prominence to our joint achievements and what they mean to science and society.

ABOUT THE AUTHORS

The authors have published several articles on research ethics in the last few years, including themes like plagiarism, predatory publishing, and authorship responsibility. They both contributed with ideas and to the writing and revision of this paper.

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