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Articles

Use of peer review by the Australian Research Council

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Introduction

National bodies responsible for allocating funds for basic research differ in the manner in which they employ peer review (see Chubin & Hackett, 1990). Some funding agencies, such as the Research Councils in the United Kingdom and the National Institute of Health in the United States, establish expert panels for each of a large number of narrowly defined research specializations. Applications for funding within each specialization are reviewed only by panel members. Other agencies also employ a panel system, but decisions as to which applications will be funded typically are made only after the panel has considered evaluations provided by reviewers who are not members of the panel. The National Science Foundation in the United States and the Australian Research Council employ this latter approach, although in different ways.

This article is concerned with the place of peer review in the process by which the Australian Research Council (ARC) allocates funds under the Large Grants Scheme. Awards under the Australian Research Council Grants Scheme constitute the primary source of funding for basic research in Australia in disciplines other than medicine and dentistry (where the National Health and Medical Research Council is the responsible body). Policy directives for higher education issued by the Australian Government in 1988 (see Dawkins, 1988), including centralizing control through a process known as "clawback" over funds once distributed by universities, increased the influence of the ARC. In 1992 the ARC had a research funding budget of \$255.5 million, of which \$96.1 million were committed to research grants, \$55 million to postgraduate awards, \$51.6 million to research infrastructure, \$20.2 million to special research centres and key centres, and \$17.7 million to research fellowships. Although universities are responsible for awarding research funds under the Small Grant Scheme (\$15.7 million were distributed in 1992 to 1412 applicants, with a success rate of 33%), the primary allocation of the \$96.1 million is undertaken by ARC through the Large Grants Scheme. Only 19% of all applications for an initial Large Research Grant to commence in 1993 were successful, in comparison to success rates of 29% for 1992 and 31% for 1991. This circumstance arose because the number of applications for initial support increased sharply at a time when funding overall remained stable and the ARC was committed to provide continuing support for projects funded in earlier years.

An investigator seeking a Large Research Grant lodges an application which is evaluated by a discipline panel or a priority panel established by ARC. Under the present system each application that survives initial culling is sent by the panel to four assessors for evaluation. As well as having access to such peer review, the panel invites the 40% of applicants surviving the second culling to comment on assessors' reports before deciding which projects should be funded. Wilson (1990), when chairperson of the Research Grants Committee, the body within the ARC responsible for funding under the Large Research Grants Scheme, noted, "The considerable increase in competition for research funding by Australian academics means it is now even more important that the allocation of

research grants by the Australian Research Council is both fair and seen to be fair" (p. 16). Supplementing expert opinion obtained through peer review with feedback from applicants might seem to provide panel members with the information needed to allow applications to be assessed strictly on the basis of merit. However, there are complex issues relating to peer review and decision making by panel members that need to be examined in considering how Large Research Grants are allocated by the ARC.

The questions of particular concern are first whether peer review as employed by the ARC is as fair, valid, and reliable as it might be, and second what the nature of decision making by panels is. Although some of these issues have been a matter for discussion within the ARC, there has not yet been independent investigation of the manner in which the ARC operates. My objective is to discuss questions bearing on the validity and reliability of evaluation of grant applications by the ARC with reference to literature on peer review and how granting agencies with a panel system of the type employed by the ARC operate. As an initial step, however, the procedures that the ARC follows need to be outlined.

The Large Grant Scheme

Individuals as well as research teams can apply for ARC funding. The following outline refers to practices the ARC will adopt in evaluating applications for support in 1995 under the Large Research Grants Scheme (see Australian Research Council, 1993). Applications close on 28 February 1994. On the basis of previous years, 2500-3000 applications are likely to be received. Each application will be processed by one of nine discipline panels (Biological Sciences - Molecular, Biological Sciences - Plant/Animal, Chemical Sciences, Earth Sciences, Engineering Sciences - 1, Engineering Sciences - 2, Physical Sciences, Humanities, Social Sciences) or by one of five priority panels (Materials science and mineral processing, Cognitive science, Biology of sustainability, Citizenship, Australia's Asian context). The panels will reject 30% of applications in April 1994 without calling for reports from external assessors, and a further 30% in July 1994 after reports have been obtained from external assessors. The assessors will typically include at least one person from among the three nominated by the applicant as qualified to evaluate the project. The 40% of applicants who remain in July after the second culling will be allowed to provide the panel with a one page comment on the assessors' reports. In September 1994 each panel will generate a rank ordering of all applications still under consideration, and assign a score to each application. Lists prepared by the discipline panels and the priority panels will go to the Research Grants Committee (a constituent committee of the ARC), which provides advice to the ARC. Recommendations are then forwarded to the Minister for Higher Education and Employment Services. Only 19% of initial projects to commence in 1993 and 22% of those to commence in 1994 received funding, and in many of these cases the level of support was below that sought by the applicant.

In 1993 each assessor approached by the ARC to evaluate an application for a Large Research Grant was requested to report on "the quality of the researcher or research group" and "the excellence of the proposed research, and the likelihood that it will lead to a significant conceptual advance; and/or an important discovery or innovation or to the solution of an important practical problem; and/or economic or social benefit for Australia". Additional criteria specified for priority areas were "the intrinsic merit of the proposal", "the probable impact of a successful outcome for the research", "the extent to which the research will lead to collaboration between institutions, or groups within institutions", and "the commercial potential or utility of the proposal". In addition to providing comments on the application, an assessor had to identify the "relative ranking of the project and the chief investigators in the international community of scholars working in this field" on seven-point scales ranging from "bottom 50%" to "top 2%". Assessors also rated the project on six dimensions (originality of the research; soundness of planning and methodology; scientific/theoretical merit; technological/applied merit, if relevant; feasibility of project; track record of the applicant) using a six-point scale ranging from "deficient" to "outstanding". Assessors were also requested to comment on progress to date, as detailed in the application, and to identify questions which the ARC should raise with the applicant.

It seems appropriate that ARC panels should obtain peer review of applications, since panel members often have to make decisions about projects in research areas where they themselves lack expert knowledge. However, several issues relating to peer review need to be considered. These relate to the selection of assessors by ARC panels, the level of expertise of assessors, the extent to which there is agreement between assessors who evaluate the same application, and the use that ARC panels make of the information they obtain from assessors.

Validity and reliability of peer review

A recent survey identified concerns about the expertise and appropriateness of assessors chosen by ARC panels. Wood, Meek, and Harman (1992) asked a sample of applicants who had not been funded by the ARC to comment on different aspects of the grant review process. Although most respondents favoured peer review as a process, many expressed concern about the quality of the reviews their application had received, the extent to which assessors chosen by ARC seemed to lack expert knowledge, and inconsistency in the evaluations offered by different assessors. The survey undertaken by Wood et al. was limited to unsuccessful applicants. Two studies (one concerned with the National Science Foundation and the other the National Cancer Institute) that took outcome into account found that successful applicants were more positive than unsuccessful applicants about the validity of evaluation, including peer review (see Chubin & Hackett, 1990). Applicants who were funded by the ARC are thus probably more likely than applicants who were not funded to claim that the peer review system as employed by the ARC yields expert appraisal of applications.

The Australian Research Council has a moral responsibility to ensure that all applications are subject to expert evaluation. To date the ARC has not demonstrated accountability on this matter. It is impossible to establish from the public record how ARC panels select assessors to evaluate applications, and whether there are internal checks and balances to ensure that an assessor is expert, not open to bias (positive or negative) as a result of prior association with the applicant, and free from conflict of interest (such as through also being an applicant for ARC funding). The appeal process introduced by the ARC in 1992 explicitly excludes appeals "... against the peer review process itself, or of the judged merit of the proposal" (*ARC News*, 1992, p. 4), as though issues such as the expertise or competence of the assessors selected by the ARC or the ARC panel is beyond question. Instead, "An applicant should appeal only when there is clear evidence that the selection procedures followed have contravened the Program Guidelines" (Australian Research Council, 1993, p. 24).

The unsuccessful ARC applicants surveyed by Wood et al. (1992) sometimes made reference to "luck of the draw", as though the selection of other assessors would have yielded a different outcome. There is now an extensive literature, covering review of manuscripts submitted to journals as well as evaluation of applications for research funding, demonstrating that assessors who are asked to evaluate the same material often disagree in the ratings they provide (see Cicchetti, 1991). Although the basis for limited consensus in evaluation may be that the assessors differ in expertise, in diligence in undertaking the task of assessment, or in the standards they employ, an alternative is that assessors evaluate the same material validly but on quite different bases. Fiske and Fogg (1990) undertook a content analysis of narratives provided by reviewers who evaluated manuscripts submitted to major psychology journals. They concluded, "In the typical case, two reviews of the same paper had no critical point in common. It seemed that reviewers did not overtly disagree on particular points; instead they wrote about different topics, each making points that were appropriate and accurate. As a consequence, their recommendations about editorial decisions showed hardly any agreement" (p. 591).

Cole, Cole, and Simon (1981) provided a compelling demonstration of the importance of selection of assessors. They submitted 150 applications (75 of which had been funded by NSF and 75 not funded by NSF) to assessors (12 each application) who were expert in the field of the research but had not been involved in the original evaluation. Many of the applications that had not been funded by NSF were rated more highly on this second round of assessment than those that had been funded. If support by NSF were dependent solely on ratings provided by assessors, Cole et al. estimated that outcomes would have been reversed in 25% of cases. Since most ARC applications are reviewed by only four assessors, "luck of the draw" in the selection of assessors may be a substantial factor in outcome.

It is a simple matter to determine the extent to which assessors evaluating the same application (or the same investigator) agree in the ratings they provide. Although such statistics have been calculated by ARC, they are never made public. It would be surprising if the consensus among assessors of ARC applications is higher than the low level of agreement reported for peer review in many studies in the literature (see Cicchetti, 1991). Since assessors of research applications and manuscripts submitted to journals generally demonstrate higher agreement in providing negative than positive evaluation (see Cicchetti, 1991), numerical ratings obtained through peer review may provide a reliable basis for ARC panels to identify projects that are well below the cut-off point. A number of applications culled by mid-year as not meriting support probably would have received low ratings even if they had been sent for evaluation to persons other than the assessors selected by the ARC. However, the extent to which peer review provides a basis for selecting among applications that survive culling is questionable.

Since attenuation in range lowers consensus in evaluation (see Hargens & Herting, 1990), it is unlikely that there would be even moderate agreement between assessors among the 40% or so of ARC applications that remain following the initial and mid-year cull. These presumably all were applications that attracted strong support from at least some assessors. The task of panels is to rate the non-culled applications so that these applications can be ranked in the order in which they merit funding. As noted earlier, only 19% of applications were funded for 1993 and 22% for 1994. If the ranking of applications (and hence funding decisions) corresponded to the average of the ratings provided by assessors, the question of selection of assessors would be of vital importance. Following Cole, Cole, and Simon (1981), it might be expected that the average of the ratings provided by the assessors of a non-culled project would change (and in some cases markedly) if a different set of persons were recruited as assessors.

If ARC panels relied simply on the average of ratings provided by the four assessors to whom an application is sent, it is likely that many worthy projects would not be supported while a number of

projects of lesser merit would be funded. There would be a substantial chance component in whether an application is funded. As noted by Stinchcombe and Ofshe (1967) in relation to editorial decisions, under circumstances where there is a low overall success rate, limited agreement between assessors, and decisions reflect the average of assessors' ratings "... it does not take a conspiracy theory of journal editing to account for the rejection of a great many good papers and the publishing of a large number of mediocre papers" (p. 117). However, ARC panels do not reach decisions about which projects to fund by averaging the ratings assessors provide for each application. Instead "... Panels must rate applications in relation to one another, which assessors cannot do because they see one or, at most, a few proposals. So Panel ratings often differ from the assessor average; occasionally they may be lower, or higher, than any of the assessors" (ARC News, 1993, p.4).

The decision making process

The processes underlying funding decisions by National Science Foundation (NSF) panels have been subjected to independent scrutiny. Cole and Cole (1981) found that although for some disciplines there was a close association between whether a project was funded and the average of the ratings provided for the project by assessors, funding decisions in other disciplines were not strongly related to the evaluations given by assessors. Panels thus decided to fund some projects that assessors had not supported strongly, while other projects that were evaluated in favourable terms by assessors were not funded.

Klahr (1985) examined the relative influence of evaluations provided by panel members and assessors on outcome through statistical analysis based on how 200 NSF applications in a single discipline (psychology) were processed. The decision making process required panel members to rank applications twice, once before assessors' ratings and reports were available and then after access to assessors' ratings and reports. Klahr found that assessors overall were lenient in the sense of favouring support at a level well above that which NSF was able to fund. In determining which projects to fund, the panel did not rely simply on the average of the assessor ratings provided for each project. In fact the average of assessor ratings correlated only .61 with outcome (whether or not a project was funded), and the average of assessor ratings provided only a minor contribution to outcome over and above the evaluations that the panel members had made before reading the assessors' reports. Klahr argued that the contribution of assessors comes from the qualitative (and expert) information they offer panel members, rather in the quantitative ratings they provide. He concluded, "The ad hoc reviewer's role should be construed more as expert testimony and less as judgment. Ad hoc reviewers should continue to be instructed to comment on the strengths and weaknesses of proposals, but they should be informed that their final overall rating is not as important as their substantive comments" (Klahr, 1985, p. 153).

It would be interesting to know the correlation between the rank ordering of applications produced by each ARC panel and the ratings given to these applications by assessors. A high correlation would indicate that funding decisions closely follow ratings provided by assessors, with panel members having limited moderating influence on outcomes. However, a low or moderate correlation would suggest that evaluations by panel members have substantial impact on outcome over and above the ratings provided by assessors. Since panels have the right to disregard ratings provided by an assessor (see ARC News, 1993, p.4), the above correlations need to be calculated on the basis of the ratings that assessors did in fact provide.

The interview process employed prior to 1994 provides prima facie evidence that ARC panels treat assessors as expert witnesses rather than as judges. The task of an ARC panel is seen as not simply averaging assessors' ratings, but reaching an informed decision based on all relevant evidence including the ratings and qualitative comments provided by assessors. In operating on this basis the panel

can discount the opinion of assessors who are perceived as incompetent, uninformed, or biased, identify and resolve bases for differences in evaluation between assessors, and reconcile what at one level may seem to be inconsistent or unreliable evidence. A panel functioning in this way operates as jury and judge, with assessors treated as expert witnesses (or perhaps sometimes as hostile or incompetent witnesses).

Each ARC panel covers a range of disciplines. For example, in terms of disciplinary affiliation the 11 members of the Social Sciences and Humanities panel in 1992 included two from psychology and one from each of anthropology, classics, economics, education, English, geography, history, journalism, and law. It would be interesting to establish the extent to which matters such as selection of assessors and determining the final rating given to a project are arrived at by disciplinary representatives rather than by the ARC panel as a whole. In 1994 panels will have extended membership, although seemingly only for the initial culling at the April meeting (see Australian Research Council, 1993, p. 2).

If individual members play a major role in deciding which applications within their own discipline will be funded, the judgment and integrity of the persons appointed to panels is of primary importance. Members of ARC panels are appointed for three year terms, and typically serve for no more than six years continuously. Selection is by a committee within the ARC, but universities, industry, the national academies, and other organizations can provide nominations for vacant positions. The fact that panel members often themselves are applicants for an ARC grant, and hence competing for a share of the limited funds distributed by ARC, has been a matter of comment within the Australian academic community. However, the ARC employs procedures to ensure panel members are not involved in evaluation of their own applications (see Australian Research Council, 1993, pp. 24-25). It nevertheless would be interesting to compare the success rate of ARC panel members with the success rate of applicants in general. Such data have never been published.

Whereas ARC panels have access to peer review (although typically from far fewer assessors per application than is the case within NSF), there is no requirement that decisions about funding made by ARC panels reflect peer review. In contrast to independent scrutiny (e.g., Cole & Cole, 1981; Klahr, 1985) of the processes by which NSF panels reach funding decisions, the manner in which ARC panels operate has not been open to investigation. A useful first step in accountability would be for the ARC to publish each year statistics reporting not only the level of consensus between assessors who evaluated the same application, but the correlation between the rank ordering of applications by each ARC panel and the average of the ratings assessors provided for these applications. If funding decisions do not correlate highly with the average of assessor ratings, it would be incumbent upon the ARC to justify the processes it employs and to defend the expertise of the persons it selects as panel members. At present the ARC is subject to limited accountability.

Under the appeal mechanism introduced in 1991, unsuccessful applicants can appeal against decisions made by the ARC "... if they feel there were deficiencies in the procedures followed", but not on the basis of "... the peer review system itself, or of the judged merit of the proposal" (*ARC News*, 1992, p. 4). Since the ARC maintains a level of secrecy about its procedures, applicants generally lack the information needed to identify "deficiencies in the procedures followed". The only obvious grounds for appeal is that an application was culled without being sent to assessors for evaluation. Applicants in time receive assessors' reports (but are not given the names of assessors) as well as the rating given to their project by the panel. The appeal mechanism seemingly does not allow an unsuccessful applicant to challenge the expertise of the assessors appointed by the panel, or to question the use that the panel made of reports received from assessors. Further, more general questions relating to peer review, such as the level of consensus in ratings between assessors and the possibility that selecting persons other

than the assessors appointed by the panel would have produced a different outcome, cannot be raised. On the grounds of accountability, the ARC should provide more explicit guidelines on grounds and processes for appeal than it does at present.

It is only recently that the ARC has made serious efforts to evaluate the impact its funding decisions have had on research and scholarship in different disciplines. Retrospective reviews, covering a five year period, are being undertaken by experts within the discipline who themselves were not eligible for ARC support. Reviews have been completed in economics, British and European history, Australian history, genetics and evolution, igneous and metamorphic petrology and geochemistry, condensed matter physics, mathematics, and ecology, while reviews are either under way or planned in materials and chemical engineering, organic chemistry, fluid mechanics, molecular biology, experimental physics, and psychology. While such reviews are useful in identifying "hits" (projects that were funded with a successful outcome, as assessed by indicators such as publications and citations) and "false alarms" (funded projects that proved non-productive), the extent to which the ARC decision making processes resulted in "misses" (failure to fund projects that would have had a successful outcome) is difficult to establish. Simply comparing the productivity and impact of applicants supported by ARC with measures for those who were not supported does not address this question, since in many disciplines the ARC is the only source in Australia for funding basic research. Rejection of an application by the ARC often means that the project cannot proceed, even though the research may have had successful outcomes if it had been funded. The retrospective reviews being undertaken by the ARC need to focus not only on hits (successful outcomes), but on documentation of the consequences of failure to fund projects.

Further comments

As well as being valid, the procedures followed by the ARC in evaluating applications must be cost effective. In order to reduce administrative costs, the ARC in 1990 required each applicant to nominate two assessors, who provided reports directly to the ARC. This system operated for only one year, presumably because the evaluations that came from applicant-nominated assessors were generally too favourable and did not prove to be useful. Although applicants are now asked to provide a list of potential assessors, all persons requested to evaluate an application are selected by ARC panels. As a further experimental approach, the ARC in 1993 requested assessors not only to provide global evaluations, but to rate the project and the applicant in terms of specific criteria. Since there has been disagreement (see Gottfredson, 1978; Marsh & Ball, 1989) as to whether ratings of specific attributes offer a more effective basis for evaluation than global ratings, it is to be hoped that the ARC will analyse and publish the data it collected on this issue.

Other ARC procedures have changed over time. For several years all applications in plant molecular biology, gene regulation, animal hormones, and ecology were evaluated by small sub-panels without applicants being interviewed and without external peer review. Since a system of specialist sub-panels is a feasible alternative to multi-disciplinary panels (where many applications may lie outside the expertise of any panel member), it would be interesting to know whether the ARC has evaluated (on an effectiveness as well as cost basis) the use of specialist rather than generalist panels. Related questions, particularly when generalist panels are used, are whether it is preferable to rely on few assessors each rating many applications rather than many assessors each rating few applications and whether assessors should be given some training in order to foster standardisation in evaluation. However, there is a limit to the demands the ARC can place on assessors, who serve without payment (they once received an honorarium).

The ARC and its predecessor, the Australian Research Grants Council, employed for many years a costly system of interviews. In

1992, for example, almost 800 ARC applicants were interviewed in nine cities. Although the seeming objective was to allow ARC panel members to explore issues raised by assessors, applicants could not respond directly to comments made by assessors, since it was only after funding decisions had been made that assessor reports were released to applicants. At least to applicants, interviews often seemed like a "fishing expedition". In view of research on the extent to which expectations and irrelevant information can bias impressions and distort judgments (see Millar, Crute, & Hargie, 1992), it is disappointing that the extent interviews influenced ARC funding decisions was never subjected to scrutiny. In 1994 the ARC, for the first time, will not interview applicants. Instead the 40% of applicants surviving the July cull will be sent assessors' reports, and be able to provide the panel with a one-page response. This process, which does not extend the review period and is much more cost effective than interviews, will permit applicants to respond to assessors in a more informed and considered manner than they could through the interview system. Further, by receiving a written response from an applicant, the ARC panel is likely to be more informed as to whether it should obtain additional expert opinion.

The changes in the Australian higher education system that led to "clawback" and greater central control over the allocation of research funds are unlikely to be reversed. Although a substantial proportion of all basic research in Australia is undertaken within universities, these institutions themselves are unlikely to gain the level of control over the distribution of funds that they once had. One means of indirect influence is by encouraging academics to seek grants. In commenting on funding under the ARC Large Grant Scheme, Brennan, the ARC chair, argued that the 19% success rate for funding under the Large Grants Scheme in 1993 reflected excessive demand for support rather than an inadequate level of funding ("the current level of government supported activity in basic research in Australian universities is about average for the middle sized OECD countries") (*ARC News*, 1992, No. 4, p. 1). Brennan's claim is that ARC Large Grant Scheme applications rose dramatically because of the emphasis placed on research funding as a performance indicator, and an index of prestige, within the National Unified System. In commenting on replacement of the binary system (where universities were funded for research but colleges of advanced education were not) by the National Unified System, Meek (1991) suggested, "There is a mystique attached to the very name 'researcher', and to be denied access to the title will lead to two classes of institutions and two classes of academics within institutions: researcher and non-researcher, with status, prestige, and wealth allocated accordingly....If status, wealth, and prestige are directly linked with research, with little or no avenue to gain an advantageous position in the hierarchy without a research function, then the result probably will be rampant institutional imitation" (p. 477). Since applications for funding under the ARC Large Grants Scheme increased by 18% in each of 1991 and 1992, such seems to have been the case.

Brennan, writing in his capacity as ARC chair, argued not that more funds need to be available for basic research, but that the demand for support through the ARC Large Grants Scheme needs to be dampened ("one must ask whether steps are needed to avoid further increases in demand for ARC funds") (*ARC News*, 1992, No. 4, p. 2). It will be interesting to establish the longer-term effects of the recent ARC rejection rates. The outcomes of interest are not only the number and nature of applications in the future but the effects that failure to receive ARC support will have on the morale and productivity of academics, many of whom have a record of research achievement. A critical issue is whether, in deciding which applicants to support at a time where the demand for funds grossly exceeded the supply, the ARC panels made the best possible decisions. An underlying question is whether the processes employed by the ARC are those likely to distribute research funds with most effect.

Conclusions

Although ARC panel members who decide which applications under the Large Grants Scheme will be funded have access to peer review, the extent to which funding by the ARC reflects peer review is uncertain. It is difficult to find information on how ARC panels operate, let alone obtain statistics. Public debate on the processes by which the ARC distributes research funds has been restricted by limited access to information. My primary objective in preparing this article is to urge the ARC to publish a detailed outline of how ARC panels operate at different stages in the decision making process (e. g., selection of assessors, culling, use of assessors' reports, ranking of applications). Further, since the data are routinely coded for computer entry and analysis, it would be a simple matter for the ARC to publish each year statistics bearing on peer review (e. g., level of consensus between assessors in different disciplines) and decisions made by panels (e. g., level of agreement with peer review).

Placing information of the above kind within the public domain (in the past it has been collected, but distributed only within the ARC) will allow informed debate about the processes adopted by the ARC. Further, the ARC will be subjected to demands for accountability that do not apply at present. For example, if it turns out that funding decisions correspond with evaluations provided by assessors, issues such as the selection of assessors and the criteria assessors employ in evaluating applications are of vital importance. Attention would instead focus on the selection of panel members and the manner in which they operate if it is shown through statistical analysis that members of ARC panels have substantial independent influence on funding decisions. The processes employed by the ARC have not been open to external scrutiny, and the ARC has never been required to justify the procedures it follows. In the spirit of accountability, the ARC should accept responsibility for providing the information needed to permit informed evaluation of its processes and effectiveness.

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