# **Title:** Nudging Scientific Advancement through Reviews

**Authors:** V. R. Posina[1], H. S. K. Nathan[2*], and A. Behera[3]

**Affiliations:**

[1]Independent Scientist, [2]Institute of Rural Management, Anand, Gujarat, India, [3]Conflict Resolution Programme, National Institute of Advanced Studies, Bengaluru, India.

*Correspondence to: Professor Hippu Salk Kristle Nathan, Institute of Rural Management Anand, Post Box No. 60, Anand – 388001, Gujarat, India. Email: hippu@irma.ac.in.

**Abstract:** We call for a change-of-attitude towards reviews of scientific literature. We begin with an acknowledgement of reviews as pathways for the advancement of our scientific understanding of reality. The significance of the scientific struggle propelling the putting together of pieces of knowledge into parts of a cohesive body of understanding is recognized, and yet undervalued, especially in empirical sciences. Here we propose a nudge, which is prefacing the insights gained in reviewing the literature with: 'Our review reveals' (or an equivalent phrase), that can bring about the desired cultural shift in the practice of science. The resulting elevation of the status of reviews to that of original findings would also bring about the desirable smoothening of the undesirable schism between theorists and experimentalists.

**One Sentence Summary:** Mandating 'Our review reveals' will elevate the status of reviews to that of original findings.

**Main Text:**

In predominantly empirical sciences such as neuroscience and economics, review articles are considered mostly secondary. They are treated as catalogues of original findings, but not original by themselves. There are a few deviations from this sort of blanket appraisal of reviews both across and within scientific fields, but those are more of an exception than rule. The contemporary scientific culture of "professional selfies" values titillating novel findings more than the intellectually painstaking organization of known information into a unitary big picture of the one reality that we are suspended in (*1*). This attitude towards reviews is fostered and sustained, in large part, by the frequent reactions of those who are well-versed with the literature that they rarely learn much from reading the reviews. The authors of the reviews also shy away from putting reviews at par with original articles, along with the scientific establishment at large. There can be two reasons for such a reaction: first, a review is a mere listing of findings; second, the preconceived 'lack of originality' notion with which one reads the reviews. Here we examine these two reasons, and propose a solution to move past the limitations constraining the realization of the full-potential of reviews.

We begin with a simple question: "Why reviews are never granted the stature of instruments of scientific advancement on par with, say, technologies such as functional magnetic resonance imaging or methods such as principal component analysis?" Is this designated place of reviews their actual space in the grand scheme of the pursuit of scientific understanding of reality? Questioned tersely: are reviews accorded their due value?

**Attributes of Good Reviews**

A review, in plain English, is a sensible and reasonable summation (abstraction) of a vast (wide and deep) experimental database, which brings all that was out of sight into the field of view. The whole is more than the sum of its parts. Two examples of this notion are electromagnetic theory in physics and category theory in mathematics (*2*, pp. 378-380). Review, or rather, a good review, is a summation via organization of discrete pieces of knowledge into a cohesive body of understanding (*3*). For example, in reviewing large volumes of experimental findings on neurological disorders, Lipton and Rosenberg (1994) showed that excitotoxity is the final common pathway of many neurological diseases (*4*); while Albright (2015), in reviewing the vast literature on the neural correlates of consciousness, showed that the transformation of sensory-based representations into scene-based representations is the core neural computation of consciousness (*5*).

Reviews are not only conducive for nurturing the universal yearning for comprehension, but also serve as signposts of major milestones in development of knowledge. For instance, Zheng (1997) in a comprehensive survey of aggregate poverty measures classified the measures as well as the desirable properties (that these measures should satisfy), and thereby provided the much needed framework for the analysis of poverty measurement (*6*). Good reviews are a steadfast commitment to unearthing the unity underlying diversity. A case in point is Ehresmann (1966) presenting mathematics as the abstract essence of knowing that unifies human thought (*7*).

Additional generic attributes of reviews embodying originality:

1. an integration of mutually contradictory findings into parts of a unified whole (**Fig. 1A**),

2. a particular organization of familiar findings endowing figural salience to an otherwise invisible unitary figure (**Fig. 1B**), or

3. an application of a concept bringing into sharp relief a hitherto unrecognizable object in a known data set (**Fig. 1C**).

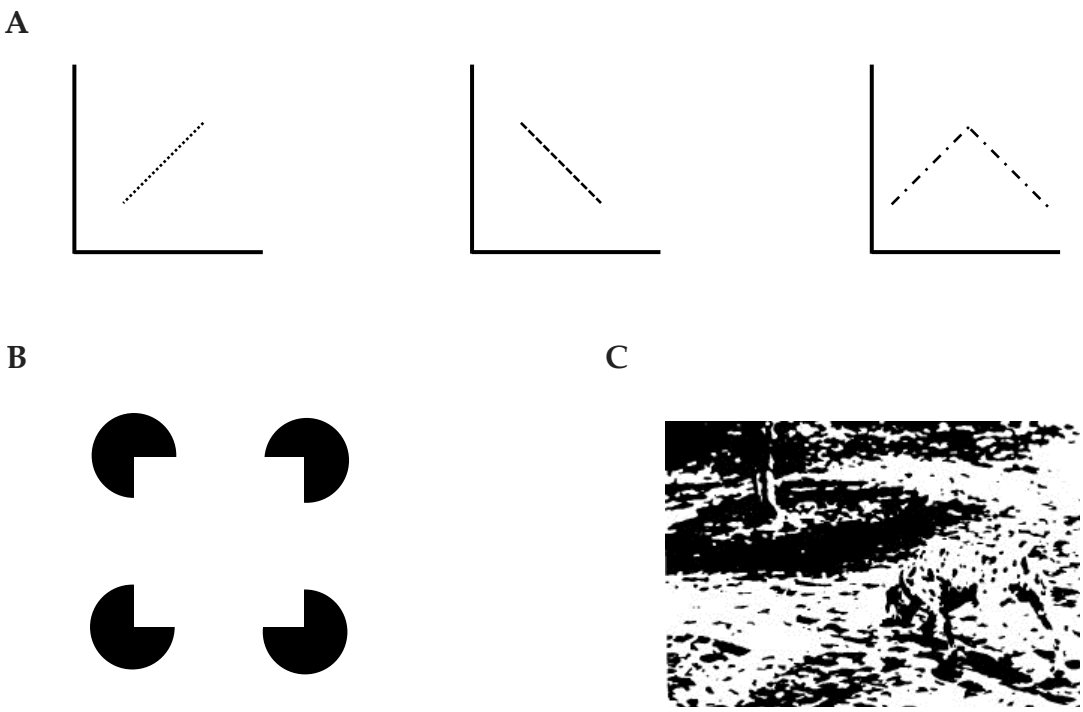


**Fig. 1. Illustration of the attributes of good reviews.** (**A**) A set of experiments show a directly proportional relation between two variables (Left panel), another set of observations might reveal an inversely proportional relationship between the same two variables (Middle panel). These seemingly contradictory findings can be seen as parts of a nonlinear dependence such as an inverted V-shaped function (Right panel). Examples include Kuznets (1955) inverted U

relationship between development and inequality (*8*), and the Environment Kuznets Curve (EKC) between development and pollution, where the trend is increasing at the initial stage of development and decreasing at a later stage of development (*9*). (**B**) A particular organization of four pac-man shapes endows enhanced brightness to a square, thereby making it visible as in the depicted Kanizsa square. (**C**) Black and white blobs of various shapes and sizes in the R. C. James image are recognized as a Dalmatian when viewed in light of a concept DOG.

Moreover, good reviews are depictions of interdisciplinary acumen of authors. See, for example, Sovacool's (2014) review of fifteen years of energy literature in the inaugural edition of Energy Research and Social Science (*10*). Quite aptly, the article appears in the journal under the category of Original Research Article. Real-world problems are often interdisciplinary. They exhibit dual, trial, or paucal characteristics which may be beyond the reach of any one individual scientist confined to a narrow research program. Reviews, because of their inherent mandate, have a fair chance of not missing different—often incoherent and conflicting—facets, even though some of these fall outside the comfort zone of the researcher. Review offers scope for viewing an issue through a kaleidoscope of multiple disciplines, where the disciplinary biases are relegated to a background. This makes reviews uniquely relevant for the advancement of science.

**The "Process" Disadvantage**

Reviews are commissioned, invariably. The practice of commissioning results in a situation where reviews are driven by news cycle and fame, along with the attendant negative effects on

the well-being of science (*11*). Overall, this cloak of invisibility puts reviews at a disadvantage compared to other research articles in the same way an indirectly elected parliamentarian would stand inferior against a direct representative of the people. So, the first and foremost way to provide a level playing field for reviews is not to distinguish them from other research articles, and allow them to pass through the same route of editorial selection and peer review. Similar welcome evolutions have taken place in other related contexts; for example, the policy change that allowed non-members to directly submit to the Proceedings of the National Academy of Sciences USA has been for the greater good of not only the journal but also the sciences.

**A Nudge**

How do we ensure that reviews are original and not mere listing of literature? The pressure to publish unleashes a flood of poor-quality reviews, which will only worsen the contemporary "senility" threatening science (*12*), unless the notion of REVIEW is well-defined, and appropriate quality control measures are put in place. Here comes the need for reformatting Review with a mandatory explicit statement: 'Our review reveals' or 'This article shows', prefacing and spelling out the novel insights gained in the course of reviewing. The researcher undertaking the review must be on the lookout for novel insights while organizing huge volumes of data, exploring the possibilities of applying different concepts, and observing from different perspectives. Adopting an equivalent phrase of 'This article shows', which is required of reports of novel experimental findings, as a norm for prefacing reviews also ensures the depiction of a complete picture of the novelty of good reviews while weeding out reviews that are mere listings of findings. Along with it, there is the attendant welcome elevation of the status of the reviews to original, which some of them rightly deserve.

To the extent reviews are the vehicles and pathways of the development of theory, such elevation of reviews would incentivize the experimentalists to theorize. Theories, as emphasized by Lawvere (2003), are the essences of practices abstracted, from a conscious participation in the practice, to guide ongoing practice (*13*). Recognizing that theorizing is not a spectator sport helps us appreciate that participating experimentalists are better situated to theorize. Thus, the proposed reformatting of Review serves its first objective by nudging researchers to undertake serious reviews that have the potential for path-breaking insights. For instance, reformatting of reviews would reward experimental neuroscientists (in their academic evaluations) for developing adequately explicit comprehensive theories of the workings of the brain that are rooted in the planned perception of reality (empirical findings; currently such theories reside in the ethereal realm of collective hopes and shared dreams of cognitive neuroscientists). Also, the proposed reformatting, in filtering out the not so serious mere literature listings, serves its second objective. On the whole, the review will get its due: its due in terms of the researchers' care and attention, and also from the viewpoint and respect of the readers.

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