2016

National Institutes of Health Director's New Innovator Award Outcomes Evaluation

FISCAL YEARS 2007-2009

OVERALL SUMMARY BY THE NIH

REPORTS BY THE SCIENCE & TECHNOLOGY POLICY INSTITUTE

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Overall Summary of the NIH Director's New Innovator Award Evaluation by the NIH

The NIH Director's New Innovator (NI) Award program was created in 2007 to support exceptionally creative early career stage investigators who propose unusually bold research with the potential for broad impact. Early career stage investigators are defined as those within ten years of receipt of their terminal research degree or completion of clinical residency and who have not yet received substantial NIH funding. The NI Award program complements other NIH efforts to support early career stage investigators by focusing on high-risk high-reward research conducted by unusually promising investigators. It is one of the four initiatives that constitute the NIH Common Fund High-Risk High-Reward (HRHR) Program.

In September 2014, NIH commissioned the Science and Technology Policy Institute (STPI) of the Institute for Defense Analysis to undertake an independent evaluation of the outcomes of NI Awards since by that time the first three cohorts of awardees had completed their five-year project periods. The two major areas of interest for NIH in the evaluation were whether the NI Award program was achieving its intended objective of fostering HRHR research and whether the NI Award program was jeopardizing the awardees' careers by encouraging them to pursue risky projects at a particularly vulnerable stage in their careers. The two key study questions thus were articulated as: 1) *Is the NI research significantly more innovative, high risk, or impactful than traditionally funded NIH research?* and 2) *What are the impacts, both positive and negative, of NI awards on the careers of awardees compared to the career impacts of a comparable traditional NIH award?*

STPI approached these two key questions using comparison groups and a mixed-mode method of analysis. To address the first key question, a matched set of early career stage investigator R01 awardees ("ESI R01 awardees") was assembled. The ESI R01 awardee comparison group was generated by first starting with the set of all ESI R01 awardees who received their R01s in 2007–2009. Each of the New Innovator Awardees was matched to one of the ESI R01 awardees in this set based on degree type, year of award, area of research, publication frequency prior to award, gender, and institution type. The matched ESI R01 awardee group was then used as a comparison group for conducting the bibliometric analyses, awardee surveys, case-study interviews, and senior scientist reviews of research publications. To address the second key question, the set of investigators who fared well in the review of their NI Award applications but did not receive the award (the "Finalists") was used as an additional comparison group, along with the ESI R01 Awardees. Comparisons were made using awardee/finalist surveys, case-study interviews with selected awardees, subsequent funding analyses, and bibliometric analyses. STPI reported the comparison evaluation with the ESI R01 awardees and comparison evaluation with the Finalists separately. This summary is being provided by NIH to integrate the findings from both reports. All charts in this summary are adapted from those presented in the evaluation reports. Readers are encouraged to consult the full reports for details.

Summary of findings pertaining to key study question 1: *Is the NI research significantly more innovative, high risk, or impactful than traditionally funded NIH research?*

For this key study question, the ESI R01 awardees were used as the comparison group.

Bibliometric analyses: Only publications supported by the awards were considered in this analysis. The NI Awardees scored higher in bibliometric measures associated with impact *per* publication and lower in publication numbers and publication rate (Table 1). The lower publication numbers and rates for NI awardees may be due in part to research projects that were less developed and with less supporting data at the time of application than was with case with ESI R01 Award applications.

Table 1. Comparison of bibliometric indicators

Bibliometric indicator	NI Awardees compared with ESI R01 Awardees
Average Citations per Publication	NI awardees > ESI R01
IPP (Journal impact factor)	NI awardees > ESI R01
RCR (Relative Citation Ratio)	NI awardees > ESI R01
SNIP (Journal Source-Normalized Impact per Paper)	NI awardees > ESI R01
SJR (SciImago Journal Rank)	NI awardees > ESI R01
H - Index	No statistically significant difference
Number of publications	ESI R01 awardees > NI awardees
Average annual publications	ESI R01 awardees > NI awardees
Time to first publication (Faster is greater)	ESI R01 awardees > NI awardees

Awardee surveys and expert analyses: Awardees were asked to assess the characteristics of their own funded research. In almost all aspects evaluated, NI Awardees more strongly characterized their own research to possess the attributes associated with innovative, risky, and impactful research than ESI R01 awardees characterized their own research to possess these attributes (Table 2). In addition, case studies were performed in which selected NI Awardees and ESI R01 Awardees were interviewed in a semi-structured format about the characteristics of their funded research and the effects of the award on their careers. The results are qualitative and overall are consistent with the other modes of analysis. Senior scientist subject matter experts were asked to evaluate awardee publication packets assigned to them. In almost all aspects, senior scientists more strongly characterized the publications of NI Awardees to possess the attributes of innovative and risky research than they did when characterizing the publications of ESI R01 Awardees (Table 2).

Table 2. Comparison of Senior Scientist Reviews and Awardee Survey Results

Survey Item	Senior Scientist Review	Awardee Survey
The research resulted in the formulation of a new idea	ESI R01 awardees > NI awardees	NI awardees > ESI R01
The research resulted in the discovery of a new phenomenon	NI awardees > ESI R01	NI awardees > ESI R01
The research resulted in new synthesis of disparate ideas	NI awardees > ESI R01	NI awardees > ESI R01
The research resulted in the advancement of a theoretical concept	NI awardees > ESI R01	NI awardees > ESI R01
The research resulted in the development of a new technology	NI awardees > ESI R01	No statistically significant difference
The research resulted in the development of a new methodology	NI awardees > ESI R01	No statistically significant difference
Research a significant departure from previous research	NA	NI awardees > ESI R01
Research required knowledge outside of field	NA	NI awardees > ESI R01
Research involved novel combination of ideas	NI awardees > ESI R01	NI awardees > ESI R01
Research at odds with prevailing thinking	No statistically significant difference	NI awardees > ESI R01
Research required novel technique or equipment	NI awardees > ESI R01	No statistically significant difference
The research combined fundamental principles, models, or experiments in novel ways	NI awardees > ESI R01	NA
The research pursued an approach that was contrary to the norm	NI awardees > ESI R01	NA
The research applied cutting-edge approaches	NI awardees > ESI R01	NA
The research will have a significant impact on the field	NI awardees > ESI R01	NA
The research was innovative	NI awardees > ESI R01	NA
The research cut across multiple disciplines	NI awardees > ESI R01	NA
The research introduced novel theoretical ideas	NI awardees > ESI R01	NA
The research introduced radically different tools	NI awardees > ESI R01	NA
The research will revolutionize the field	NI awardees > ESI R01	NA
The research was rigorous	ESI R01 awardees > NI awardees	NA

Summary of findings pertaining to key study question 2: *What are the impacts, both positive and negative, of NI awards on the careers of awardees compared to the career impacts of a comparable traditional NIH award?*

The ESI R01 Awardees and Finalists were used as the two comparison groups with the New Innovator Awardees. Career impacts were grouped into those affecting professional advancement, ability to obtain new funding, and publication records pre- and post-award.

Professional advancement: Indicators of professional advancement were research expansion, professional recognition, and employment status. In almost all indicators, no statistically significant differences were noted with either comparison group (Table 3). The only significant differences noted were in popular press coverage and percentage with tenure decision pending (with respect to ESI R01 Awardees) and journal cover features (with respect to Finalists).

Table 3. Comparison of professional development indicators

Indicators of professional development	NI Awardees compared with ESI R01 Awardees	NI Awardees compared with Finalists
Expanded to new disciplines	No statistically significant difference	No statistically significant difference
Expanded research lab	No statistically significant difference	No statistically significant difference
Formed new collaborations	No statistically significant difference	No statistically significant difference
Received honor/award	No statistically significant difference	No statistically significant difference
Popular press coverage	NI Awardees > comparison group	No statistically significant difference
Journal cover feature	No statistically significant difference	NI Awardees > comparison group
NIH study section regular reviewer	No statistically significant difference	No statistically significant difference
Received tenure	No statistically significant difference	No statistically significant difference
Applied for tenure (still pending)	NI Awardees > comparison group	NA

Ability to obtain new funding: NI Awardees were compared to ESI R01 Awardees and to Finalists in their record of applying for and obtaining additional NIH funding. Only the R01 award data are presented here since the R01 is the primary method for investigator-initiated NIH funding.

Compared with ESI R01 Awardees, NI Awardees submitted and received more Type 1 (new) R01 applications than did the ESI R01 Awardees, but submitted and received fewer Type 2 (continuing) R01 applications (Table 4). This is to be expected since NI Awards are not renewable and NI Awardees typically would submit a Type 1 R01 application to continue their research project; whereas, ESI R01 awardees typically would submit Type 2 R01 applications to continue their research project. If Type 1 R01 applications from NI Awardees are compared with Type 1 and Type 2 R01 applications from ESI R01

Awardees, then the two groups are similar in most respects. Compared with the Finalists, the NI Awardees are similar in most respects since most Finalists applied for Type 1 R01 awards after not receiving the NI Award.

Table 4. Comparison of R01 application and funding record subsequent to initial award/funding decision

Funding indicator	NI Awardees compared with ESI R01 Awardees R01 Type 1	NI Awardees compared with ESI R01 Awardees R01 Type 2	NI Awardees compared with ESI R01 Awardees NI R01 Type 1, ESI R01 Type 1&2	NI Awardees compared with Finalists R01 Type 1	NI Awardees compared with Finalists R01 Type 2	NI Awardees compared with Finalists NI R01 Type 1, Finalist R01 Type 1&2
Proportion of group applying	NI Awardees > comparison group	Comparison group > NI Awardees	No statistically significant difference	No statistically significant difference	Comparison group > NI Awardees	NI Awardees > comparison group
Median number of applications submitted	NI Awardees > comparison group	Comparison group > NI Awardees	NI Awardees > comparison group	No statistically significant difference	Comparison group > NI Awardees	No statistically significant difference
Percentage of applications awarded	NI Awardees > comparison group	No statistically significant difference	No statistically significant difference	No statistically significant difference	No statistically significant difference	No statistically significant difference
Median number of applications awarded	NI Awardees > comparison group	Comparison group > NI Awardees	No statistically significant difference	No statistically significant difference	No statistically significant difference	No statistically significant difference
Proportion of group funded	NI Awardees > comparison group	Comparison group > NI Awardees	No statistically significant difference	No statistically significant difference	No statistically significant difference	No statistically significant difference

Bibliometric record before and after award or funding decision: To glean insights into the overall bibliometric impact of funding, bibliometric indicators of NI Awardees were compared with ESI R01 Awardees and Finalists pre- and post-funding. “Pre- and post-funding” means pre- and post-*start of funding* for the NI Awardees and ESI R01 Awardees and means pre- and post-*decision not to fund* the NI Award application for the Finalists. To more accurately assess the impacts of funding, a shift of plus one year was added in demarcating the pre- and post-funding publication periods. Given the time it typically takes for a manuscript to be reviewed and published, publications in the first year of the award are considered to not have been supported by the NI Award or ESI R01

Award. A similar plus one year shift is applied to the Finalists so that the relative bibliometric indicators of this group can be better compared to that of the NI Awardees.

The bibliometric indicators were grouped into impact (the impact per publication and overall impact – H-index), productivity (the raw number of publications and rate of publication), co-authorship (the degree to which collaborators were engaged), and interdisciplinarity (the breadth of scientific topics covered in the investigator's publication portfolio as determined by the count of unique Scopus subject codes represented in the portfolio). The primary differences occur in the "impact" category, in which the NI Awardees have greater impact measures than do the two comparison groups, except with respect to the H – index (Table 5). With most other indicators, the NI Awardees are similar to the two comparison groups.

Table 5. Comparison of bibliometric indicators pre- and post-award/funding decision

Bibliometric Indicator	NI Awardees compared with ESI R01 Awardees Pre-award + 1	NI Awardees compared with ESI R01 Awardees Post-award + 1	NI Awardees compared with Finalists Pre-decision + 1	NI Awardees compared with Finalists Post-decision + 1
Average Citations per Publication	NI Awardees > comparison group	No statistically significant difference	NI Awardees > comparison group	No statistically significant difference
IPP (Journal Impact Factor)	NI Awardees > comparison group	NI Awardees > comparison group	NI Awardees > comparison group	NI Awardees > comparison group
SNIP (Journal Source-Normalized Impact per Paper)	NI Awardees > comparison group	NI Awardees > comparison group	NI Awardees > comparison group	NI Awardees > comparison group
SJR (SciImago Journal Rank)	NI Awardees > comparison group	NI Awardees > comparison group	NI Awardees > comparison group	NI Awardees > comparison group
H - Index	No statistically significant difference	No statistically significant difference	No statistically significant difference	Comparison group > NI Awardees
Number of publications	No statistically significant difference	No statistically significant difference	No statistically significant difference	No statistically significant difference
Average Annual Publications	No statistically significant difference	NI Awardees > comparison group	No statistically significant difference	No statistically significant difference

Impact

Produc-tivity

Bibliometric Indicator	NI Awardees compared with ESI R01 Awardees Pre-award + 1	NI Awardees compared with ESI R01 Awardees Post-award + 1	NI Awardees compared with Finalists Pre-decision + 1	NI Awardees compared with Finalists Post-decision + 1
Average number of co-authors per publication	No statistically significant difference	No statistically significant difference	No statistically significant difference	No statistically significant difference
Unique co-authors	No statistically significant difference	No statistically significant difference	NI Awardees > comparison group	No statistically significant difference
Unique co-author institutions	No statistically significant difference	No statistically significant difference	No statistically significant difference	No statistically significant difference
Unique co-author countries	No statistically significant difference	No statistically significant difference	No statistically significant difference	No statistically significant difference
Total unique subject codes	No statistically significant difference	No statistically significant difference	No statistically significant difference	No statistically significant difference

Co-authorship

Interdisc-iplinarity

Conclusions:

Key study question 1: "*Is the NI research significantly more innovative, high risk, or impactful than traditionally funded NIH research?*" The mixed-mode method of evaluation used suggests that, with most measures, the New Innovator Award program supports research that is more innovative, risky, and impactful than research that typically is reviewed and funded using the traditional R01 program. This conclusion should not be construed to mean that traditional R01 funding does not support impactful research, but rather that New Innovator Award program has been successful in specifically targeting research that is inherently risky and with the potential for unusually great impact. It also follows that the New Innovator Award program has succeeded in identifying researchers who are capable and willing to undertake such research. It should be noted that the evaluation assesses only the first three cohorts of the NI Awards. The research characteristics of later cohorts may have changed as may have the research characteristics of the broader ESI R01 awardee community.

Key study question 2: "*What are the impacts, both positive and negative, of NI awards on the careers of awardees compared to the career impacts of a comparable traditional NIH award?*" The mixed-mode method of evaluation used suggests that, with most measures, the New Innovator Award did not have a significantly more positive or negative impact on the careers of its awardees than did the ESI R01 Award. As indicated in the introduction, a primary motivation for posing this question was the concern of whether supporting early career stage investigators pursuing high-risk research was placing their research careers in jeopardy. However, the results indicate that in terms of ability to secure subsequent NIH funding and advance along the career path, the NI Award does not place its recipients at a particular disadvantage. It should be noted

that this evaluation only considers the first three cohorts of NI Awardees, so there may be temporal confounders that affect this analysis, since the qualities of investigators attracted to this program as well as the academic community's awareness and perception of this program may have changed over time. It also should be noted that only a few (1 – 3) years after the end of the project period are considered here and that longer term trends in research productivity and impact may not yet be apparent.

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An Outcome Evaluation of the National Institutes of Health Director's New Innovator Award Program for Fiscal Years 2007–2009

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S C I E N C E & T E C H N O L O G Y P O L I C Y I N S T I T U T E

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Executive Summary

In September 2014, the National Institutes of Health (NIH) Office of the Director contracted with the IDA Science and Technology Policy Institute (STPI) to evaluate the research and career outcomes for the 2007–2009 recipients of the Director's New Innovator (NI) Award Program. This evaluation builds on previous NI award studies that STPI performed in 2011, including assessment of the feasibility of evaluating the research and career outcomes of the 2007–2009 NI awardees. The 2011 feasibility assessment determined that, by 2014, the 2007–2009 NI awardees would have had enough time to complete their research, publish the results, and experience the effects of the award on their career trajectories.

The NI Award Program was modeled after the successful NIH Director's Pioneer Award (NDPA) and targets investigators within 10 years of their terminal research degree or medical residency who have not yet competed successfully for a substantial NIH research grant. Both the NDPA and NI award programs differ from the traditional NIH Research Grant Program (R01) awards (which support discrete, specified, circumscribed research projects) in ways that are designed to enable innovative and higher-risk biomedical and behavioral research.

Methods

The primary assessment tools used in STPI's mixed-methods approach to this NI award outcome evaluation are as follows:

- *Awardee survey*. The STPI team designed a survey to query NI awardees about their perceptions of their research and awards. Questions focused on whether they perceived (1) their research to be high-risk and innovative; (2) the NI award to have had distinct impacts on their career progression; and (3) the NI award mechanism to have been different from traditional R01 grant mechanisms. The survey was also distributed to a matched comparison group of 115 Early Stage Investigators (ESI) who received their first R01 in 2007–2009 and matched the NI awardees on the characteristics of gender, pre-award publications, institute type (terminal degree), degree type, research area, and award year.
- *Senior scientist review*. The STPI team developed another survey to obtain senior scientists' expert opinions of the innovation and potential scientific impact resulting from their review of NI awardee research, generally in the form of manuscripts the awardees provided through the Awardee Survey. The senior scientists the STPI team selected to survey were investigators whose R01 grants were in their tenth or greater consecutive year and who had served 6 months or longer on an NIH review committee. Concepts from the NIH Research, Condition, and Disease Categorization Process were used to pair reviewers with awardees.

- *Bibliometric analysis*. The STPI team analyzed data on publications attributed to the NI or ESI R01 award (attributed publications) and on all papers published by the awardee (career publications). In the career publication analysis, pre-award publications (number of papers published prior to receiving an NI or ESI award plus 1 year) and post-award publications (number of papers published after receiving an NI or ESI award minus 1 year) were compared to assess changes in productivity (e.g., total publications), impact (e.g., Relative Citation Ratio), coauthor network (e.g., average coauthor per publication), and interdisciplinarity (e.g., unique subject codes).
- *Grant analysis*. To evaluate the ability of NI awardees to compete successfully for grants after receipt of the NI award, the STPI team collected NI and ESI R01 grant information for analysis. The analysis included numbers of NDPA and R01 applications and awards and numbers of applications submitted and grants received by NI awardees for new competitive grants and competitive grant renewals.
- *Case study interviews*. The STPI team conducted case study interviews with selected NI and ESI R01 awardees. These semi-structured interviews obtained more in-depth, anecdotal, and qualitative information about the research output from the awards and the impact of the awards on recipients' career progression. The case study interviews also solicited recommendations from NI awardees on ways to improve the NI Award Program.

Integration of Findings

The diverse results the team obtained through the surveys, bibliometric and grant analyses, and case study interviews fell into three areas: research, career, and award mechanism.

Research

The research component of the evaluation considered the extent to which research conducted by NI awardees was more innovative, higher risk, and more impactful than research conducted by an ESI R01 comparison group. The STPI team integrated results from the awardee survey, senior scientist review, and case studies to address the constructs of innovation and risk. A summary of the team's findings are as follows:

- *Innovation*: For the purposes of this report, innovative research is operationalized as the development, use, and diffusion of novel, interdisciplinary ideas. Overall, NI awardees rated their research as more innovative than ESI R01 awardees rated their research, and senior scientist reviews were more likely to rate NI research as more innovative than ESI R01 research. STPI found no significant difference in interdisciplinarity for NI and ESI R01 awardee research for attributed publications as measured by the number of unique subject codes assigned to journals publishing awardee research.
- *Risk*: The STPI team defined high-risk research as having an inherent, high degree of uncertainty and the capability to produce a major impact on important problems in

biomedical or behavioral research. Overall, NI awardees and senior scientist reviewers perceived NI awardee research as having more of the characteristics of high risk than ESI R01 awardees and senior scientist reviewers perceived for ESI R01 research.

- *Impact*: To assess the potential of NI research to have a major scientific impact, the STPI team examined the extent to which the research could lead to, or was likely to lead to, advances in biomedical or behavioral research. Overall, NI awardees' award-attributed publications had higher citation rates and journal impact factors than ESI R01 awardees' award-attributed publications, suggesting higher research impact. NI awardees publish fewer attributed publications than ESI R01 awardees, annually and in total, and take longer to publish. This may be explained, in part, because more data may be required to publish innovative findings and more iterations of journal review may be needed to publish in high-impact journals.

Career

The career component of the evaluation considered the extent to which the NI award influenced the careers of awardees compared to the career impacts of comparable traditional NIH awards. The STPI team used the awardee survey, grant records, and case studies to assess characteristics of professional advancement and ability to obtain new funding. Bibliometric analysis methods were used to ascertain award effects on career publications. A summary of the team's findings in these areas are as follows:

- *Professional advancement*: To assess professional advancement, the STPI team analyzed indicators of laboratory and research expansion, professional recognition, and employment status. Approximately the same percentage of NI and ESI R01 awardees expanded their laboratories and changed institutions after receiving their respective awards. There was no statistical difference in NI and ESI R01 awardee employment, and the majority of respondents reported being employed by academic institutions. There was no significant difference in interdisciplinarity for NI and ESI R01 awardee research for career publications as measured by this approach. Overall, the NI award does not accelerate nor impede professional advancement.
- *Ability to obtain new funding:* The STPI team examined application and award records to determine whether NI and ESI R01 awardees differed in their ability to compete for NIH funding after their respective awards. STPI found that NI awardees were more likely to submit applications and receive grants. NI awardees submit more applications for DP1 and R01 Type 1 (new) competitive grants than ESI R01 awardees submit, and to receive more awards. The converse occurs for R01 Type 2 (competitive renewal) awards. NI awardees apply for and receive fewer R01 Type 2 grants than ESI R01 awardees receive. Comparison of NI awardees' R01 Type 1 and ESI R01 awardees' R01 Type 1 and Type 2 (combined) grants indicates that NI awardees submit more applications, but the groups have a similar likelihood of being funded.

- *Award effects on career publication*: To assess the broader effects of the NI award on the awardee's career, the STPI team used bibliometric approaches to compare characteristics of NI and ESI R01 career publications. The team assessed impact and productivity, interdisciplinarity, and, as a measure of collaboration, co-author networks. The team found that NI awardees had higher journal impact factors than ESI R01 awardees both prior to and following their awards; however, there was no difference in the citation rates for post-award career publications for the two groups. In addition, NI and ESI R01 awardees wrote similar numbers of career publications after receipt of their awards, and although the average number of NI awardee annual publications increased. NI and ESI R01 awardees were also similar in their co-author networks as well as in the interdisciplinarity of the research in their career publications.

Award Mechanism

The award mechanism component of the evaluation considered the extent to which the novel aspects of the NI award mechanism were perceived as beneficial to the awardee, as reported in response to the awardee survey. A summary of the team's findings are as follows:

- *Award process*: As a measure of the alignment of NI awardee research with traditionally funded NIH research, the STPI team examined awardee perspectives on the likelihood that their research could fit the traditional NIH R01 research paradigm and review process. The team concluded that NI awardees were more likely to perceive their research as non-traditional and inconsistent with the NIH grant process. Further, while they would have sought NIH funding for their NI award research, the NI awardees believe that they would be more successful obtaining funding from non-NIH sources.
- *Scope and flexibility*: The STPI team also examined awardee perspectives on the scope and flexibility of their awards and found that NI awardees perceived their awards as having the flexibility and time to allow for non-traditional research; however, both NI and ESI R01 awardee groups reported modification of their research proposals during the 5-year grant cycle.

Key Questions Addressed

The STPI team used the integrated findings from its outcome evaluation for the 2007–2009 cohort of NI award recipients to answer the evaluation's two key questions:

1. *Is the NI research significantly more innovative, high risk, or impactful than traditionally funded NIH research?* The STPI evaluation demonstrates that, for the metrics and time course employed in this evaluation, the NI Award Program is successfully attracting and funding early career researchers who are proposing and conducting innovative, high-risk, and impactful research. The STPI team acknowledges the time limitation of this evaluation. The NI awards were made in 2007–2009. As 5-year awards, these early career investigators were 1–3 years post award, and the need for more time for innovative and high-risk

research to mature, or the impact of the research to be realized, may be necessary. This consideration may be explained, in part, by the need to produce more data to publish innovative findings, and by the fact that more iterations of journal review are often needed to publish in high-impact journals and accrue citations. It is also possible that productivity, as measured by number of publications and time between award and first publication, may be counter to the goals of the NI award, which promotes a flexible, high-risk research plan and the ability to fail and re-direct research. It is important to note that STPI did not evaluate the maturity of the innovative research nor assess whether it could be translated successfully to traditional NIH R01 funding. The STPI grant analysis suggests that NI awardees, as a group, were successful in applying for and receiving R01s, although over a third received no new R01 awards following receipt of their NI awards.

2. *What are the impacts, both positive and negative, of NI awards on the careers of awardees compared to the career impacts of a comparable traditional NIH award?* The STPI evaluation demonstrates that receipt of the NI award did not provide an advantage to NI awardees over the ESI R01 award, as measured by the research, the laboratory, and most professional recognition indicators employed in this evaluation. This finding may be a function of the early career status of both awardees groups. Early career investigators at academic and research institutions, regardless of funding mechanism, are focused on factors that are essential to career progression and tenure, such as establishing an independent research program, expanding laboratory resources and collaborative networks, and publishing peer-reviewed papers. The STPI team also noted characteristics of NI awardees that may indicate a higher likelihood of career success beyond the timeframe covered in this analysis. For example, NI awardees have higher journal impact factors for their award-attributed and career publications than ESI R01 awardees. Further, they are more likely to submit applications for new NIH competitive grants, including the NIH Director's Pioneer Award (NDPA), and be funded. The team identified no negative impacts of the NI award on career trajectory through the awardee survey. A few case study interviewees noted that their institutions did not recognize the NI award as meeting the funding criterion for tenure because it was not seen as equivalent to an R01 award and it lacked the flexibility of a no-cost extension, which can hamper innovative research that needs to be redirected and may require more than 5 years to complete.

Conclusion

The data reported in this evaluation show that the NIH Director's New Innovator Award Program has successfully attracted early career investigators who used the novel aspects of the program to propose and conduct innovative, high-risk, and impactful biomedical and biobehavioral research. The NI award does not significantly accelerate or impede the career trajectory of NI awardees. It is important to note that the STPI evaluation does *not* demonstrate that the NI Award *caused* changes in the indicators and metrics evaluated. Rather, the evaluation assesses the status

of indicators for NI awardees compared to an awardee group similar in characteristics who received a different but comparable award.

Contents

1. Introduction

A. Overview of the National Institutes of Health Director's New Innovator Award Program

The National Institutes of Health (NIH) Director's New Innovator (NI) Award Program was created in FY 2007 to stimulate highly innovative research and support promising new investigators who may not have the preliminary data to fare well in the traditional peer review system.[1] This is the second NIH Director's award program within the High Risk Research Initiative operated by the NIH Office of the Director to support innovative biomedical and behavioral research. The NI program was modeled after the successful NIH Director's Pioneer Award (NDPA) and targets early stage investigators, that is, investigators within 10 years of their terminal research degree or medical residency who have not yet competed successfully for a substantial NIH research grant, such as the NIH R01 grant or equivalent.[2] The NDPA and NI award programs differ from the traditional NIH R01 awards in several respects. Both programs have review criteria that emphasize the creativity and innovative thinking of the investigator, applications are relatively brief, preliminary data are not required, and the review process is conducted by *ad hoc* committees of extramural reviewers rather than the traditional study sections operated by the Center for Scientific Review. Additionally, NI award proposals do not require a detailed budget submission, and the funds are disbursed in total at the beginning of the grant. Each NI award allocates the total 5 years of funding ($1.5 million total direct costs) at the time of award. Although NI award funding is similar to the value of 5-year R01 grants, this approach allows more flexible use of funds by NI awardees and modification of research direction based upon research results. The differences between the NIH Director's New Innovator Award Program and the traditional R01 mechanism are designed to enable innovative and higher-risk biomedical and behavioral research.

B. Purpose of the Outcome Evaluation

In September 2014, the NIH Office of the Director contracted with the IDA Science and Technology Policy Institute (STPI) to evaluate the research and career outcomes of the 2007–2009 NI awardee cohorts so that NIH might understand if the NI-program-supported innovative research and promising young investigators. This evaluation builds on the previous NI award studies that STPI performed.

[1] Funding Opportunity Announcement: 2007 NIH Director's New Innovator Award Program (DP2). http://grants.nih.gov/grants/guide/rfa-files/RFA-RM-07-009.html

[2] Grants considered equivalents include R23, R29, R37 or U01.

In 2011, the STPI team conducted an evaluation of the process to solicit and select NI awardees.[3] Later the same year, the STPI team also assessed the feasibility of evaluating the research and career outcomes of the 2007–2009 NI awardees[4] and determined that, by 2014, sufficient time would have elapsed for the investigators to complete the research in their awards, publish the results, and experience the effects of the award on their career trajectories.

C. Study Questions

The 2007–2009 New Innovator Funding Opportunity Announcements and the STPI 2011 Feasibility Study provide the framework for the goals of the research and career outcomes evaluation. Based upon these documents, and in consultation with NIH, the STPI team addressed the following two key study questions:

1. Is the NI research significantly more innovative, high risk, or impactful than traditionally funded NIH research?

   To understand these key concepts, the STPI team performed a literature review on the definitions and characteristics of innovation, risk, impact, and interdisciplinarity (Appendix A). For the purposes of this study, *high-risk, high-reward research* is defined as research with an inherently high degree of uncertainty and the capability to produce a major impact on important problems in biomedical and behavioral research. *Innovative research* is defined as duplicable knowledge considered new in the context in which it is introduced and demonstrated to be useful in practice. The STPI team defined *interdisciplinarity* as a mode of research that integrates concepts, methods, or data from two or more bodies of specialized knowledge or research practice to advance new fundamental knowledge or to solve complex problems whose solutions are beyond the scope of a single field of research practice (STPI NI Award memo on interdisciplinarity, January 2015).

2. What are the impacts, both positive and negative, of NI awards on the careers of awardees compared to the career impacts of a comparable, traditional NIH award?

The impact of the NI award on an awardee's career is assessed through indicators of professional advancement such as the receipt of honors and awards, expansion of awardees' laboratories, development of collaborative networks, tenure, employment status, and ability to obtain new funding.

[3] Process Evaluation of the National Institutes of Health Director's New Innovator Award program: 2007–2009 (2011).

[4] Feasibility Study of an Outcome Evaluation of the National Institutes of Health's New Innovator Award Program (2010).

D. Scope of the Evaluation

This study used a mixed-methods approach to assess the NI award impact on research outputs and awardee career trajectory. This approach compensates for the limitations inherent in any single method by providing multiple data streams that can be integrated into overarching findings. For this NI award evaluation, the STPI team performed a literature review, designed and administered two surveys, completed a bibliometric analysis and a grant analysis, and conducted case study interviews. The 2007–2009 NI awardee cohorts and a matched comparison group of Early Stage Investigators (ESI R01 Awardees) receiving their first R01 provided the study populations. A synopsis of the primary assessment tools is provided here, and detailed information on the analytical methods is introduced at the beginning of each survey or assessment section.

1. Awardee Survey

The purpose of the Awardee Survey was to query NI awardees on their perceptions of their research and award. Specifically, the survey instrument was designed to assess, in contrast to a matched comparison group, whether the 115 NI awardees perceived their research to be high-risk and innovative; the NI award to have had distinct impacts on their career progression; and the NI award mechanism to have been different from traditional NIH grant mechanisms. The matched comparison group consisted of 115 ESI R01 awardees who received their first R01 in 2007–2009 and matched the NI awardees on the characteristics of gender, pre-award publications, institute type (terminal degree), degree type, research area, and award year. (Both surveys are provided in Appendices D and E.)

2. Senior Scientist Reviewer Survey

The STPI team developed a second survey instrument to obtain senior scientists' expert opinions of the innovation and potential scientific impact resulting from NI awardee research, generally through the review of manuscripts provided by the awardees through the awardee survey. Using the IMPAC II database, accessed through Query View Report (QVR), the STPI team derived a list of researchers whose R01 grant was in its tenth or greater consecutive year and who had served 6 months or longer on an NIH review committee. RCDC[5] concepts were used to pair reviewers with awardees. Senior scientists reviewed the three outputs (typically publications) chosen by the awardees and assessed research innovativeness and potential impact on the field of science. (The full survey is provided in Appendix F.)

[5] RCDC is NIH's Research, Condition, and Disease Categorization Process, which was created in 2009 to provide a consistent classification system for NIH-funded research. RCDC uses a computerized process to tag projects with one or more categorizations. There are 265 unique categories, each of which represents a research area (e.g., neuroscience), disease (e.g., asthma), or condition (e.g., chronic pain). Source: NIH Research Portfolio Online Reporting Tools (RePORT), "Frequently Asked Questions," https://report.nih.gov/rcdc/faqs.aspx.

3. Bibliometric Analysis

Bibliometric analyses were performed on publications attributed to the NI or ESI R01 award (attributed publications) and on all papers published by the awardee (career publications). In the career publication analysis, pre-award publications (the number of papers published prior to receiving the NI or ESI R01 Award plus 1 year) and post-award publications (all papers published after receiving their award plus 1 year) were compared to assess changes in productivity (e.g., total publications), impact (e.g., Relative Citation Ratio (RCR)), coauthor network (e.g., average coauthor per publication), and interdisciplinarity (unique subject codes).

4. Grant Analysis

To evaluate the ability of NI awardees to compete successfully for grants after receipt of the NI award, the STPI team derived NI and ESI R01 grant information from the IMPAC II database and analyzed the number of all Type 1 (new competitive grants) and Type 2 (competitive renewals) applications submitted and grants received by awardees, as well as the number of DP1 and R01 applications and awards.

5. Case Study Interviews

The STPI team conducted case study interviews with selected NI and ESI R01 awardees. These semi-structured interviews obtained more in-depth, anecdotal, and qualitative information about the research output from the award and the impact of the award on career progression. The case study interviews also solicited recommendations from NI awardees on ways to improve the NI Award Program.

E. Overview of the Report

This report is divided into eight chapters and has nine appendices. Following the introduction (Chapter 1) and development of comparison groups (Chapter 2), Chapters 3–7 detail the methods and results for the awardee survey, senior scientist review, bibliometrics analysis, grant analysis, and case studies, respectively. Chapter 8 integrates the results into overarching findings and relates them to the key study questions, and Chapter 9 relates them to the key study questions. The appendices contain supplementary information on methodology, and copies of the survey and review instruments.

2. Establishing Comparison Groups

A well-defined comparison group is essential to the evaluation of New Innovator awardee research and career outcomes. The New Innovator Award program targets ESI R01 awardees, or those researchers who are within 10 years of their terminal research degree or medical residency and who have not yet competed successfully for a substantial NIH research grant. The ESI designation is also used in the NIH review of traditional R01 applications, and this population of researchers is designated ESI R01 recipients. Therefore, NI and ESI R01 awardees (hereafter called ESI R01 awardees) have similar early investigator status and receive awards of similar size and length. They differ in the intent of the research because the awards support two contrasting types of research—high risk, innovative (NI award) versus traditional research (ESI R01 award). Identification of an ESI R01 comparison group that matches the NI awardee group on important characteristics but differs on the research award allows the STPI team to evaluate the impact of the NI award on the NI awardee research and career outcomes.

A. Identifying an ESI R01 Comparison Group

Development of an ESI R01 comparison group requires the following workflow: (1) identify a valid candidate pool of ESI R01 recipients who received their ESI R01 from 2007–2009; (2) establish a database of important background characteristics to match ESI R01 and NI awardees; and (3) using matching algorithms, identify a matched subset of ESI R01 awardees who are similar to NI awardees in terms of background characteristics that may affect outcomes of interest.

1. Identifying Candidate Pool of ESI R01 Awardees

NIH's QVR system contains a data element delineating a researcher's ESI status through a check box. This approach does not indicate when ESI status was initiated or when it expired. Therefore, the STPI team developed a method to accurately identify ESI R01 awardees, as defined by NIH.

The STPI team first identified a pool of all candidates who received an R01 award within the study period of 2007–2009, resulting in a collection of approximately 95,000 records from the QVR system. From this list of 2007–2009 R01 recipients, the team selected only records which were designated as new or Type 1 projects. This reduced the pool of candidates to approximately 13,500 records. To accurately identify ESI R01 awardees from this pool of R01 awardees, the team then applied the NIH criteria for ESI eligibility to the collected QVR data. The STPI team also confirmed by manual review that the PI had not received an R01 before the award date of the 2007–2009 grant under consideration.

a. Determining ESI Eligibility for R01 Awardees

To accurately identify ESI R01 awardees from this pool of R01 awardees, the STPI team then applied the NIH criteria for ESI eligibility to the collected QVR data. The team determined which

degrees were "terminal degrees"[6] and manually identified the date of completion for these terminal degrees in the IMPAC II database and added 10 years. This date was then compared to the award date of the grant to select which PIs were ESIs at the time of their first R01 award.

Doctors of Medicine (MDs) maintain ESI eligibility for 10 years after the end of their residency. The timeframe for medical residency is delineated in a physician scientist's NIH Biosketch and required manual inspection to determine ESI eligibility. Because medical residency data are inconsistently reported in the NIH Biographical Sketch, it was not feasible to efficiently collect residency end dates for all MDs in the ESI R01 candidate pool. Therefore, all MDs were included in the matching analysis, and their records were inspected *post hoc* for ESI eligibility. Only ESI-eligible MDs were retained in the candidate ESI R01 pool.

b. Removing Duplicate Records in the ESI R01-Eligible Pool

The STPI team also determined that projects listed in QVR for the pool of approximately 3,600 ESI R01 Awardees could have multiple records if multiple PIs were listed on the application or if there were supplemental awards. Duplicate records were identified and removed based upon their NIH Project Code excluding suffixes,[7] while making sure to retain the record of the contact PI of the project as well as the primary award (no supplements or amendments). The final candidate pool was composed of 2,965 researchers.

B. Characteristics to Match NI and ESI R01 Awardees

1. Matching Areas of Science with Topic Modeling

Matching a comparison group based upon the awardees' area of science is important because the expected outputs and outcomes of research may vary across scientific fields. For example, the standard rate of publications may be quite different in fields such as plasma physics when compared to molecular biology. In fact, using specific techniques, such as electrophysiology, can affect the standard rate of publications even within a given field. Therefore, to obtain an ontology of science areas that provides a useful level of granularity while mitigating risks of human biases,

[6] Terminal degrees were determined by the study group to be the following: Doctor of Philosophy (PhD), Doctor of Medicine (MD), Doctor of Science (DSc or ScD), Doctor of Public Health (DPH), Doctor of Veterinary Medicine (DVM), Doctor of Dental Surgery (DDS), Doctor of Osteopathic Medicine (DO), and Doctor of Pharmacy (PHMD).

[7] NIH Project Codes are composed of the acronym of the administrating IC, a five digit serial number, and a suffix composed of a hyphen (grant year) (additional information). For example, the first supplement of a project within its third year from the Office of Director may look like this: OD00123-03S1. For the purposes of de-duplication, unless otherwise stated, we only use the Project Code excluding its suffixes: OD00123, from the example.

the STPI team used a topic modeling algorithm to organically develop topics from a designated corpus.

a. Topic Model Methodology

Topic modeling is a form of natural language processing that estimates the distribution of abstract concepts (called *topics*) across a collection of documents (A and B in Figure 1). The technique identifies patterns of co-occurring terms within individual documents in order to construct topics (C in Figure 1). Each topic assigns the probability of a term appearing for a given topic. For example, *cell* and *DNA* would have a high probability of appearing together in a given topic, while terms such as *DNA* and *black hole* would have a relatively low probability of appearing together. Documents can then be described as a distribution of the topics generated by the model (D in Figure 1).

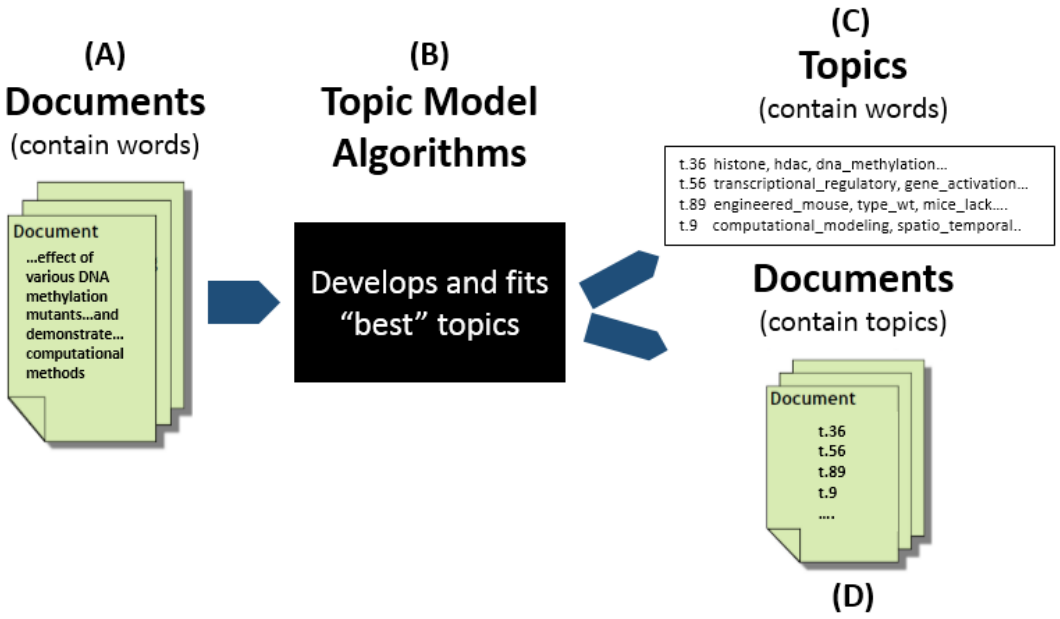


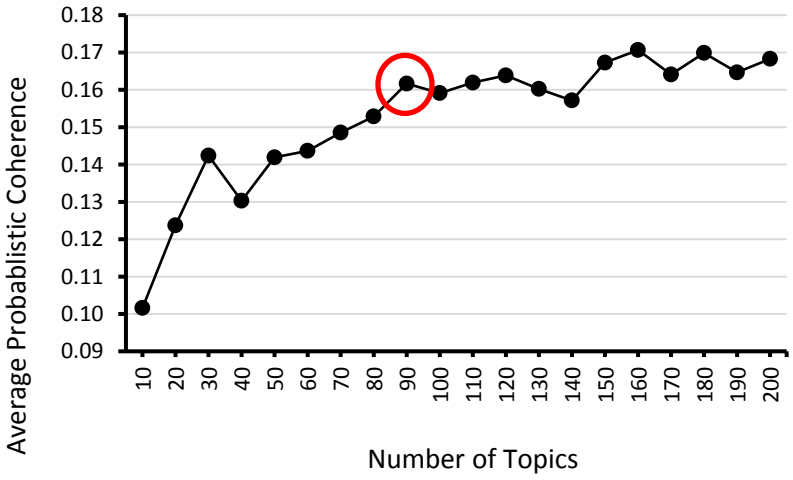
Figure 1. Basic Topic Modeling Process

For this study, abstracts from projects of NI awardees as well as the entire ESI-eligible awardee pool were used as inputs to build multiple topic models with varying numbers of topics. Abstracts that were not available for automatic download on QVR were manually extracted from the awardee's application. Using the topic label and terms that were generated by the algorithms for each topic, the STPI team manually validated the models through the examination of coherency topics. The most coherent and parsimonious model was used as an input to the matching algorithm.

b. Identifying and Verifying the Most Parsimonious Topic Model

The topic model algorithm generated multiple models, each containing different numbers of topics. Choosing the model with the most appropriate number of topics for inclusion in the

matching algorithm required assessing the modeling statistics, including the r^2, log-likelihood, and coherence values of the model. Probabilistic coherence is a metric developed by STPI that measures the propensity for the top words in a topic to appear together within documents. Averaging the coherence of all topics within a model has been shown to provide the most informative metric for identifying potential models. Isolated peaks in the coherence plots are indicative of the most coherent models (Figure 2).



Note: Coherence plots of varying number of topics tend to generate multiple isolated peaks. These models are considered candidates that must be manually verified by STPI or subject matter experts in order to identify the most parsimonious model.

Figure 2. Coherence Plot of Topic Models Generated with 10–200 Topics

The final step of verifying the topic models and identifying the most parsimonious model for inclusion in matching algorithm required human judgement. The STPI team examined the models that were identified as candidates via their average coherence values. To identify the most parsimonious model, the team examined every topic for each candidate model and the terms associated with each topic, the topic's label, the coherence scores, and the prevalence (or frequency within the corpus) of each topic. We then identified topics that should be dropped either because they were nonsensical or provided little value for the matching process. Topics determined to be of little value to the matching process were usually ones that would be seen across a majority of the corpus, e.g., topics that are built on terms such as "investigate," "research," or "examine." If models had over 10% of topics that were determined to be dropped, these models were discarded from consideration.

c. Results

The STPI team determined that the topic model with 90 topics were the best candidates for inclusion in the matching algorithm. In order to use the topic modeling results as inputs to the matching algorithm, the document-to-topic matrix created by the topic model was transformed into

an author-to-topic matrix, which allowed the results to be merged into the database containing all of the other matching variables for the analysis.

The final results of the topic model are found in Appendix B. The mathematical and statistical details underpinning topic modeling are beyond the scope of this report but available upon request.

2. Pre-Award Publication Frequency as a Matching Characteristic

Bibliometric research suggests a connection between publication rate (i.e., research productivity) and innovation (Heinze and Bauer 2007; Simonton 2004). While the literature describes constraints on research productivity by noting that quantity and quality of publications matter, the number of pre-award publications, paired with the topic model matching, provides a proxy for "researcher quality" in a field of research. Pre-award publications were defined as publications published up to one year after the award of interest (i.e., R01 or NI) was received and were summed to create a pre-award publication count for each researcher.

Further information on the selection of a publication database and the determination of author publications is provided in the bibliometric methods section.

3. Matching on Gender

Awardee gender was included as a matching variable to reduce variability in potential career impacts that may be a function of gender.

4. Matching on Pedigree and Institution Type

The term "academic pedigree" is frequently used to categorize the prestige of the institutions from which one obtains degrees or employment. The STPI team assessed four metrics to determine whether the ESI comparison group could be matched to the NI Awardees by established measures that rank institutions and universities.

- The Carnegie Classification of Institutions of Higher Education is a framework for classifying U.S. colleges and universities to identify groups of roughly comparable institutions.
- The National Research Council (NRC) Data-Based Assessment of Research-Doctorate Programs in the United States benchmarks accessible information on doctoral programs at 212 universities for the academic year 2005–2006 to permit program comparisons.
- NIH Research Funding by Institution ranks 1,491 institutions by research dollars received. The STPI team divided the top 200 institutions into quartiles and classified the remainder as 5+.
- U.S. News and World Report College Rankings categorizes U.S. colleges and universities by 50 factors.

The STPI team determined that the NRC Data-based Assessment of 212 universities was insufficiently comprehensive, and the U.S. News and World Report College Rankings included

more non-academic than academic factors in its rankings. The limited scope of these two classification tools precluded their use in assessment of pedigree for NI and ESI R01 awardees.

The STPI team next developed the list of institutions at which the 115 matched pairs of NI and ESI R01 awardees received their terminal degrees and identified their NIH funding quartile and Carnegie Ranking. No clear rank or quartile could be assigned to 27% and 30% of the universities, respectively, including several international universities.

Based on this information, the STPI team was unable to use a semi-objective external measure of institutional merit to reliably determine academic pedigree across all academic institutions represented by the NI and ESI R01 awardees. Although not a direct substitute, the team selected institution type as a readily available characteristic that would provide an *exact match* between NI and ESI R01 Awardees. Institution type, that is, a medical institution, university, national laboratory, or private company at which they performed their research, reflects the research culture in which the NI and ESI R01 research is performed.

5. Variables Excluded from Matching

The STPI team considered several other potential matching variables that were eventually excluded from the matching analysis. *Years Since PhD* was excluded because there was little variability between the NI and ESI groups for these variables given the selection criteria for NI awardees and ESI R01 awardees required that awardees were within ten years of their terminal degree. *Ethnicity* and *Job Title* were not consistently reported across groups- therefore, these variables were also eliminated.

C. Nearest Neighbor Matching on Mahalanobis Distances

While several methods for matching NI awardees to ESI R01 awardees exist, nearest neighbor matching on Mahalanobis distances is a versatile method that allows for exact matching on nominal variables and nearest neighbor matching on continuous variables (Rosenbaum 2005). Mahalanobis distances indicate how close cases are to one another in multidimensional space. More specifically, they are measurements of the distance from a point in a correlated multivariate distribution to the center of that distribution. The one-to-one nearest neighbor matching algorithm looks in all directions around each NI awardee's position in this distribution and identifies one closest ESI R01 awardee as the NI awardees' match. A simplified example is illustrated in Figure 3.

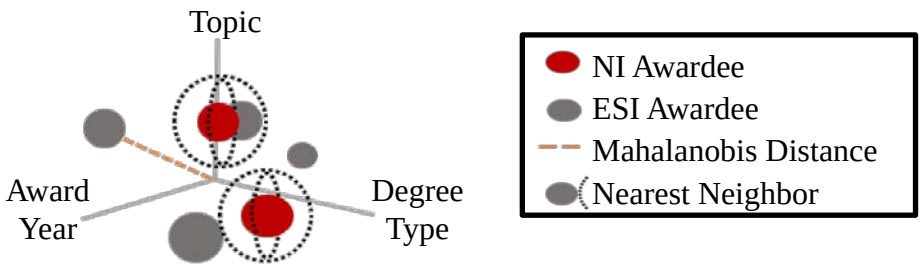


Figure 3. Example Mahalanobis Distance and Nearest Neighbors

After iterating and assessing multiple models and assessing resulting balance and bias scores – the degree to which pre-matching group differences are minimized post-match – the STPI team chose a model that included exact matches for gender, award year, degree type, and institution type and nearest neighbor matches for pre-award publications and topic model scores. Using this matching method, the team identified 115 ESI R01 Awardees who matched the NI awardees and would serve as a matched comparison group. All further analyses are conducted on the NI awardees and the matched-ESI group, or a subset of these groups.

3. Awardee Survey

Surveys allow an analyst to collect answers to specific, important questions. These questions are often varied, cover a diverse range of topics, and can be asked in multiple formats. The NI and ESI R01 awardee survey was designed to use multiple formats to assess awardee attitudes and opinions on the following questions:

- Was NI research risk different from ESI research risk?
- Was NI research innovativeness different from ESI research innovativeness?
- Was NI career impact different from ESI career impact?
- Was NI career progression different from ESI career progression?
- Was the NI funding mechanism perceived to be different from traditional NIH funding mechanism (e.g., R01, R21)?

The extent to which NI awardees *differed* from ESI R01 awardees in terms of these questions is both a subjective and objective matter. One component of this assessment of *difference* is the extent to which NI awardees *perceived* their research to be more risky, innovative, and impactful. Additionally, details about career progression and view towards the NIH funding mechanism are best assessed with a survey approach, as these data are either the private thoughts and opinions of awardees, or not readily accessible through other means.

The survey was administered to the 115 NI and 115 ESI R01 Awardees, and those who completed the survey were designated survey respondents (Figure 4).

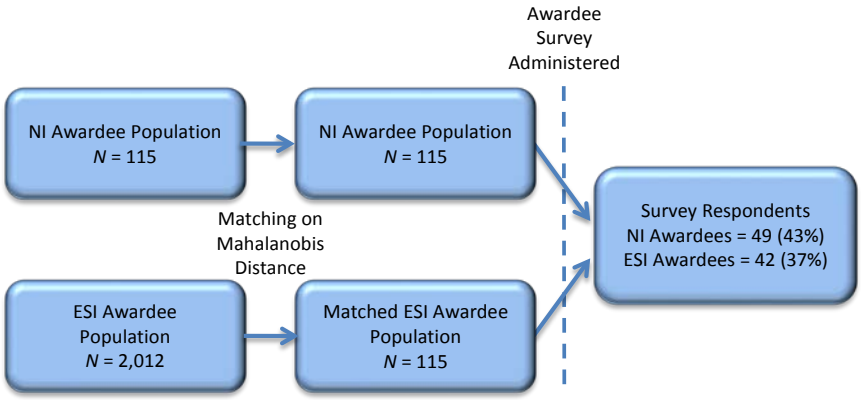


Figure 4. Awardee Survey Populations and Respondents

A. Methods

1. Survey Structure and Administration Procedure

The NI and ESI R01 awardee surveys were comprised of nearly identical content, organization, and administration procedures. Each section of the survey will be discussed below, as will any differences between the NI and ESI surveys (See Appendices D and E for the NI and ESI R01 Awardee surveys, respectively).

NI and ESI R01 awardee surveys were created using SurveyGizmo, a web-based survey design. Potential respondents can be sent a survey link tailored to a customizable and user-specific survey either through SurveyGizmo's email interface or through pasting the survey link into an email and contacting potential respondents directly.

2. Constructed Terms and Definitions

a. Perceived Research Risk

A five-item assessment of risk[8] was created to assess the construct of perceived research risk. Items were presented on a five-point Likert-type scale (1 = strongly disagree, 5 = strongly agree). Each item assessed one of the five components of risk: conceptual risk, technical risk, experience risk, and multidisciplinary risk. For instance, conceptual risk was measured with the item "My research was at odds with prevailing thinking." Items were not aggregated because the scale did not demonstrate adequate inter-item consistency (α = .62).

b. Perceived Research Innovativeness

Innovative research is defined as "duplicable knowledge considered new in the context it is introduced and demonstrated useful in practice." A six-item assessment was created to assess perceived research innovativeness. For instance, the development of a novel technology was assessed with the item "My research resulted, or will potentially result in, the development of a new technology." Items were presented on a five-point Likert-type scale (1 = strongly disagree, 5 = strongly agree). Items were not aggregated because the scale did not demonstrate adequate inter-item consistency (α = .69).

c. Perspectives on Research and Integration with NIH Funding Process

Five survey items were created to assess how awardees viewed their research in the context of what NIH typically funds. These items captured several perspectives on the NIH, including data requirements (e.g. "My research had little or no preliminary data when I submitted my

[8] Colwell, Rita R., Director of the National Science Foundation, Briefing to the Office of Legislative and Public Affairs, October 2003.

application") and perspectives on the types of research funded (e.g., "Overall, my research was different from what is typically funded through NIH"). Items were presented on a five-point Likert-type scale (1 = strongly disagree, 5 = strongly agree).

d. Perspectives on the Scope and Flexibility of the Award

Three survey items were created to assess awardees' perspectives on the scope and flexibility of their award in terms of funding flexibility, length of the award, and perceived freedom to pursue non-traditional research (e.g., "The NI (or ESI) allowed me to pursue non-traditional research"). NI awardees received an item set without any reference to ESI R01 awardees and vice versa. Items were presented on a five-point Likert-type scale (1 = strongly disagree, 5 = strongly agree).

e. NI Awardees' Views on Their Awards

Three items were created to assess NI awardees' perspectives on whether their research was likely to be funded through traditional R01 mechanism (R01, R21, etc.), whether their NI research was likely to be funded outside the NIH, and whether they would have chosen to seek traditional funding if the NI program did not exist. These items were not administered to ESI R01 awardees. Items were presented on a five-point Likert-type scale (1 = strongly disagree, 5 = strongly agree).

f. Perspectives on Additional Funding and Career Advancement

NI and ESI R01 awardees were asked to report additional funding received. Further, awardees were asked to report advances in their career, including whether they expanded their labs, developed new collaborations, and received tenure, among other indicators.

B. Results

In the following sections, statistical analyses are presented for each section of the survey. Non-parametric statistical tests were used throughout due to the presence of skewed distributions for some variables and to provide continuity of interpretation. The Wilcoxon ranked sum test (U statistic) was used for between group comparisons on continuous variables and *r* was selected as a measure of effect size.[9] (See Appendix I for additional information on the statistical approach implemented and interpretation of effect sizes.) All statistical tests are reported in tables in the appropriate section for reference, but are omitted from the body of text to reduce redundancies in reporting. All confidence intervals are 95% CIS.

[9] While a within-subject analysis is preferred for the analysis of matched data, 19 out of a possible 115 NI-ESI pairs responded to the survey solicitation. Matched-pairs analyses lacked the statistical power required to detect meaningful effects for several analyses. For both between group and within-subject analyses, the direction of effects were consistently in the same direction. Between-subject analyses are reported in the body of the report.

Additionally, Likert-type scales were rescaled such that positive values indicate agreement and negative values indicate disagreement (–2 = strongly disagree, 2 = strongly disagree).

The survey response rate was 42%. Population characteristics were known for several background variables: Gender, institution type (terminal degree), terminal degree type, pre-award publications, and year of qualifying award. Statistical comparisons were conducted to assess if respondents varied significantly from the population regarding background variables. No statistically significant respondent-population differences were uncovered for any background variable (all chi-square *ps* > .09). Thus, no source of potential participation bias could be detected across known population characteristics. Survey Respondent characteristics are detailed in Appendix C.

1. Awardees' Perceptions of Research Risk

There were statistically significant group differences between the NI and ESI R01 awardees on four out of five items assessing risk, such that NI awardees reported greater agreement on items related to the sub-constructs of conceptual, experiential and multidisciplinary risk. While awardees, on average, tended to agree that their research was risky, the data indicate that NI awardees were stronger in this belief. There were no statistically significant differences on the item "The research required novel techniques and equipment." Instead, both groups had high agreement with this item. See Table 1 for specific findings and Figure 5 for a visual depiction of responses by group across risk items.

Table 1. NI and ESI R01 Awardees' Self-Reported Perspectives on Research Risk

	Group						
	NI Awardees		ESI R01 Awardees				
	M	SD	M	SD	U	p	r
Research a significant departure from previous research	1.02	0.99	0.05	1.18	1466	<.001	0.41
Research required knowledge outside of field	1.51	0.74	0.71	1.11	1454	<.001	0.38
Research involved novel combination of ideas	1.86	0.54	1.69	0.47	1250	.009	0.27
Research at odds with prevailing thinking	1.39	0.84	0.93	1.05	1299	.021	0.24
Research required novel technique or equipment	1.29	1.04	0.88	1.28	1160	.109	0.17

Note. Likert values scaled from -2 (Strongly Disagree) to 2 (Strongly Agree) for clarity.

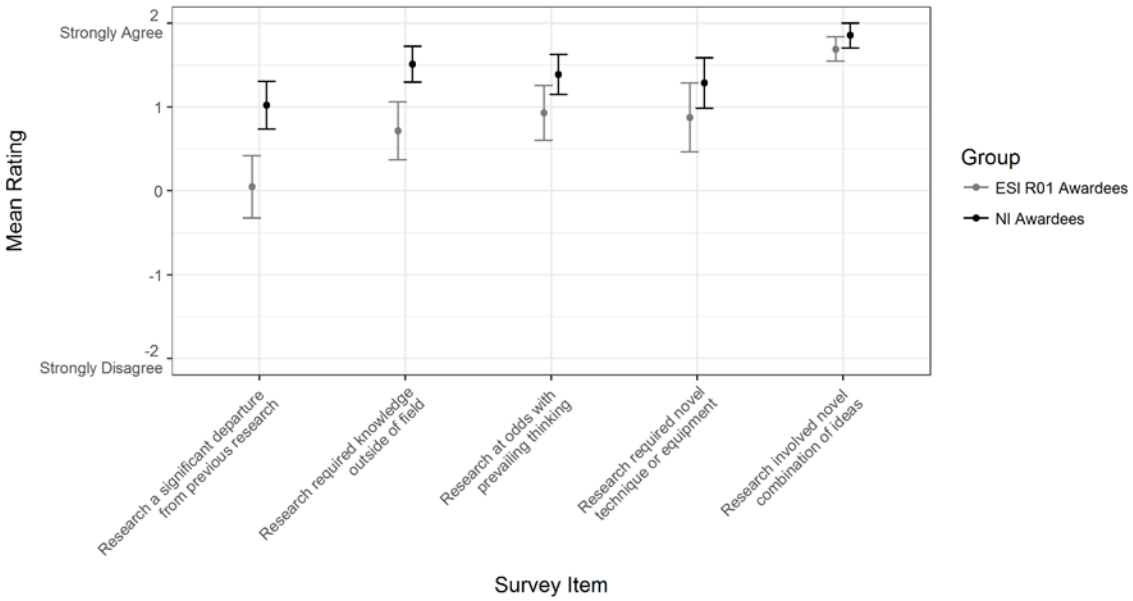


Figure 5. NI and ESI R01 Awardees' Self-Reported Perspectives on Research Risk

2. Perceived Research Innovation

There were statistically significant group differences between the NI and ESI R01 awardees on four out of six items assessing innovativeness, such that NI awardees reported larger scores on these items. While awardees, on average, tended to agree that their research was innovative, the data indicate that NI awardees were stronger in this belief. There were no statistically significant differences on perceived innovativeness in the context of creating new methodologies or technologies. Instead, NI awardees indicated greater perceived innovativeness associated with the formulation of new ideas, discovery of a new phenomenon, synthesis of new ideas, and advancement of theoretical concepts than ESI R01 awardees. See Table 2 for specific findings and Figure 6 for a visual depiction of responses by group across perceived innovativeness items.

Table 2. NI and ESI R01 Awardees' Self-Reported Perspectives on Research Innovativeness

	Group						
	NI Awardees		ESI R01 Awardees				
	M	*SD*	M	SD	U	p	r
The formulation of a new idea	1.84	0.53	1.55	0.59	1297	.005	0.29
The discovery of a new phenomenon	1.55	0.77	1.21	0.84	1274	.028	0.23
New synthesis of disparate ideas	1.33	0.94	0.95	0.99	1275	.036	0.22
The advancement of a theoretical concept	1.43	0.94	1.14	0.90	1255	.047	0.20
The development of a new technology	0.57	1.35	0.07	1.33	1241	.084	0.18
The development of a new methodology	1.22	1.09	0.93	1.16	1189	.167	0.14

Note. Likert values were scaled from –2 (strongly disagree) to 2 (strongly agree) for clarity.

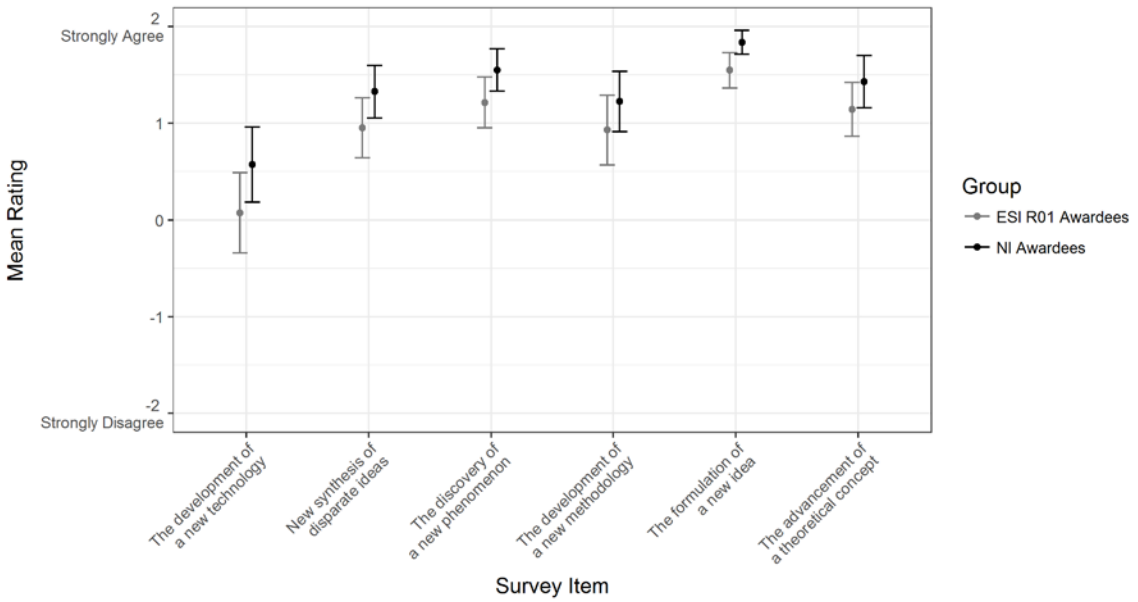


Figure 6. NI and ESI R01 Awardees' Self-Reported Perspectives on Research Innovativeness

3. Perspectives on Research and Integration with NIH Funding Process

There were statistically significant group differences between the NI and ESI R01 awardees on all four items assessing how awardees viewed their research in the context of what NIH typically funds. Overall, NI awardees reported that their research is different from what NIH typically funds, while ESI R01 awardees disagreed with this statement on average. NI awardees tended to agree that their research had little preliminary data and disagreed that their research had an appropriate NIH study section and fell within the research interests of a single NIH institute, center, or office. The opposite was true of ESI R01 awardees. See Table 3 for specific findings and Figure 7 for a visual depiction of responses by group across items.

Table 3. NI and ESI R01 Awardees' Self-Reported Perspectives on Integration with NIH Funding Process

	Group						
	NI Awardees		ESI R01 Awardees				
	M	SD	M	SD	W	p	r
Overall, my research was different from what is typically funded through NIH	1.59	0.64	-0.26	1.23	1807	<.001	0.68
My research had little or no preliminary data when I submitted my application	0.49	1.32	-1.38	1.17	1745	<.001	0.62
My research had an NIH study section with appropriate scientific expertise	-0.47	1.24	1.02	0.84	362	<.001	0.57
My research falls into the research interest of a single NIH institute/center	-1.27	1.00	-0.12	1.27	498	<.001	0.46
Over the course of the grant period, my research idea changed significantly from what was initially proposed	0.86	1.06	0.38	1.21	1259	.056	0.20

Note. Likert values are scaled from –2 (strongly disagree) to 2 (strongly agree) for clarity.

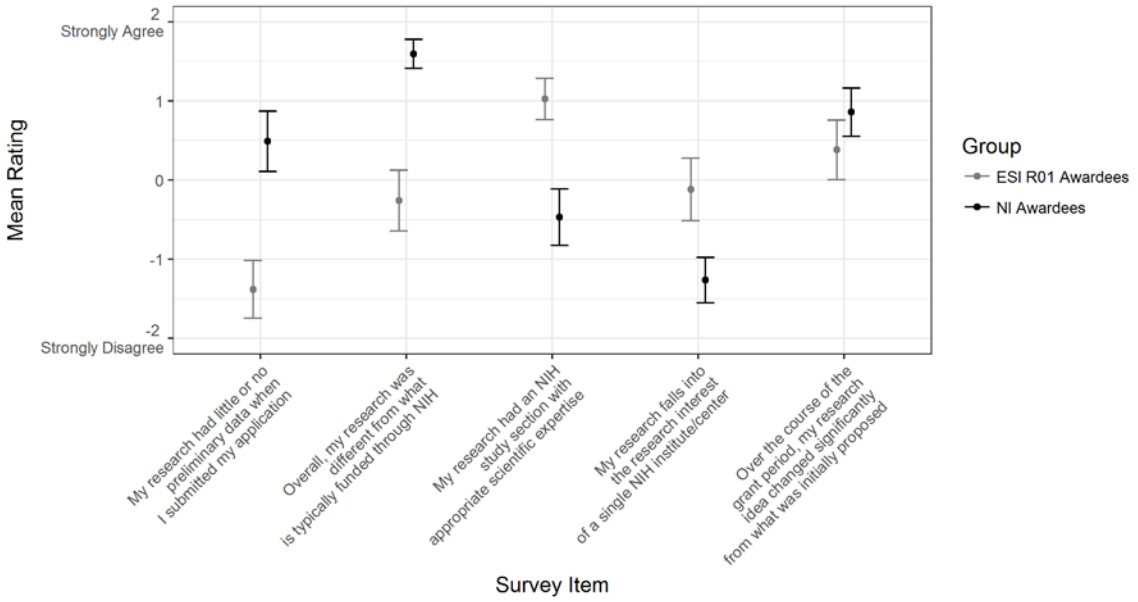


Figure 7. NI and ESI R01 Awardees' Self-Reported Perspectives on Integration with NIH Funding Process

4. Perspectives on Scope and Flexibility of Awards

There were statistically significant group differences between the NI and ESI R01 awardees on all three items used to assess awardees' perspectives on the scope and flexibility of their awards, such that NI awardees reported larger scores for these items. While awardees, on average, tended to agree that their awards were flexible in terms of research direction, funding, and period of performance, the data indicate that NI awardees were stronger in these beliefs. Average NI ratings for items relating to flexibility in funding and research direction were near the maximum value of the scale, indicating particularly strong agreement with these items. See Table 4 for specific findings and Figure 8 for a visual depiction of responses by group across items.

Table 4. NI and ESI R01 Awardees' Self-Reported Perspectives on Scope and Flexibility of Awards

	Group				
	NI Awardees	ESI R01 Awardees			
Item	M (SD)	M (SD)	W	p	r
The NI (or ESI) award allowed me the freedom to pursue non-traditional research	1.92 (0.28)	0.71 (1.20)	1708	<.001	0.66
The NI (or ESI) award allowed for the flexible use of funding	1.90 (0.57)	1.00 (1.04)	1664	<.001	0.64
The period of the NI (or ESI) award was long enough for me to redirect research as ideas/methods evolved	1.37 (1.05)	0.55 (1.31)	1479	<.001	0.40

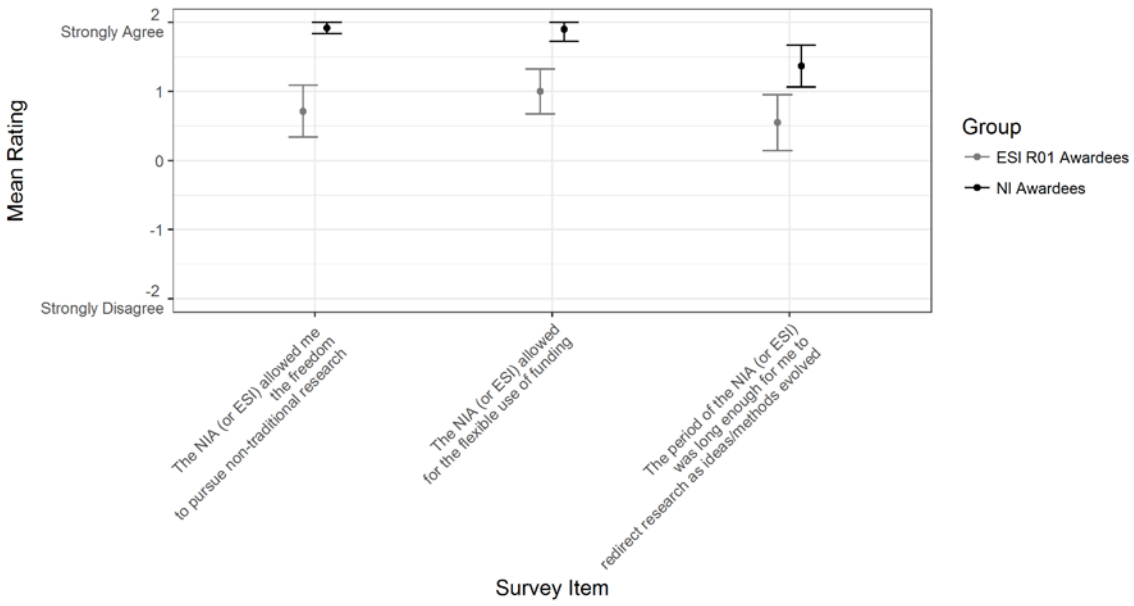


Figure 8. NI and ESI R01 Awardees' Self-Reported Perspectives on Scope and Flexibility of Awards

5. NI Awardees' Views on their Awards

NI awardees responses to items associated with their awards could not be statistically compared to ESI R01 awardees because the items are NI award-specific. Instead, average responses were compared to the mid-point of the scale (*neither agree or disagree*). Statistical significance in this analysis indicates that average responses were unlikely sampled from a population distribution centered on the mid-point. Statistically significant findings were detected

for two of the three items used to assess NI awardees' views on their awards. NI awardees indicated that their awards were unlikely to be funded through traditional NIH mechanisms if the NI award program did not exist or the research was funded through sources other than NIH. See Table 5 for specific findings and Figure 9 for a visual depiction of responses across items.

Table 5. NI Awardees' Self-Reported Views on their Awards

Item	M (SD)	V	p	r
My research was likely to be funded through traditional NIH mechanisms (R01, R21, etc.) if the NI program did not exist	–1.57 (0.71)	7	<.001	0.64
My research was likely to be funded through sources other than the NIH	–1.00 (1.10)	59	< .001	0.49
I would have chosen to seek traditional NIH funding (R01, R21, etc.) for my research had the NI program not existed	0.20 (1.41)	510.5	.288	0.11

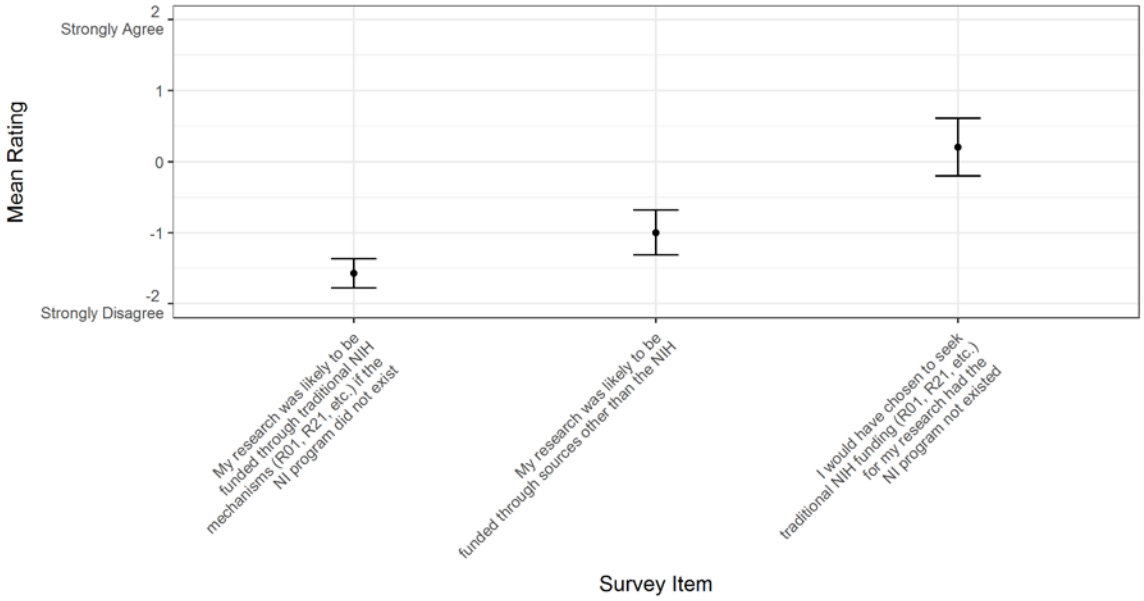


Figure 9. NI Awardees' Self-Reported Views on their Awards

6. Perspectives on Career Advancement

a. Current Employment

The majority of awardees reported employment at an academic institution, followed by medical institutions with a university affiliation (see Table 6). There were no statistically significant group differences across employment categories.

Table 6. Current Employment of NI and ESI R01 Awardees

	NI Awardees	ESI Awardees
Academic Institution	80%	74%
Medical Institution (University Affiliation)	10%	17%
Other*	10%	9%

*National Laboratories, medical affiliations not associated with a university, and industry.

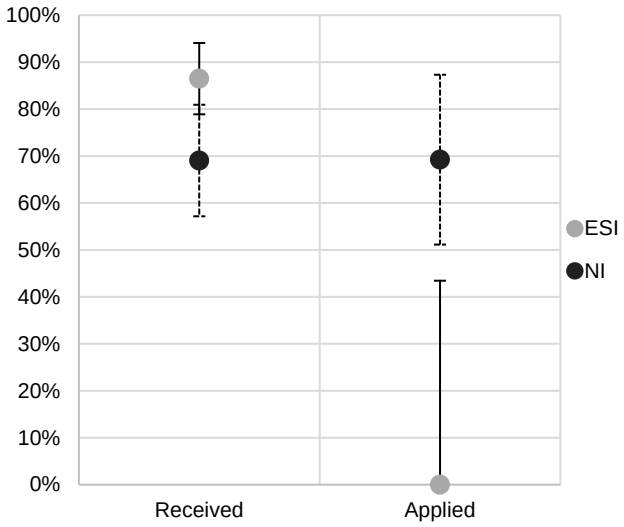
b. Global Job, Research, and Laboratory Indicators

The STPI team queried NI and ESI R01 awardees on measures that would indicate award impact on their career trajectory. The team conducted Chi-square tests to assess whether there were group differences across global job indicators and lab indicators. Only two indicators were statistically different. NI awardees were significantly more likely to have received popular press media coverage (see Table 7), and more NI than ESI R01 awardees reported applying for tenure at the time of the survey (see Figure 10).

Table 7. Global Job, Research, and Laboratory Indicators for NI and ESI R01 Awardees

Job, Research, or Laboratory Indicator	NI Awardees	ESI Awardees
Changed Institutions	20%	24%
Expanded Focus of Lab to new Disciplines	90%	93%
Expanded Research Lab	92%	91%
Formed New Collaborations	100%	98%
Received Honor/ Award	86%	69%
	*	
Popular Press Media Coverage	76%	53%
Journal Cover Feature	41%	33%
Asked to Serve as Regular Reviewer	82%	90%

*$p < .05$.



N = 70 $\alpha_{(2\text{-tail})}$ = .05; Power = .45 Power = .92

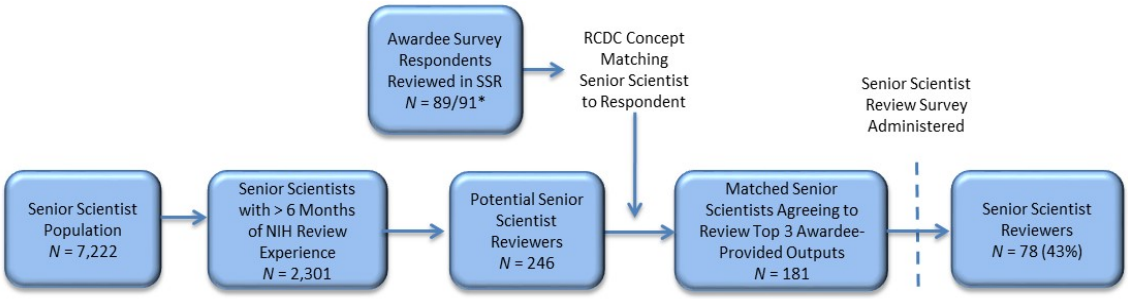
Figure 10. Tenure Status of NI and ESI R01 Awardees at Tenure-Granting Institutions

C. Summary of Findings

Overall NI Awardees reported that their research was more risky and innovative than ESI R01 Awardees reported for their research. Further, NI Awardees rated their NI application as having less preliminary data and rated their research as different from what the NIH typically funds. NI and ESI R01 awardees received tenure at a similar rate, although NI awardees who had not received tenure at the time of the survey applied in a significantly higher proportion than did ESI R01 awardees. The two groups were similar in terms of other laboratory and career indicators, except for a larger percent of NI Awardees being featured in the popular press.

4. Senior Scientist Review

To balance the self-reporting of attitudes and opinions by the NI and ESI R01 awardees on research innovativeness and risk in the awardee survey, the STPI team developed a review process in which senior scientists provided expert opinion of the NI and ESI R01 awardee research. The relationship of the Senior Scientist Review to the Awardee Survey is depicted in Figure 11.



Note: Two ESI R01 Awardee Survey respondents did not provide their top three outputs and therefore could not be reviewed by the senior scientists.

Figure 11. Senior Scientist Survey Methodology

A. Senior Scientist Reviewer Selection Criteria

The STPI team used QVR to identify a pool of 2,301 senior scientist reviewers (SSRs) that met the following criteria: (1) the tenth year of R01 funding occurred between 2011–2015, (2) at least 6 months of NIH committee service had been completed, and (3) RCDC concepts were available for each senior scientist's most recent R01 award. These criteria ensure that a selected senior scientist had the appropriate expertise to review an awardee's research outcomes and that the team had sufficient data with which to match SSRs to awardees.

B. Assigning Awardees to Senior Scientist Reviewers

Cosine similarity scores were derived for each SSR–awardee pair using RCDC concepts and associated concept weights.[10] These scores provide an indication of how similar RCDC concepts are for awardees and SSRs.[11] Cosine similarity scores were then submitted to a linear programming

[10] RCDC is NIH's Research, Condition, and Disease Categorization Process, which was created in 2009 to provide a consistent classification system for NIH-funded research. RCDC uses a computerized process to tag projects with one or more categorizations. There are 265 unique categories, each of which represents a research area (e.g., neuroscience), disease (e.g., asthma), or condition (e.g., chronic pain). SOURCE: NIH Online Reporting Tools (RePORT), "Frequently Asked Questions," https://report.nih.gov/rcdc/faqs.aspx.

[11] Cosine similarity is used to measure the similarity between two vectors. Cosine ranges from –1 to 1 and can be understood and visualized easily in two dimensions. The cosine of two lines 180 degrees apart (going in two

algorithm that maximized overall cosine similarity scores, subject to the constraints that each awardee was reviewed by at least six SSRs, and each SSR was assigned three awardees. These constraints ensured adequate awardee coverage and minimized the burden on SSRs, such that SSRs were not assigned too few or too many awardees to review. SSRs did not know whether a given packet of research was associated with an NI or ESI, and they may have been assigned multiple NI awardees or none at all.

C. Awardee Packets

Eighty-nine NI awardees and ESIs who completed the awardee survey and provided references for three outputs best represent what was achieved with funding. The STPI team created a packet of outputs for each awardee. Names were redacted from each output. SSRs reviewed the packet for each of the three awardees assigned to them.

D. Senior Scientist Review Protocol

SSRs were contacted by email and phone. Emails contained a written solicitation and a letter from Francis Collins requesting their participation in the study. Potential SSRs who did not respond to two participation requests or declined to participate were replaced with back-up SSRs. This process was repeated for three rounds of participation solicitations. Participants were given approximately four weeks to complete the review and received a $500 remuneration for participation. SSR response rates can be found in Table 8. Most awardees were reviewed by one to three SSRs, while five were reviewed by more than five SSRs. Two awardees were not reviewed by any SSRs (Table 9).

Table 8. SSR Respondent Rates

Potential Reviewer Group	Response Rate for Potential Reviewer Group
All Potential Reviewers	32% (78/246)
All Potential Reviewers that Responded When Contacted	43% (78/181)
All Potential Reviewers Responding "Yes" to Solicitation for Participation	70% (78/112)

completely opposite directions) is –1, while when there is a 0 angle between them (going in the same direction), the cosine is 1. When looking at two sets of text, one can turn each of the sets into a word count vector and then compute the cosine similarity between each of these now numerical vectors, giving you some measure of similarity between the original sets of text.

Table 9. Review Frequencies

Number of Times Reviewed	Number of Awardees
1	14
2	31
3	22
4	15
5	4
6	1

E. Survey Results

SSRs were instructed to read each packet of outputs and complete a 20-item survey assessing research risk (Table 10), outcomes for each packet (Table 11), and innovativeness (Table 12). These items were presented on a five-point Likert-type scale (1 = strongly disagree, 5 = strongly agree). See Appendix F for the SSR survey.

Packet ratings were modeled using a Bayesian Ordinal Model approach. Standard Markov Chain Monte Carlo techniques were used to obtain parameter estimates and associated 95% confidence intervals for NI and ESI means and *p* values corresponding to group differences. See Appendix H for additional information about this model.

1. Research Risk

There were statistically significant group differences between NI awardees and ESI R01 awardees on two of the three items assessing research risk. SSRs reported overall larger ratings for NI awardees on the items “The research involved a novel combination of ideas” and “The research required a novel technique or equipment” compared to ESI R01 awardees. There was no statistically significant group difference on the item “The research was at odds with prevailing wisdom.” See Table 5 for specific findings and Figure 9 for a visual depiction of responses across items.

Table 10. SSR Assessment of Research Risk

	NI Awardees		ESI R01 Awardees		
Survey Item	**Mean**	**95% CI**	**Mean**	**95% CI**	**p**
Research involved novel combination of ideas	1.97	[1.91, 2.03]	0.79	[0.73, 0.68]	.01
Research required novel technique or equipment	1.30	[1.25, 1.35]	1.03	[0.96, 1.09]	.01
Research at odds with prevailing thinking	0.74	[0.68, 0.80]	0.80	[0.75, 0.85]	.10

Note. Bayesian Ordinal Model using Standard Markov Chain Monte Carlo technique used to compare groups.

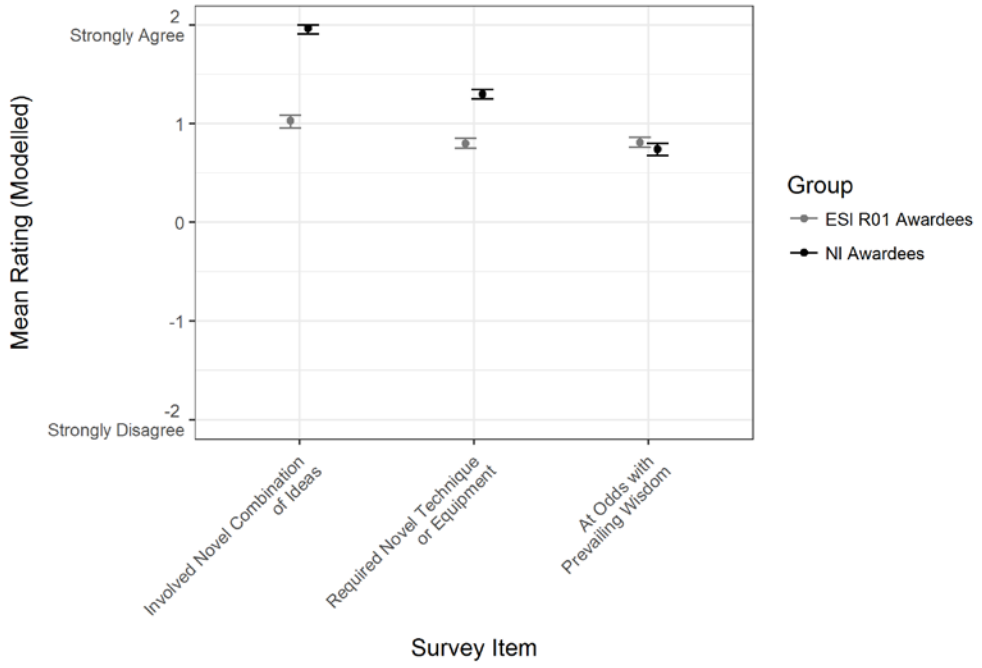


Figure 12. SSR Assessment of Research Risk

2. Research Outcomes

There were statistically significant group differences on all six survey items related to research outcomes. SSRs reported larger overall ratings for ESI R01 awardees on the item "The research resulted in the advancement of a theoretical concept" compared to NI awardees. SSRs reported larger overall scores for five of the six items assessing research outcomes, with the largest group differences found for the item "The research resulted in the development of a new technology." Overall, these findings indicate that NI awardees were rated as having better research outcomes than ESI R01 awardees. See Table 11 for descriptive statistics and Figure 13 for a visual depiction of SSR ratings for Research Outcomes.

Table 11. SSR Assessment of Research Outcomes

	NI Awardees		ESI R01 Awardees		
Survey Item	**Mean**	**95% CI**	**Mean**	**95% CI**	**p**
The development of a new technology	0.27	[0.20, 0.34]	-0.14	[-0.22, -0.08]	0.01
New synthesis of disparate ideas	0.83	[0.76, 0.89]	0.57	[0.50, 0.64]	0.01
The development of a new methodology	1.06	[1.01, 1.11]	0.84	[0.78, 0.90]	0.01
The discovery of a new phenomenon	1.27	[1.21, 1.32]	1.05	[0.99, 1.12]	0.01
The formulation of a new idea	1.08	[1.02, 1.14]	1.16	[1.10, 1.23]	0.03
The advancement of a theoretical concept	0.87	[0.81, 0.93]	0.81	[0.75, 0.87]	0.05

Note. Bayesian Ordinal Model using Standard Markov Chain Monte Carlo technique used to compare groups.

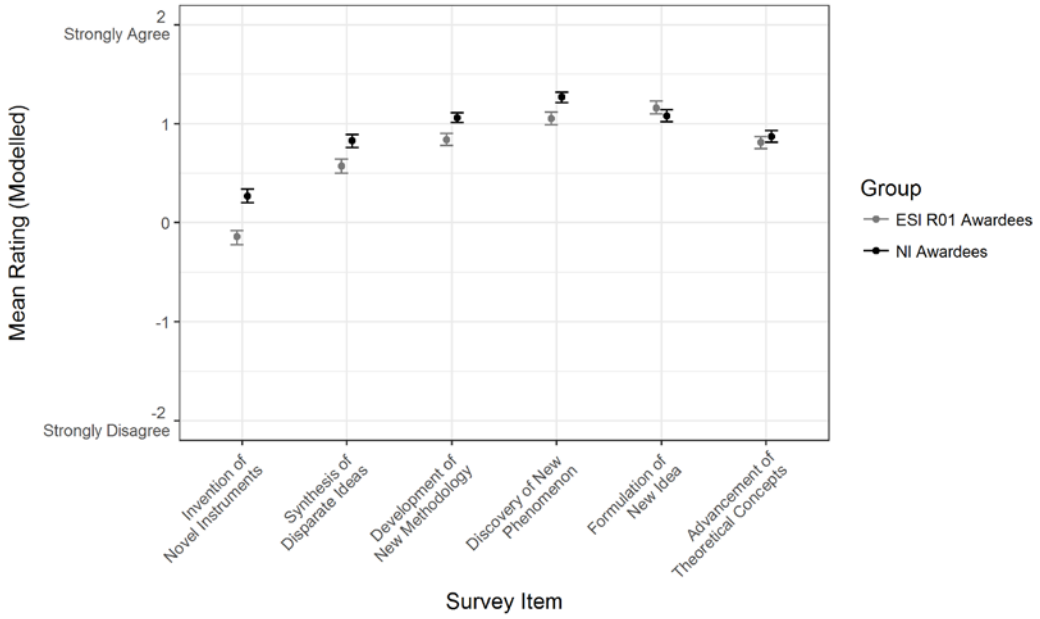


Figure 13. SSR Assessment of Research Outcomes

3. Research Innovativeness

There were statistically significant group differences on all 10 survey items related to research innovativeness. SSRs reported larger overall scores for ESI R01 awardees on the item "The research was rigorous" compared to NI awardees. This finding is discussed in the Integration of Findings section. SSRs reported larger overall scores for NI awardees on 9 out of 10 items related to research innovativeness. Overall, these findings indicate that NI awardees were rated as having more innovative research than ESI R01 awardees. See Table 12 for descriptive statistics and Figure 14 for a visual depiction of SSR ratings for Research Innovativeness.

Table 12. SSR Assessment of Innovativeness of Research

	NI Awardees		ESI R01 Awardees		
Survey Item	**Mean**	**95% CI**	**Mean**	**95% CI**	**p**
Combined fundamental principles, models, or experiments in novel ways	0.63	[0.59, 0.67]	0.27	[0.23, 0.32]	.01
Pursued an approach that was contrary to the norm	1.20	[1.11, 1.28]	0.73	[0.64, 0.82]	.01
Applied cutting-edge approaches	0.26	[0.21, 0.31]	0.05	[-0.01, 0.10]	.01
Will have a significant impact on the field	1.02	[0.97, 1.08]	0.85	[0.79, 0.91]	.01
Was innovative	1.15	[1.10, 1.21]	0.85	[0.80, 0.90]	.01
Cut across multiple disciplines	0.90	[0.84, 0.96]	0.81	[0.74, 0.87]	.02
Introduced novel theoretical ideas	1.07	[1.00, 1.13]	0.90	[0.83, 0.97]	.01
Introduced radically different tools	0.98	[0.93, 1.03]	0.40	[0.34, 0.46]	.01
Will revolutionize the field	0.56	[0.48, 0.64]	0.39	[0.30, 0.56]	.01
Was rigorous	1.34	[1.27, 1.42]	1.43	[1.35, 1.51]	.05

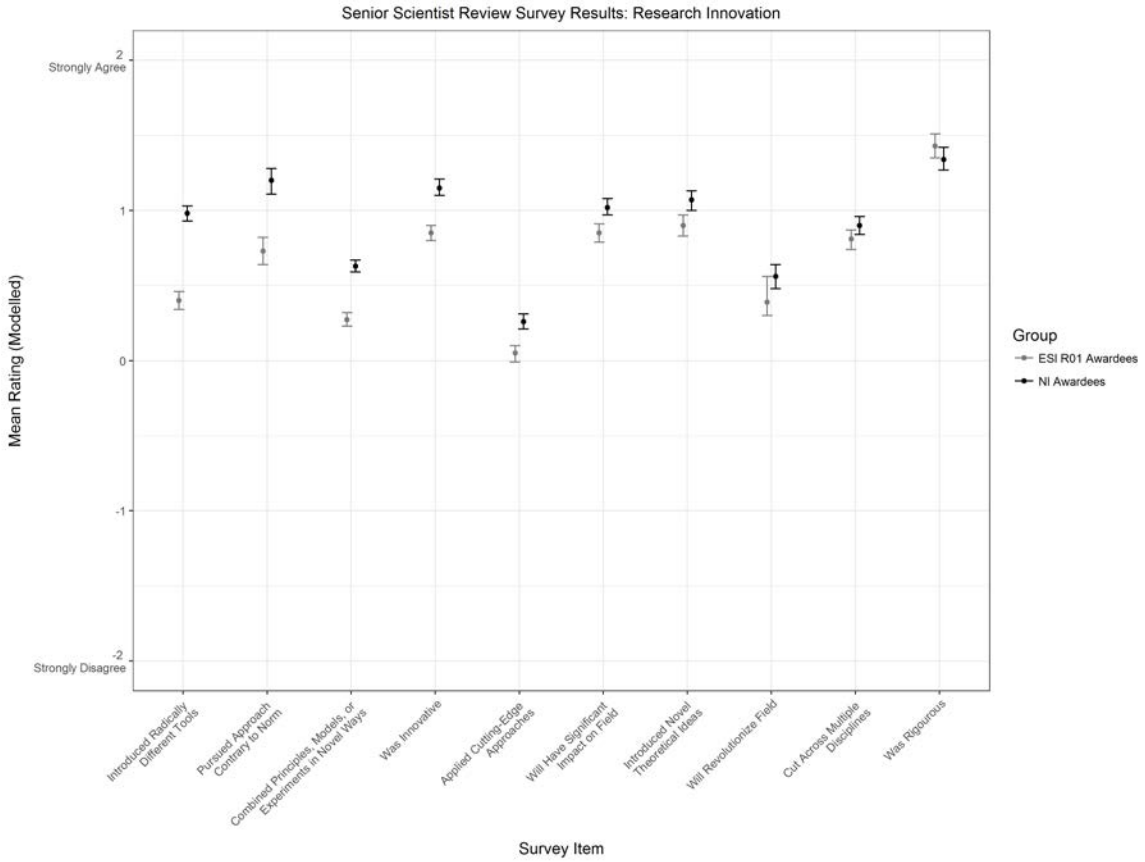


Figure 14. SSR Assessment of Innovativeness of Research

4. SSR Results Summary

Overall, the findings from the SSR assessment provide clear evidence that NI research was rated as more risky, innovative, and impactful than ESI R01 awardee research. It is plausible that ESI R01 awardee research was rated as more rigorous because of the incremental nature of R01 research compared to research funded through the NI mechanism.

5. Bibliometric Analysis

The statistical analysis of scholarly publications and books, bibliometrics, has long been a cornerstone in program evaluations (Narin 1987). Unlike surveys, bibliometrics provides an alternative way to quantify research outputs without expert reviewers. The bibliometric analysis was performed on the 115 NI and 115 ESI R01 awardees (Figure 15).

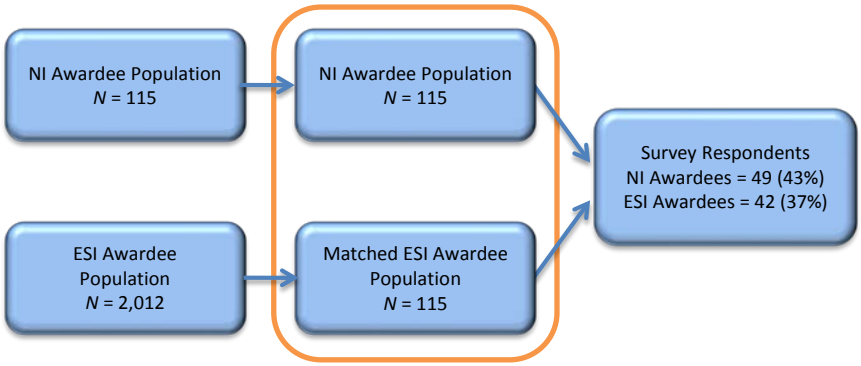


Figure 15. Awardee Populations for Bibliometric Analysis

The STPI team created four broad categories of analysis for each awardee's research portfolio: *productivity*, *impact*, *interdisciplinarity*, and *coauthor network*. First, *productivity* measures the general output of research products by a researcher. Second, *impact* is meant to tap into the "information dissemination" factor and indicates the perception of research quality by the two "gates" of peer-review—publishers (journal prestige) and peer researchers (citations). The rationale behind these metrics is that prestigious journals will inevitably reach a wider audience and publications with high citation counts have inherently been read by many. Third, *interdisciplinarity* captures the breadth of knowledge being engaged by an awardee's research. Lastly, analysis of each awardee's *coauthor network* measures the spread of their collaboration network across individuals, institutions, and countries, indicating their ability to broker collaboration networks.

The analysis was divided into two sections, each linked directly to one of the two research questions. The first section investigates the effect of the NI award and ESI R01 award on research quality and impact by analyzing only publications directly attributed to the research grants—hereafter referred to as *attributed publications*. The second section investigates the effect of the research grants on each awardee's career by comparing their entire bibliometric profiles pre- and post-award for all career publications.

While bibliometrics provides a method of objectively analyzing the awardee groups through their respective bodies of publications, bibliometrics do have some notable caveats (Ismail et al. 2009):

1. *Publication data can be messy and incomplete*. Not only do the range of publications and journals vary based on the chosen dataset, but identifying correct author names and affiliations can also be difficult. Particularly with common names (e.g., John Smith), multiple authors may be publishing under the same name, making the task of identifying the correct set of publications attributed to the author of interest difficult and time-consuming.
2. *Citation counts and other bibliometric analyses are not perfect objective measures in a vacuum*. Studies have shown that citation count measures can be biased against early researchers, who lack the established record of publications to gain significant citation counts. Additionally, researchers cite other papers for a broad range of reasons and the consistency in citation behavior (e.g., providing background, criticizing previous work, paying "homage" to field pioneers) can vary from researcher to researcher. Lastly, researchers have noted that bibliometrics can often struggle to entirely capture the "quality" of papers.

The STPI team sought to minimize uncertainty in the publication sets used for this analysis. First, the use of attributed publications significantly reduced the uncertainty concerning whether the analyzed publications were correctly attributed to our awardee groups. Since these publications were drawn from NIH databases, in which authors must self-report publications, the team feels this significantly reduces any chances of false positive or false negative publications. Second, while career publication sets are difficult to check by hand due to the sheer number of publications included, the team followed a consistent methodology intended to reduce erroneous publication sets, as explained in the next section.

A. Methods

1. Types of Analyses

Two broad types of analyses (attributed publication analyses and career publication analyses) were conducted on awardees' bibliometric data. Both types of analyses have advantages and disadvantages (Table 13). First, attributed publication analysis allows for the direct linkage of a particular grant funding mechanism to a given output. Thus, group differences on metrics associated with attributed publications can be interpreted as being directly influenced by the award. However, attributed publications only provide one segment of an awardees' publication profile and are necessarily at the grant level. That is, grant-level publications need not be authored by the NI or ESI R01 awardee. Further, research that is unrelated to a specific award may nonetheless have an impact on an awardees' career. Career publication analysis affords the analysis of a larger segment of an awardees' publication portfolio and has the advantage of a pre-award and post-award analysis and awardee group analysis. Further, the effects of the NI can be considered in terms of the change in research quality from before the award to after the award. See Table 13 for a comparison of the two approaches.

Table 13. Comparison of Award-Attributed and Career Publication Analyses

Analysis	Advantages	Disadvantages
Award-Attributed Publications	Confidence in data accuracy and completeness	Cannot assess spillover effects to other research areas not tied to grant
	Ability to associate publication to specific grant	Inability to account for pre-award group differences
Career Publications	Can assess overall impact of award above and beyond publications directly tied to award	Less confidence in the completeness of data

2. Programming Language

The STPI team used *R*, a programming language and environment for statistical computing and graphics (R Core Team 2016). It is a GNU project based on the *S* language and environment. *R* also has the advantage of being designed specifically for data handling and data manipulation and for possessing a diverse library of open-source packages intended to supplement and enhance the baseline capabilities of the language. *R* was used to ingest publication metadata and perform relevant analyses.

3. Selecting Publication Database

Two major publication databases—Scopus and EBSCO Host—were tested against a sample subset of three NI and three ESI R01 awardees. For each author searched, the STPI team checked the publications returned from each database against the author's curriculum vitae (CV) in order to gauge the levels of false positive (i.e., returned publications that are not the author's) and false negative (i.e., publications from the author's CV that are not returned) results. EBSCO Host had a false positive rate of 33.6% and a false negative rate of 37.8%, while Scopus had rates of 1.3% and 17.9%, respectively. In total, EBSCO Host returned an average of 59.7% of an author's CV publication set, while Scopus returned an average of 82.1%. Given these findings, the team selected Scopus as the database to be used to acquire publications for each author.

4. Obtaining Correct Scopus Author IDs and Publication Sets

a. Attributed Publications

The STPI team acquired attributed publication lists using the NIH RePORTER database. Among the range of information contained in this public-facing database, RePORTER keeps track of publications produced using support from an NIH grant. Awardees are required to acknowledge all Federal funding sources in each publication and, in the case of the NIH, self-report these attributed publications to the funding agency.

Using the RePORTER publication lists, each publication was queried against the Scopus database to acquire citation information and journal metadata (e.g., journal ranking). Each query returned results in XML files, which were then parsed using *R*.

The STPI team removed errata, letters, and replies from consideration. Additionally, the team removed two attributed publications that were later retracted from their respective journals. With these criteria in place, a total of 3,726 publications were supported by the NI and matched ESI R01 awards, with 1,714 publications attributed to the NI and 2,012 attributed to the matched ESI R01 awards.

b. Career Publications

For career publications, awardee names and institutions were queried against the Scopus database. When searching authors using name and affiliated institution, Scopus occasionally returns multiple author IDs. It is possible for an author's publication set to be split into two or more author IDs, particularly if the author has switched institutions or published under a different name at some time point. The STPI team determined which author IDs were correct for each author of interest.

A multistep process was followed using the *R* programming environment:

1. Searches that returned a single author ID were assumed correct.
2. Searches that returned multiple author IDs were assumed correct if all the returned institutions for the author were the same.
3. Searches that returned multiple author IDs with non-identical institutions were assumed correct if all the returned institutions could be matched to the author's affiliated institution found on the NI database.
4. Remaining search results with multiple author IDs were checked by hand. Authors were searched online and the NI team determined which returned author IDs were correct.

The correct author IDs were then compiled into a list that was then used to query the Scopus API for all publications affiliated with those authors. Each author ID query returned publications in XML files, which were then parsed using *R*. In the end, 14,849 publications were determined to be valid.

5. Qualities Assessed

Seeking to quantify the four measured research qualities—productivity, impact, coauthor network, and interdisciplinarity—the STPI team leveraged a range of bibliometric techniques. Table 14 outlines the metrics included in each of these research qualities.

Table 14. Research Quality Categories and Associated Metrics

Research Quality	Metric	Description
	Total Publications	Raw count of publications.
	Publication Delay Relative to Award	Time lag between award start and publication date.
	Annual Publications	Time-normalized rate of publication in the form of average publications per year.
Productivity & Impact	Average Citations per Paper	Average count of citations per publication.
	H Index	A metric proposed by Hirsch (2005) that is defined as the number of papers (*h*) with at least *h* citations each.
	Journal Impact per Paper (IPP)	Also known as raw impact per paper, this number denotes the average number of citations per paper published in a journal (Moed 2010). These data are provided by Scopus for each journal.
	Relative Citation Ratio (RCR)	Article level, field independent method to identify influential papers.
	Journal Source-Normalized Impact per Paper (SNIP)	Similar to IPP, but normalized to account for differences in citation rates between fields of study (Moed 2010). These data are provided by Scopus for each journal.
	SCImago Journal Rank (SJR)	A computed ranking score that is calculated using citation weighting schemes and eigenvector centrality (González-Pereira, Guerrero-Bote, and Moya-Anegón 2010). These data are provided by Scopus for each journal.
Coauthor Network	Average Coauthors per Publication	Average number of other authors on a given publication.
	Unique Coauthors	Count of unique authors that awardee has published with.
	Unique Coauthor Affiliations	Count of unique coauthor institutions and countries. Captures how many different countries and institutions have been collaborated with.
Interdisciplinarity	Unique Journal Subject Codes	Count of unique journal subject matter/field indicators, as provided by Scopus.

a. Attributed Publication Analysis

Attributed publication analyses are within subject (conducted on matched pairs of NI awardees and ESI R01 awardees). Further, non-parametric statistical tests were used due to the presence of skewed distributions for some variables and to provide continuity of interpretation. The Wilcoxon signed-rank test was used for NI to ESI comparisons, and *r* was selected as a measure of effect size. Bootstrapped 95% confidence intervals were created for group medians for each variable assessed. A positive value for *r* indicates that the variable is larger for NI awardees, while a negative value indicates that the variable is larger for ESI R01 awardees.

b. Career Publication Analysis

Career publications analyses were conducted as within-subject, doubly multivariate GLM-repeated measures analyses, with two within subject variables (Group: NI, ESI R01; Time: *Pre-award* + 1, *Post-award + 1*) across all measures of research quality and outputs. *Pre-award* + 1 publications refer to all publications published before one year after receipt of award. *Post-award + 1* publications refer to all publications published at least one year following receipt of award. Due to severe positive skew for several bibliometrics that likely violate the assumption of normality, the data were transformed using a natural log transformation. Thus, all career publication analyses are presented in log units.

A doubly multivariate GLM-repeated measures analysis allows for the estimation of several effects, including the main effects for Group and Time, as well as the Group X Time interaction. A statistically significant main effect of Group, ignoring other main effects and the interaction, indicates statistically significant group differences on a bibliometric outcome. A statistically significant effect of Time, in the absence of other effects, indicates statistically significant increases or decreases in a bibliometric outcome from pre-award to post-award. A statistically significant Group X Time interaction indicates group differences in bibliometric outcomes that vary from pre-award to post-award. For example, it may be the case that NI awardees have a number of publications similar to that of ESI R01 awardees before receiving their award, but had significantly more publications following the award than did ESI R01 awardees. In the presence of a statistically significant interaction, main effects are omitted.

c. Publication Sources

Publications used for the attributed publication analysis were obtained from NIH RePORTER using grant IDs. Career publications were obtained using names and institutional affiliation for a given PI. These two methods provided varying numbers of publications and contain different sources of errors and are therefore not comparable.

B. Results: Award Effect on Research Output and Quality

In the following sections, statistical analyses are presented for each of the research qualities for attributed and career publications.

1. Research Productivity

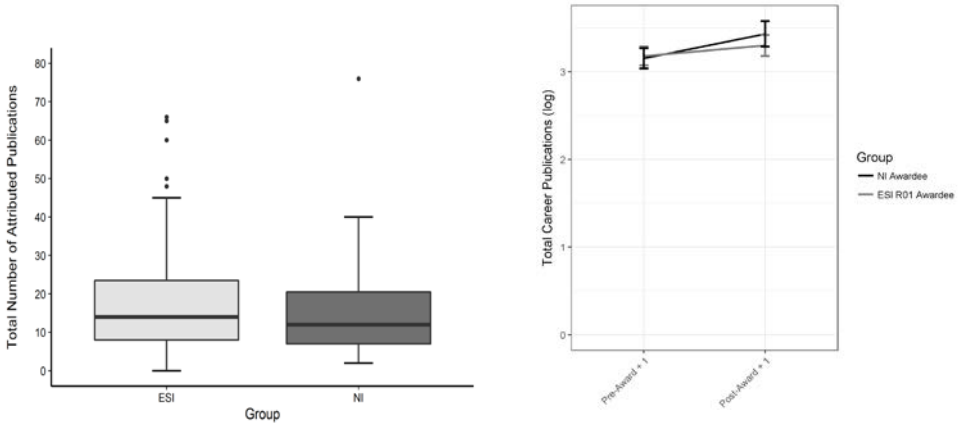
a. Number of Publications

The STPI team analyzed the total number of publications and their timing to understand researcher productivity—defined as the raw production of research outputs—under the NI and ESI R01 Awards.

Attributed Publication Analysis. NI awardees produced fewer total attributed publications than their ESI counterparts (Wilcoxon signed-rank, $V = 2198$, $p = .022$, $r = –0.15$). The median NI

awardee produced 12 publications (95% CI [11.25, 13.15]) and the median ESI R01 awardee produced 14 publications (95% CI [10.20, 16.99]) (Figure 16, Panel A).

Career Publication Analysis. Overall, there was no statistically significant effect of Group, $F_{(1,110)} = .58$, $p = .449$, $\eta^2_p = .005$. There was a statistically significant effect of Time, $F_{(1,110)} = 4.46$, $p < .001$, $\eta^2_p = .178$; awardees had more total publications *post-award* + 1 compared to *pre-award* + 1 ($M_{\log(\text{post award}) - \log(\text{pre award})} = .014$, 95% CI [0.019, 0.265]). There was no statistically significant Group X Time interaction for total career publications, indicating that group differences in total publications did not vary significantly over time (Figure 16, Panel B).



Panel A. Attributed Publications Panel B. Career Publications

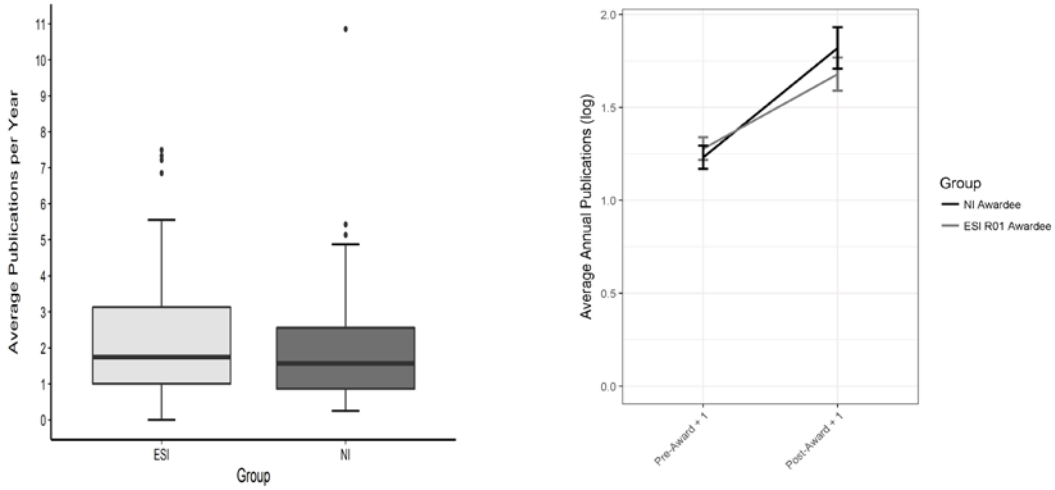
Figure 16. Number of Publications

b. Annual Publication Production

Attributed Publication Analysis. NI awardees produced fewer publications on an annual basis when compared with matched ESI R01 awardees, Wilcoxon signed-rank, $V = 2204$, $p = .024$, $r = -0.14$. The median NI awardee produced 1.57 publications per year (95% CI [1.32, 1.81]), and the median ESI R01 awardee produced 1.75 publications per year (95% CI [1.22, 2.14]) (Figure 17, Panel A).

Career Publication Analysis. There was a statistically significant Group X Time interaction for average annual publications, $F_{(1,110)} = 16.33$, $p = < .001$, $\eta^2_p = .129$, indicating that group differences in annual publications varied from *pre-award* + 1 to *post-award* + 1 publications. Follow-up simple effects analyses were conducted to tease apart this interaction. Regarding average annual publications, NI awardees average more annual publications *post-award* + 1 than ESI R01 awardees, $M_{\log(\text{NI}) - \log(\text{ESI})} = .142$, $p = .025$, 95% CI [0.019, 0.265], but there was no statistically significant difference in *pre-award* + 1 average annual publications between NI

awardees and ESI R01 awardees, $M_{log(NI) - log(ESI)}$ = .047, p = .245, 95% CI [–0.126, 0.033]. (See Figure 17, Panel B)[12].



Panel A. Attributed Publications Panel B. Career Publications

Figure 17. Annual Publication Production Results

c. Timing of Publications

Attributed Publication Analysis. NI awardees tended to produce grant-attributed publications later than their ESI counterparts, Wilcoxon signed-rank, V = 4556, p < .001, r = –0.27 (Figure 18). The median NI awardee published an average of 4.14 years after receiving the award (95% CI [3.91, 4.30]), while the median ESI R01 awardee published an average of 3.68 years after receiving the award (95% CI [3.41, 3.87]). On the aggregate level, NI publications were produced an average of 4.16 years after the award year, while ESI publications were produced an average of 3.90 years after the award year (Figure 19).

Career Publication Analysis. No corresponding data exist for pre-award data for this metric. Therefore, no analysis was conducted.

[12] The differences in Annual Publication Findings and Total Publication Findings may seem contradictory; however, the direction and magnitude of effects were similar for both analyses. This discrepancy was due to minor differences in annual publication rates over time, with later cohorts publishing more annual publications per year, in combination with later cohorts having slightly fewer total publications on average.

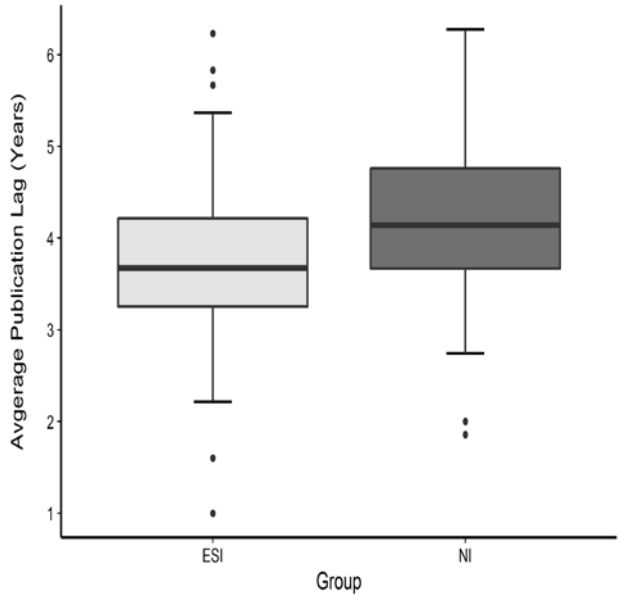


Figure 18. Average Lag Time between Publication and Award Year

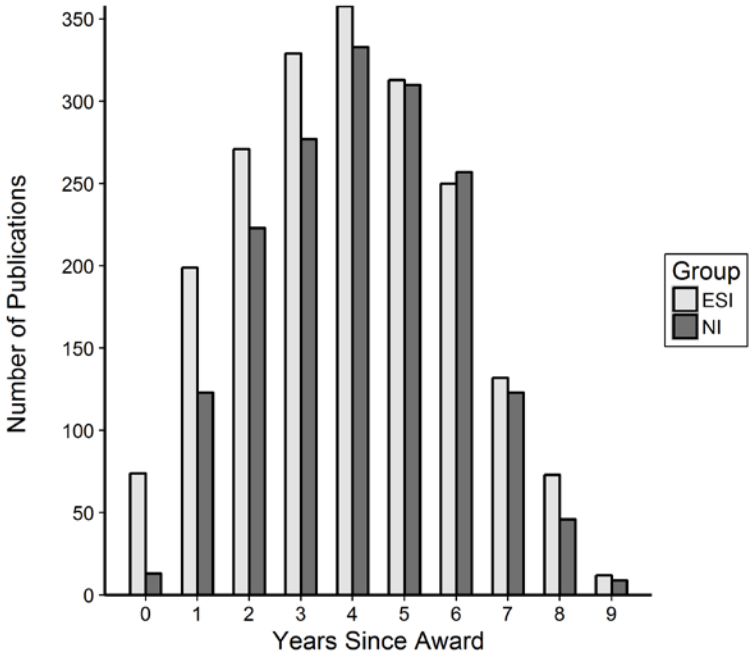


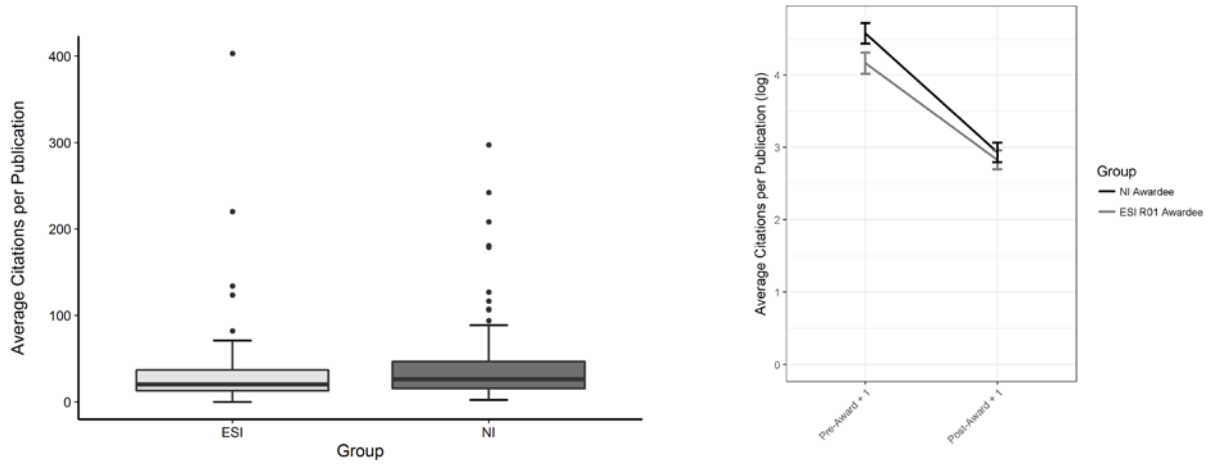
Figure 19. Distribution of Lag Time between Publication and Award Year

The STPI team used citations and journal ranking metrics to better understand the impact of research produced by NI awardees and ESI R01 awardees. Both metrics provide a proxy for an understanding of the relevance and quality of the published research—citations indicate reception among fellow researchers, while journal rankings indicate the perception of the research by academic publishers.

d. Citation Count

Attributed Publication Analysis. NI grant-attributed publications were cited more frequently by other researchers than ESI R01-attributed publications, Wilcoxon signed-rank, $V = 4324$, $p = .006$, $r = .18$. The median NI awardee averaged 26.41 citations per publication (95% CI [21.12, 31.25]), while the median ESI R01 awardee averaged 20.36 citations per publications (95% CI [14.92, 24.45]) (Figure 20, Panel A).

Career Publication Analysis. There was a statistically significant Group X Time interaction for average number of citations per publications, $F_{(1,110)} = 10.15$, $p = .002$, $\eta^2_p = .084$, indicating that group differences in average citation rates varied for *pre-award* + 1 and *post-award* + 1 publications. Follow-up simple effects analyses were conducted to tease apart this interaction. NI awardees tended to have more average citations per publication than ESI R01 awardees for *pre-award* + 1 publications, $M_{\log(NI) - \log(ESI)} = .412$, $p < .001$, 95% CI [0.223, 0.600], but there was no statistically significant group difference in average citations per publications for *post-award* + 1 publications, $M_{\log(NI) - \log(ESI)} = .103$, $p = .230$, 95% CI [–0.066, 0.271] (Figure 20, Panel B).



Panel A. Attributed Publications

Panel B. Career Publications

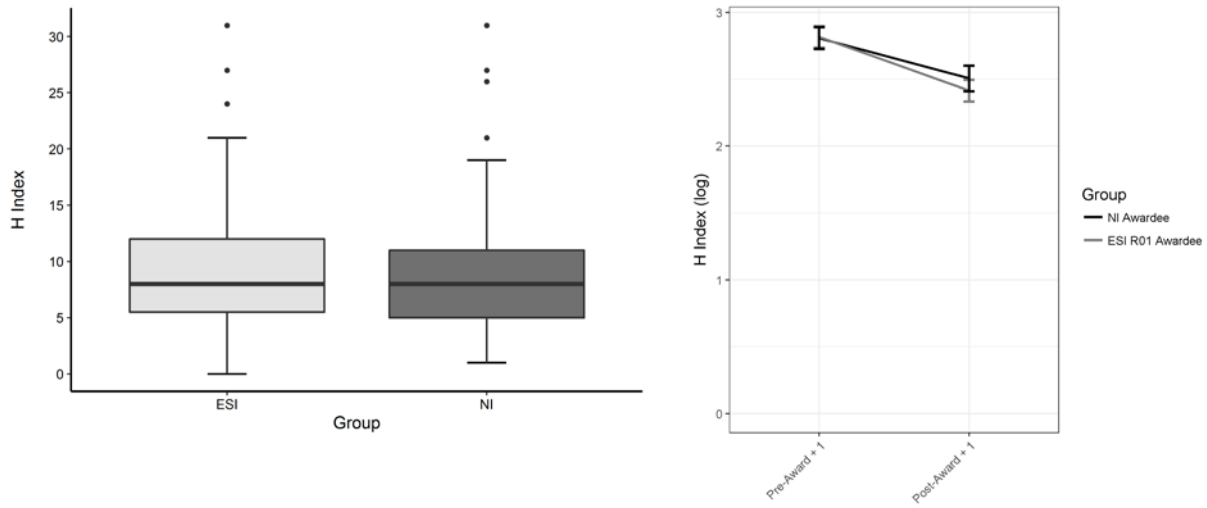
Figure 20. Average Citations per Publication.

e. H Index

Attributed Publication Analysis. NI and ESI R01 awardees did not differ significantly in their attributed publication H Index, Wilcoxon signed-rank, $V = 2652$, $p = .462$, $r = –0.05$. Both the median NI awardee and the median ESI R01 awardee had an H Index of 8 (95% CI [6.46, 9.00] and 95% CI [6.34, 8.99], respectively) (Figure 21, Panel A).

Career Publication Analysis. Overall, there was no statistically significant difference between NI awardees and ESI R01 awardees with respect to H-index, $F_{(1,110)} = .699$, $p = .405$, $\eta^2_p = .006$. There was a statistically significant difference in H-indexes from *pre-award* + 1 *to post-award* +

1, $F_{(1,110)}$ = 108.74, p < .001 , η^2_p = .497, such that awardees' *pre-award* + 1 H-indexes were significantly larger than *post-award* + 1 H-indexes, $M_{\log(\text{post award}) - \log(\text{pre award})}$ = –0.352, 95% CI [–0.419, –0.285]. There was no statistically significant Group X Time interaction, $F_{(1,110)}$ = 3.06, p = .083 , η^2_p = .027, indicating that group differences in H-indexes did not significantly vary from *pre-award* + 1 to *post-award* + 1 (Figure 21, Panel B).



Panel A. Attributed Publications

Panel B. Career Publications

Figure 21. H Index

2. Journal Impact Factor and Ranking

The STPI team calculated the average journal impact factor of each NI and matched ESI R01 awardee. The team used three journal impact factors: (1) *Impact Per Publication (IPP)*, which measures the average number of citations per journal publication; (2) *Source-Normalized Impact Per Publication (SNIP)*, which normalizes the IPP metric to account for differences between research fields; and (3) *SCImago Journal Ranking (SJR)*, which emphasizes the sources used by prestigious journals and creates associated weights associated with levels of prestige. Relative Citation Ratios (RCR) was included as an article-level, field-independent measure.[13]

a. Relative Citation Ratio (RCR)

Relative Citation Ratios (RCRs) were obtained from a subset of attributed publications published from 1995-2014 (N = 3, 276). One ESI did not have any qualifying publications; this case and the matched NI counterpart were removed from the analysis. Overall, NI awardees

[13] More complete explanation of RCR can be found at https://icite.od.nih.gov

(Median = 2.05, 95% CI [1.78, 2.30]) published articles with larger RCRs than ESI R01 awardees, (Median = 1.57, 95% CI [1.34, 1.85]), Wilcoxon signed-rank, $V = 4529$, $p < .001$, $r = .23$ (Figure 23). When compared to the medians for all NIH-funded papers that are listed on the NIH iCITE website, the NI awardee median approximates the 76th percentile and the ESI R01 awardee median approximates the 67th percentile.

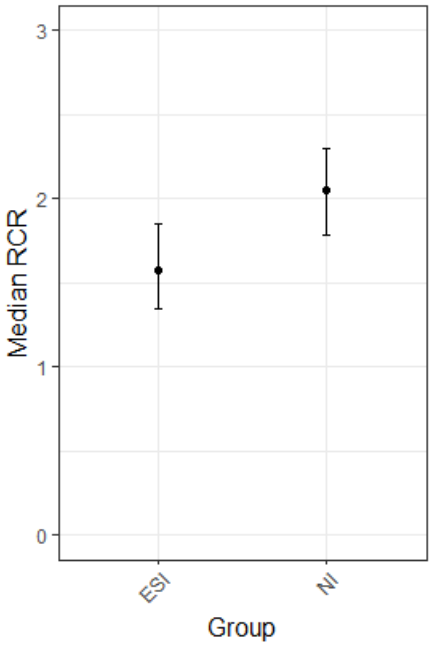
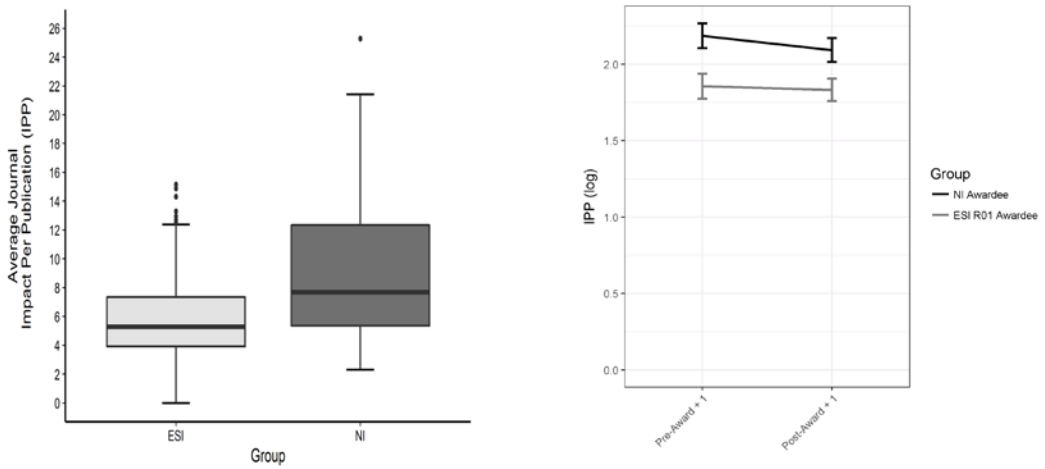


Figure 22. Attributed Publication Analysis: RCR

b. IPP Journal Metric

Attributed Publication Analysis. The median NI awardee published in a journal with an average IPP score of 7.69 (95% CI [6.71, 8.47]), while the median matched ESI R01 awardee published in a journal with an average IPP of 5.30 (95% CI [4.84, 5.74]), Wilcoxon signed-rank, $V = 5200$, $p < .001$, $r = .34$ (Figure 23, Panel A).

Career Publication Analysis. Overall, NI awardees tended to publish in journals with larger IPPs than ESI R01 awardees, $F_{(1,110)} = 39.94$, $p < .001$, $\eta^2_p = .266$, $M_{\log(NI) - \log(ESI)} = .296$, 95% CI [0.203, 0.389]. Further, there was a statistically significant effect of Time, $F_{(1,110)} = 7.03$, $p = .009$, $\eta^2_p = .060$, such that awardees tended to publish *post-award* + 1 publications in journals with smaller IPPs ($M_{\log(\text{post award}) - \log(\text{pre award})} = .296$, 95% CI [0.203, .389]). There was no statistically significant Group X Time interaction, $F_{(1,110)} = 2.65$, $p = .106$, $\eta^2_p = .024$ (Figure 23, Panel B).



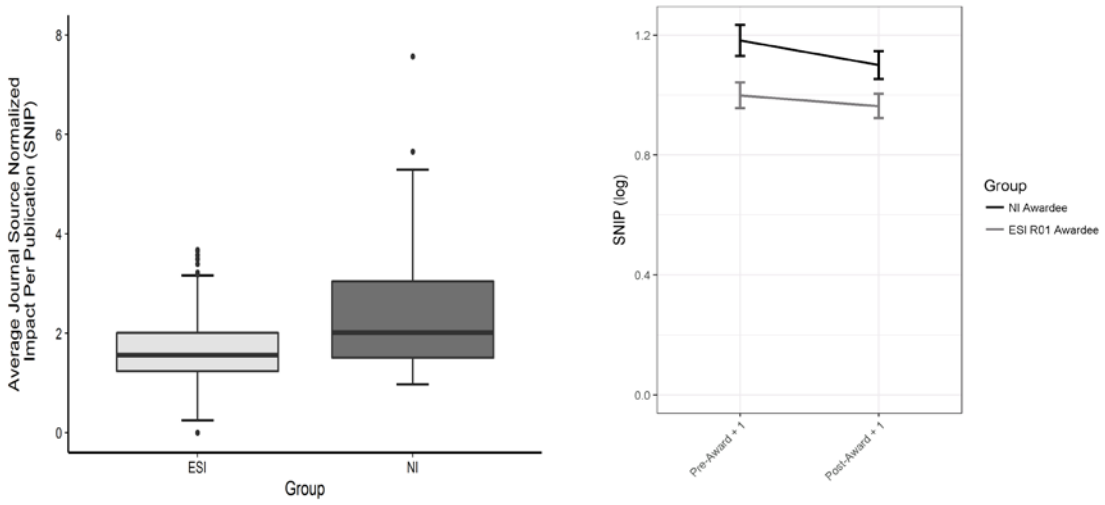
Panel A. Attributed Publications Panel B. Career Publications

Figure 23. Average Impact per Publication (IPP)

c. SNIP Journal Metric

Attributed Publication Analysis. When using the field-normalized impact factor, the median NI awardee published in a journal with a mean SNIP of 2.04 (95% CI [1.84, 2.23]), while the median ESI R01 Awardee published in a journal with a mean SNIP of 1.56 (95% CI [7.48, 1.64]), Wilcoxon signed-rank, $V = 4964$, $p < .001$, $r = .30$ (Figure 24, Panel A).

Career Publication Analysis. There was a statistically significant effect of group, $F_{(1,110)} = 32.45$, $p < .001$, $\eta^2_p = .228$, such that NI awardees tended to publish in journals with a larger SNIP than did ESI R01 awardees ($M_{\log(NI) - \log(ESI)} = .160$, 95% CI [0.104, 0.215]). Further, there was a statistically significant effect of Time, $F_{(1,110)} = 15.52$, $p < .001$, $\eta^2_p = .124$, such that awardees tended to publish *post-award* + 1 publications in journals with a smaller SNIP ($M_{\log(NI) - \log(ESI)} = -0.059$, 95% CI [–0.088, –0.029]). There was no statistically significant Group X Time interaction, $F_{(1,110)} = 2.83$, $p = .095$, $\eta^2_p = .025$ (Figure 24, Panel B).



Panel A. Attributed Publications Panel B. Career Publications

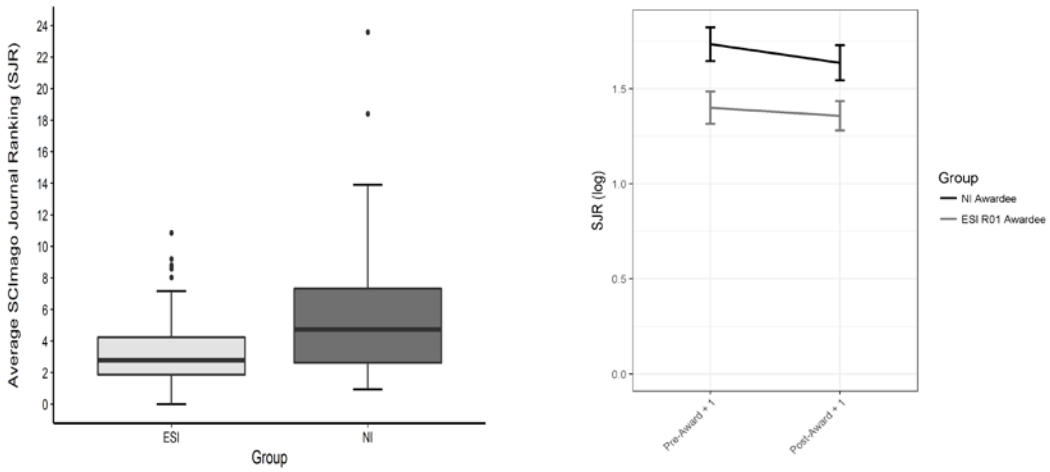
Figure 24. Average Source-Normalized Impact per Publication (SNIP)

d. SCImago Journal Ranking (SJR)

Attributed Publication Analysis. NI grant-attributed publications were more likely to be published in journals with a higher SJR relative to their matched ESI counterparts. The median NI awardee published in a journal with a mean SJR of 4.75 (95% CI [3.94, 5.69]), while the median ESI R01 Awardee published in a journal with a mean SJR of 2.79 (95% CI [2.42, 3.09]), Wilcoxon signed-rank, $V = 5231$, $p < .001$, $r = .35$ (Figure 25, Panel A).[14]

Career Publication Analysis. There was a statistically significant effect of group, $F_{(1,110)} = 39.61$, $p < .001$, $\eta^2_p = .266$, such that NI awardees tended to publish in journals with larger SJRs than did ESI R01 awardees ($M_{\log(NI) - \log(ESI)} = .307$, 95% CI [0.210, 0.403]). Further, there was a statistically significant effect of Time, $F_{(1,110)} = 9.51$, $p = .003$, $\eta^2_p = .080$, such that awardees tended to publish *post-award* + 1 publications in journals with smaller SJRs ($M_{\log(\text{post award}) - \log(\text{pre award})} = -.070$, 95% CI [–0.115, –0.025]). There was no statistically significant Group X Time interaction, $F_{(1,110)} = 1.68$, $p = .197$, $\eta^2_p = .015$, indicating that the relationship between Group and SJR did not vary significantly from *pre-award* + 1 to *post-award* + 1 (Figure 25, Panel B).

[14] For reference, *Nature* has an SJR of 17.31, *Science* has an SJR of 10.11, *Proceedings of the National Academy of Sciences of the United States (PNAS)* has an SJR of 5.78, and *PLoS ONE* has an SJR of 1.30.



Panel A. Attributed Publications Panel B. Career Publications

Figure 25. Average SCImago Journal Ranking (SJR)

e. Summary of Findings: Research Impact and Productivity

The results from the bibliometric analysis on impact and productivity metrics indicate that NI awardees tended to publish fewer grant-attributed publications than ESI R01 awardees. Further, the lag between administration of the award and first attributed publication tended to be longer for NI awardees than ESI R01 awardees. However, NI awardees tended to publish more *post-award* + 1 compared to ESI R01 awardees, despite having a similar number of *pre-award* + 1 annual career publications.

NI awardees tended to publish attributed publications in journals with larger IPP, SNIP, and SJR ratings. Further, NI awardees tended to have more citations per publication than ESI R01 awardees. However, NI awardees and ESI R01 awardees do not differ significantly in their attributed publication H Index. Regarding career publications, NI awardees tended to have more citations for *pre-award* + 1 career publications and publish in journals with larger IPP, SNIP, and SJR ratings than do ESI R01 awardees.

3. Coauthor Network

In order to better understand how the NI and ESI R01 Awards affected research collaboration, the STPI team analyzed the network of coauthors formed by each awardee's body of publications. All analyses indicates that the NI award has no notable effect on coauthor network size relative to similar ESI R01 Awards.

a. Average Authors per Paper

Career Publication Analysis. There was no statistically significant effect of group, $F_{(1,110)} = .003$, $p = .958$, $\eta^2_p < .001$. There was a statistically significant effect of Time, $F_{(1,110)} = 54.83$, $p < .001$, $\eta^2_p = .333$, such that awardees tended to have more authors per publication for *post-award*

+ 1 publications ($M_{\log(\text{post award}) - \log(\text{pre award})}$ = .212, 95% CI [0.155, 0.269]). There was no statistically significant Group X Time interaction, $F_{(1,110)}$ = .61 , p = .435, η^2_p = .006, indicating that the relationship between Group and average co-authors per publication did not vary significantly for *pre-award* + 1 *to post-award* + 1 (Figure 26).

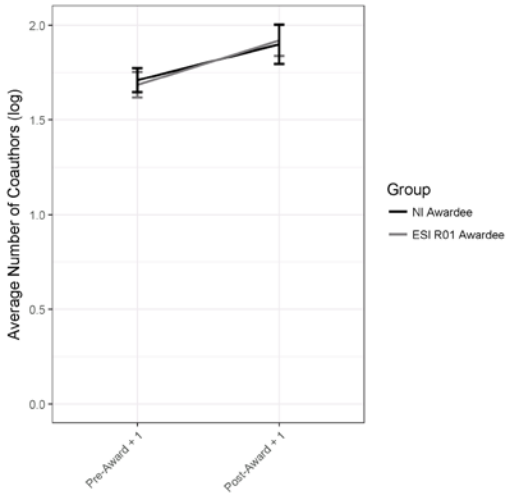


Figure 26. Career Publication Analysis: Average Number of Authors per Paper

b. Unique Number of Coauthors

Career Publication Analysis. There was no statistically significant effect of group, $F_{(1,110)}$ = .580, p = .448, η^2_p = .005. There was a statistically significant effect of Time, $F_{(1,110)}$ = 76.43, p < .001 , η^2_p = .410, such that awardees tended to have more total co-authors in their network following their awards ($M_{\log(\text{post award}) - \log(\text{pre awardI})}$ = .440, 95% CI [0.341, 0.540]). There was no statistically significant Group X Time interaction, $F_{(1,110)}$ = .340 , p = .561, η^2_p = .003, indicating that the relationship between Group and total co-authors did not vary significantly from *pre-award* + 1 to *post-award* + 1 (Figure 27).

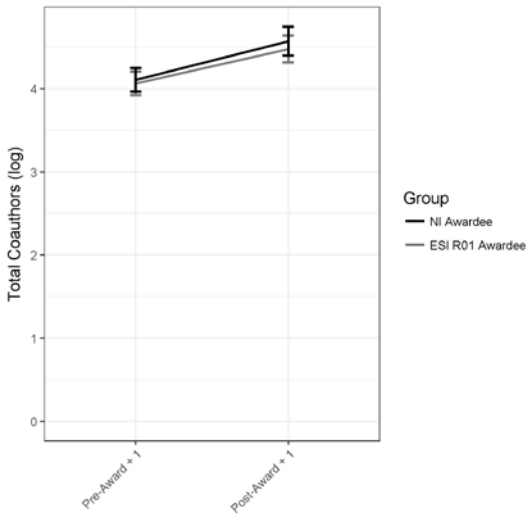


Figure 27. Career Publication Analysis: Number of Unique Coauthors.

4. Coauthor Affiliations

a. Number of Institutions engaged in Grant Supported Research

Career Publication Analysis. There was no statistically significant effect of group, $F_{(1,110)}$ = .836, p = .362, η^2_p < .008. There was a statistically significant effect of Time, $F_{(1,110)}$ = 54.13, p < .001 , η^2_p = .330, such that awardees tended to have more institutions in their network following their award ($M_{\log(\text{post award}) - \log(\text{pre award})}$ = .384, 95% CI [0.281, 0.488]). There was no statistically significant Group X Time interaction, $F_{(1,110)}$ = .804, p = .413, η^2_p = .006, indicating that the relationship between Group and total institutions did not vary significantly from *pre-award* + 1 to *post-award* + 1 (Figure 28).

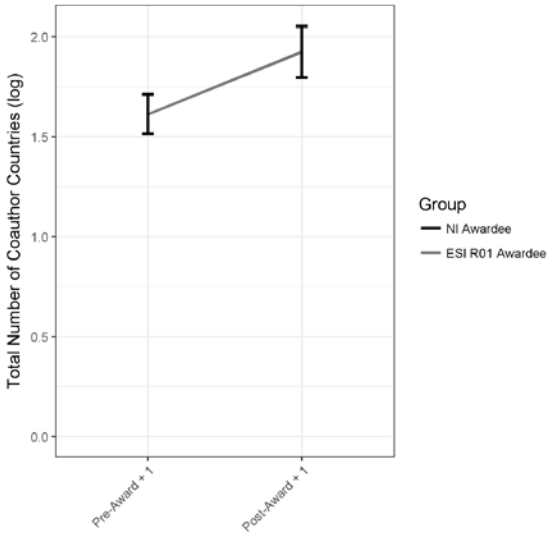


Figure 28. Career Publication Analysis: Count of Unique Institutions in Coauthor Network

Career Publication Analysis. There was no statistically significant effect of group, $F_{(1,110)}$ = .0004, p = .984, η^2_p < .001. There was a statistically significant effect of Time, $F_{(1,110)}$ = 47.93, p < .001 , η^2_p = .303, such that awardees tended to have more countries in their networks following their awards ($M_{\log(\text{post award}) - \log(\text{pre award})}$ = .311, 95% CI [0.222, 0.400]). There was no statistically significant Group X Time interaction, $F_{(1,110)}$ = .001 , p = .976, η^2_p < .001, indicating that the relationship between Group and total countries did not vary significantly from *pre-award* + 1 to *post-award* + 1 (Figure 29).

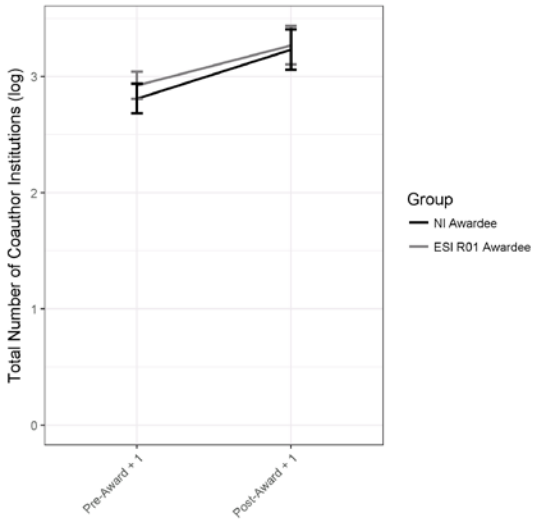


Figure 29. Career Publication Analysis: Count of Unique Countries in Coauthor Network

b. Summary of Findings: Co-author Network

NI awardees and ESI R01 awardees had similar profiles of co-author networks for career publications. Both NI awardees and ESI R01 awardees increased the size of their co-author networks following their respective awards, as evidenced by *post-award* + 1 increases in the number of coauthors, institutions, and countries involved in their published research.

5. Interdisciplinarity

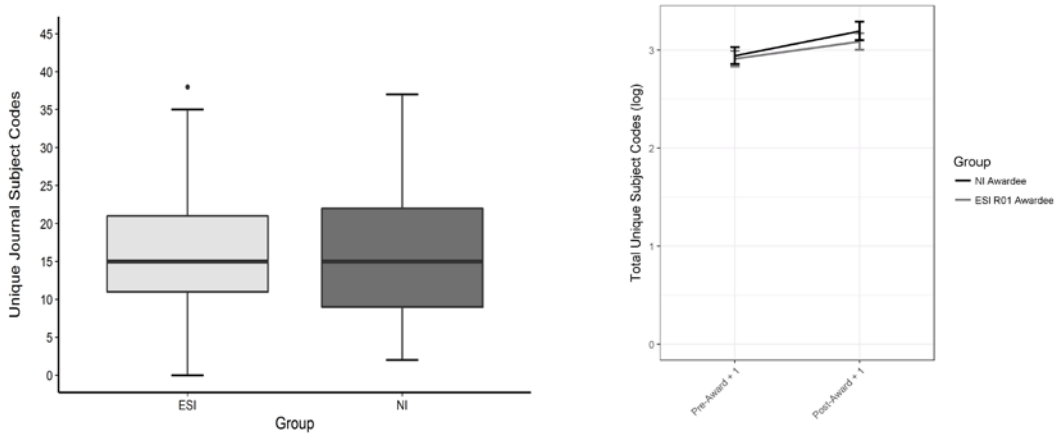
As noted previously and in Appendix A, interdisciplinarity is defined as a mode of research by teams or individuals that integrates perspectives/concepts/theories and/or tools/techniques and/or information/data from two or more bodies of specialized knowledge or research practice. Its purpose is to advance fundamental understanding or to solve problems whose solutions are beyond the scope of a single field of research practice. This concept can be operationalized through an assessment of the number of unique subject codes associated with a research publication.

a. Journal Subject Codes

The STPI team analyzed journal subject codes assigned by Scopus to journals as an indicator of the fields covered within. A journal can have a single subject code or upward of a half dozen. While these subject codes do not provide as much insight as an in-depth read of each publication, they can serve as a proxy for the fields contained in the grant-funded research.

Attributed Publication Analysis. There was no statistically significant difference in the number of unique subject codes covered by NI and ESI grant-attributed publications, Wilcoxon signed-rank, $V = 2885$, $p = .62$, $r = -0.03$. Both the median NI and median ESI R01 Awardees published across 15 unique subject codes (95% CI [13.07, 18.72] and 95% CI [13.78, 16.69]), respectively (Figure 30, Panel A).

Career Publication Analysis. There was no statistically significant effect of group, $F_{(1,110)} = 1.80$, $p = .182$, $\eta^2_p = .016$. There was a statistically significant effect of Time, $F_{(1,110)} = 63.70$, $p < .001$, $\eta^2_p = .367$, such that awardees tended to have more total subject codes following their awards ($M_{\log(\text{post award}) - \log(\text{pre award})} = .311$, 95% CI [0.222, 0.400]). There was no statistically significant Group X Time interaction, $F_{(1,110)} = 2.40$, $p = .124$, $\eta^2_p = .021$, indicating that the relationship between Group and total unique subject codes did not vary significantly from *pre-award* + 1 to *post-award* + 1 (Figure 30, Panel B).



Panel A. Attributed Publications Panel B. Career Publications

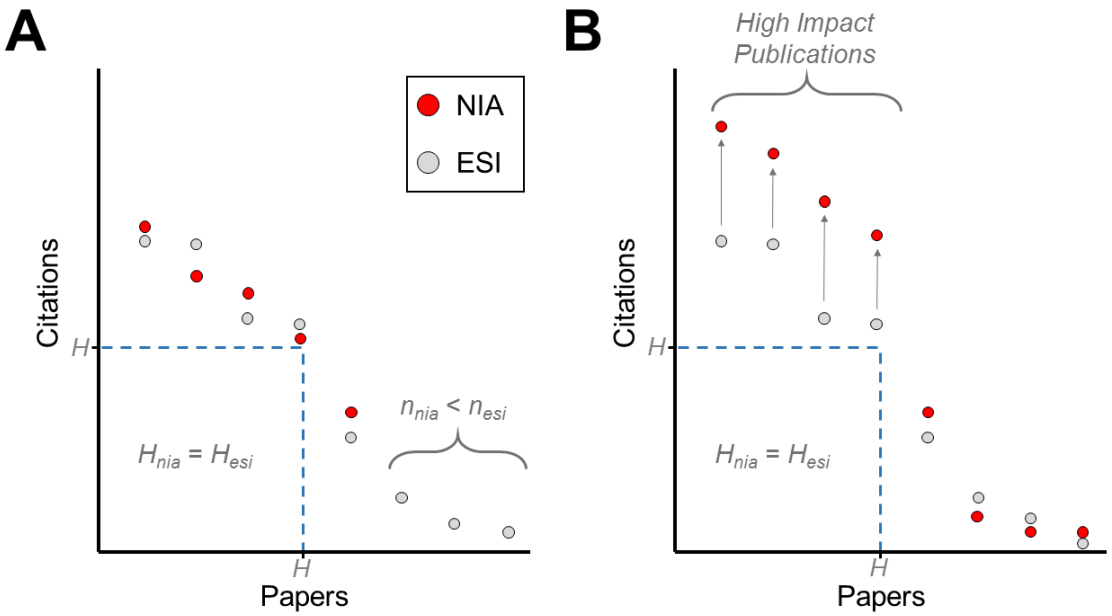
Figure 30. Unique Journal Subject Codes

b. b. Summary of Findings: Interdisciplinarity

NI awardees and ESI R01 awardees had similar profiles with respect to unique subject codes.

C. Summary of Findings

Bibliometric analysis shows that NI awardees and ESI R01 awardees differ significantly in publication production, most indicators of publication impact, and one aspect of coauthor networks (Table 15). NI awardees produced fewer grant-attributed publications on both an annual and cumulative basis. Furthermore, NI awardees tended to take longer to produce publications when compared with their ESI counterparts. On the other hand, NI awardees produced publications that received more citations from other researchers and were published in higher-impact journals. Interestingly, NI and ESI R01 Awardees do not differ significantly in terms of grant-attributed H Index, despite NI awardees averaging more citations per publication. This may be because NI awardees produce fewer publications on average, or it may be that while ESI and NI both have a similar number of high-impact publications, those by NI awardees receive more citations (Figure 31). Additionally, while ESI R01 Awardees tended to publish in collaboration with more institutions than NI awardees, there was no other indication that ESI and NI coauthor networks differ in any quantitative or qualitative sense. Lastly, NI and ESI R01 Awardees do not differ in terms of interdisciplinarity, as measured by the number of unique journal subject codes associated with attributed publications.



Note: In both explanations above, the hypothetical NI awardee has a higher average citation count per publication, but the same H Index as the hypothetical ESI R01 awardee. (A) The NI awardee has fewer low-impact publications. (B) While the ESI and NI awardee have the same number of high-impact publications (those above the H Index threshold), those of the NI awardee average more citations.

Figure 31. Possible Explanations for NI Awardees Averaging More Citations per Publication than ESI R01 Awardees, Yet Having the Same H Index as ESI R01 Awardees

Table 15. NI and ESI R01 Award-Attributed Publication Bibliometrics

		Group						
		NI Awardees		ESI R01 Awardees				
		Mdn	95% CI	Mdn	95% CI	*V*	*p*	*r*
Production	**Number of Publications**	12	[10.20, 13.17]	14	[11.25, 17.00]	2197.5	**<.05**	**-0.15**
	Publications per Year	1.57	[1.32, 1.81]	1.75	[1.75, 2.14]	2204	**<.05**	**-0.14**
	Publishing Delay	4.14	[3.91, 4.30]	3.68	[3.41, 3.87]	4556	**<.001**	**0.26**
Impact	**Avg. Citations per Publication**	26.41	[21.11, 31.25]	20.36	[14.92, 24.45]	4324	**<.01**	**0.18**
	H-Index	8	[6.46, 9.00]	8	[6.34, 8.99]	2652	.46	-0.05
	Avg. RCR	2.05	[1.78, 2.30]	1.57	[1.34, 1.85]	4529	**<.001**	**0.23**
	Avg. Journal IPP	7.69	[6.71, 8.47]	5.30	[4.84, 5.74]	5200	**<.001**	**0.34**
	Avg. Journal SNIP	2.04	[1.84, 2.23]	1.56	[1.48, 1.64]	4964	**<.001**	**0.30**
	Avg. Journal SJR	4.75	[3.94, 5.69]	2.79	[2.42, 3.09]	5231	**<.001**	**0.35**
Coauthor Network	**Avg. Coauthors per Publication**	5.68	[5.17, 6.06]	5.79	[5.10, 6.48]	3430.5	.79	0.02
	Unique Coauthors	39	[30.24, 45.88]	42	[33.23, 50.06]	2904.5	.29	-0.07
	Unique Coauthor Institutions	9	[7.11, 10.77]	12	[10.65, 14.69]	2178	**<.01**	**-0.17**
	Unique Coauthor Countries	3	[2.53, 3.62]	3	[2.12, 3.99]	1932	.15	-0.10
Inter-disciplinarity	**Unique Journal Subject Codes**	15	[12.60, 17.61]	15	[13.02, 16.29]	2885	.62	-0.03

Note. Statistically significant findings are in bold.

6. Grant Funding Analysis

The ability to compete successfully for grant funding is often necessary for the continuation of biomedical and biobehavioral research. To examine the NI and ESI R01 awardee's ongoing funding status, the STPI team analyzed the number of grant applications submitted by the NI and ESI R01 awardees over the eight years following the receipt of their respective awards and the number of those applications that were funded.

A. Methodology

NI and ESI grant information was obtained from the IMPAC II database. The STPI team used *R* software to extract records for applications on which the 230 NI and ESI R01 awardees were listed as PIs. The 5,429 resulting records were reduced to 2,036 after: (1) restricting analyses to Type 1 and Type 2 competitive applications; (2) removing Type 1 applications for the originally awarded project; (3) removing applications submitted before the award date or after 8 years of the award date; and (4) keeping one record per distinct awardee, type, and project (i.e., resubmissions were not counted as new applications).

The STPI team then compared: (1) the proportion of each awardee group that applied; (2) the average number of applications submitted by NI and ESI R01 Awardees; (3) the rate at which each groups' applications were awarded; (4) the average number of awards received by NI and ESI R01 Awardees; and (5) the proportion of each awardee group that received one or more awards. These comparisons were made for all Type 1 applications for any NIH grant, DP1 Type 1 applications, and R01 applications. More specifically, the team tested R01 Type 1 applications, R01 Type 2 applications, R01 Type 1 and 2 applications combined, and R01 Type 1 and 2 applications from the ESI R01 Awardee group versus Type 1 applications for only the NI awardee group for R01 grants. The final unbalanced comparison was motivated by the question of whether ESI researchers were more likely to submit Type 2 R01 applications to continue their original award research.

To test significant differences between the proportion of awardees who applied and were awarded funding, the team used McNemar's chi-square test for paired data. Two sample proportion tests and Fisher's Exact tests (for small expected frequencies) assessed the degree to which the award group was related to the proportion of applications awarded. Wilcoxon signed rank tests for paired samples were used to assess differences in the number of applications submitted and awarded for each group. All tests were two-tailed with $\alpha_{critical} = .05$. Significance levels were not adjusted for multiple comparisons. Summary tables with descriptive and inferential statistics follow each results sub-section.

B. Results: NI and ESI Post-Award Grant Applications and Awards

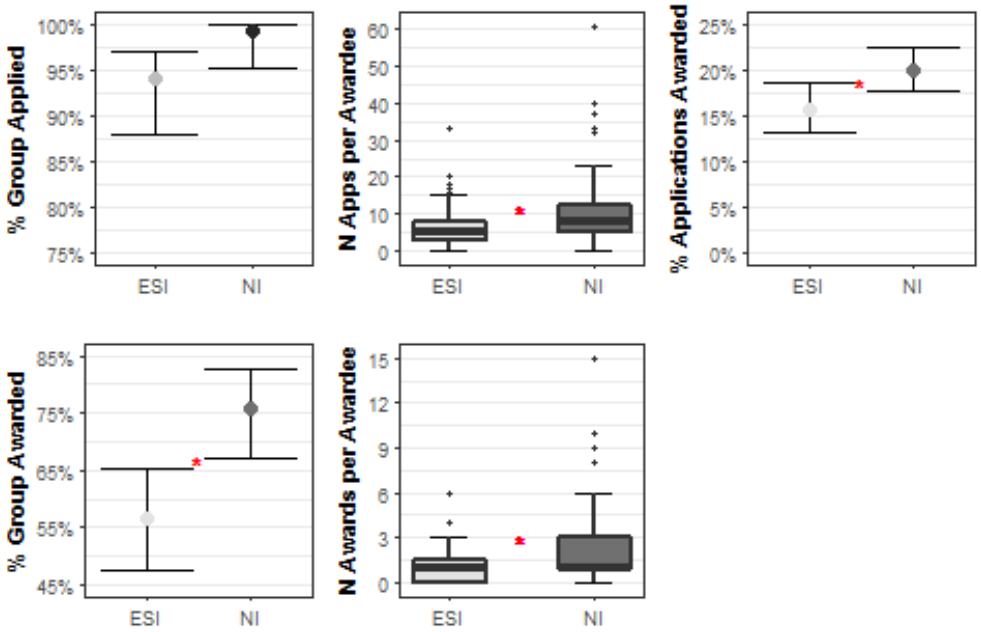
1. All NIH NI and ESI Applications and Awards

a. Applied for Funding

The STPI team first examined all Type 1 applications for any NIH grant submitted by NI and ESI R01 Awardees. There was no significant difference in the proportion of each awardee group that submitted at least one application. However, NI awardees submitted significantly more applications than did ESI R01 Awardees. Comparisons are illustrated in Figure 32, and Table 16 provides descriptive statistics and statistical test results.

b. Received Funding

Compared to the ESI R01 Awardee group's applications, NI awardee applications were awarded at a significantly higher rate. Thus, on average, NI awardees received significantly more awards than did ESI R01 Awardees. The proportion of awardees who were funded was significantly higher in the NI awardee group as compared to the ESI R01 Awardee group.



* Indicates statistically significant difference

Figure 32. All NIH Grants Applied for and Received by NI and ESI R01 Awardees

Table 16. All NIH Applications and Awards

	NI Awardees		*ESI R01 Awardees*		*Test Statistic*	*p Value*	*Effect Size*
	Statistic	**95% CI**	**Statistic**	**95% CI**			
Applications							
Mean (SD)	10.17 (8.70)	[8.48, 11.65]†	6.43 (5.24)	[5.44, 7.35]†			
Median	8.00	[6.00, 9.00]†	5.00	[4.00, 5.00]†	V = 777.50	**<.001**	r = **0.24**
Proportion of Group Applied	99.13% (114/115)	[95.24%, 99.96%]‡	93.91% (108/115)	[87.97%, 97.02%]‡	$\chi^2_{(df=1)}$ = 3.12	.077	*OR* = 7.00
Awards							
Mean (SD)	2.03 (2.23)	[1.60, 2.41]†	1.01 (1.21)	[0.78, 1.22]†			
Median	1	[1.00, 2.00]†	1	[0.00, 1.00]†	V = 969.00	**<.001**	r = **0.27**
Percentage of Applications Awarded	19.93% (233/1169)	[17.74%, 22.32%]‡	15.68% (116/740)	[13.23%, 18.47%]‡	$\chi^2_{(df=1)}$ = 5.21	**.022**	*Phi* = **0.05**
Percentage of Group Awarded	75.65% (87/115)	[67.06%, 82.58%]‡	56.52% (65/115)	[47.40%, 65.23%]‡	$\chi^2_{(df=1)}$ = 7.60	**.006**	*OR* = **2.22**

Note. Statistically significant findings are in bold; OR = Odds Ratio.
† Bootstrapped Basic confidence intervals.
‡ Wilson score-test-based binomial confidence intervals.

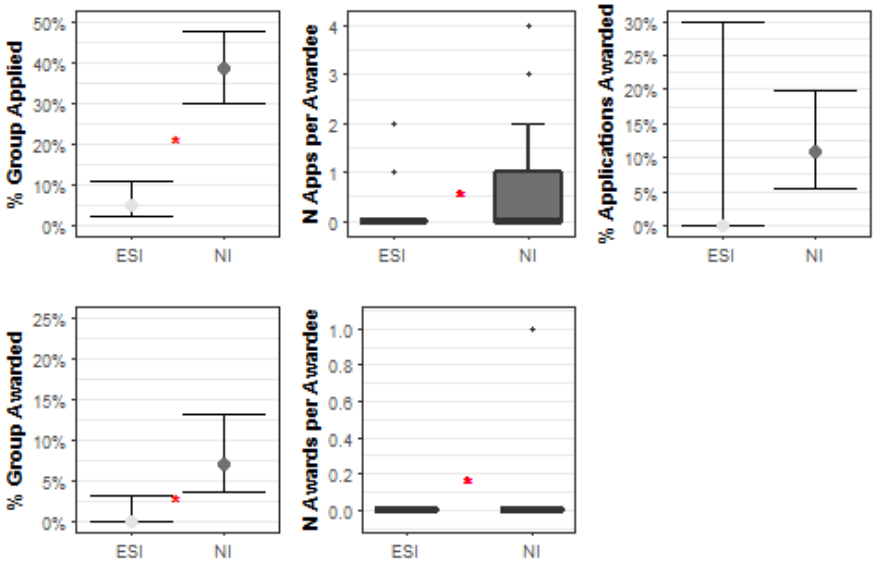
2. DP1 Awards

a. Applied for Funding

A significantly higher proportion of NI awardees than ESI R01 Awardees applied for DP1 funding. In addition to being more likely to apply, NI awardees also submitted significantly more applications. Figure 33 illustrates all comparisons, and Table 17 provides all descriptive statistics and statistical test results.

b. Received Funding

DP1 applications were awarded at a similar rate for each awardee group. However, NI awardees received significantly more awards than did ESI R01 Awardees because they submitted more applications (Of the 74 NI awardee DP1 applications submitted, 8 were awarded; for the 9 ESI R01 awardee DP1 applications, none were awarded). The proportion of awardees who received DP1 funding was significantly higher in the NI awardee group compared to the ESI R01 Awardee group.



* Indicates statistically significant difference

Figure 33. DP1 Grants Applied for and Received by NI and ESI Awardees

Table 17. DP1 Applications and Awards

	NI Awardees		ESI R01 Awardees		Test Statistic	p Value	Effect Size
	Statistic	**95% CI**	**Statistic**	**95% CI**			
Applications							
Mean (SD)	0.64 (1.00)	[0.45, 0.82]†	0.08 (0.35)	[0.01, 0.14]†			
Median	0.00	[0.00, 0.00]†	0.00	[0.00, 0.00]†	V = 150.00	**<.001**	r = **0.32**
Proportion of Group Applied	38.26% (44/115)	[29.89%, 47.39%]‡	5.22% (6/115)	[2.41%, 10.92%]‡	$\chi^2_{(df=1)}$ = 27.38	**<.001**	*OR* = **7.33**
Awards							
Mean (SD)	0.07 (0.26)	[0.02, 0.11]†	0.00 (0.00)	[0.00, 0.00]†			
Median	0.00	[0.00, 0.00]†	0.00	[0.00, 0.00]†	V = 0.00	**.006**	r = **2.22**
Percentage of Applications Awarded	10.81% (8/74)	[5.58%, 19.91%]‡	0.00% (0/9)	[0.00%, 29.91%]‡	$\chi^2_{(df=1)}$ = 0.19	0.660	*Phi* = 0.11
Percentage of Group Awarded	6.96% (8/115)	[3.57%, 13.13%]‡	0.00% (0/115)	[0.00%, 3.23%]‡	$\chi^2_{(df=1)}$ = 6.12	**.013**	*OR* = **17.00**

Note. Statistically significant findings are in bold ; OR = Odds Ratio.
† Bootstrapped Basic confidence intervals.
‡ Wilson score-test-based binomial confidence intervals.

3. R01 Grants

The STPI team analyzed differences in several combinations of R01 Type 1 and Type 2 applications and awards in order to understand the NI and ESI post-award application and award landscape. Figures 34a and 34b illustrate all comparisons, and descriptive statistics and results for each comparison are shown in Tables 18a, 18b, 18c, and 18d.[15]

a. Applied for Funding

A significantly higher proportion of NI awardees applied for R01Type 1 grants than did ESI R01 Awardees. NI awardees also submitted significantly more applications than did ESI R01 Awardees.

In contrast, compared to the ESI R01 Awardee group, a significantly lower proportion of the NI awardee group submitted R01 Type1 and 2 applications. NI awardees also submitted significantly fewer R01 Type 2 applications than did ESI R01 Awardees.

Ignoring type, similar proportions of the NI and ESI R01 Awardee groups submitted R01 applications. However, NI awardees submitted more applications on average than did ESI R01 Awardees. Type 1 applications submitted by NI awardees were more numerous than Type 1 and 2 applications submitted by ESI R01 Awardees.

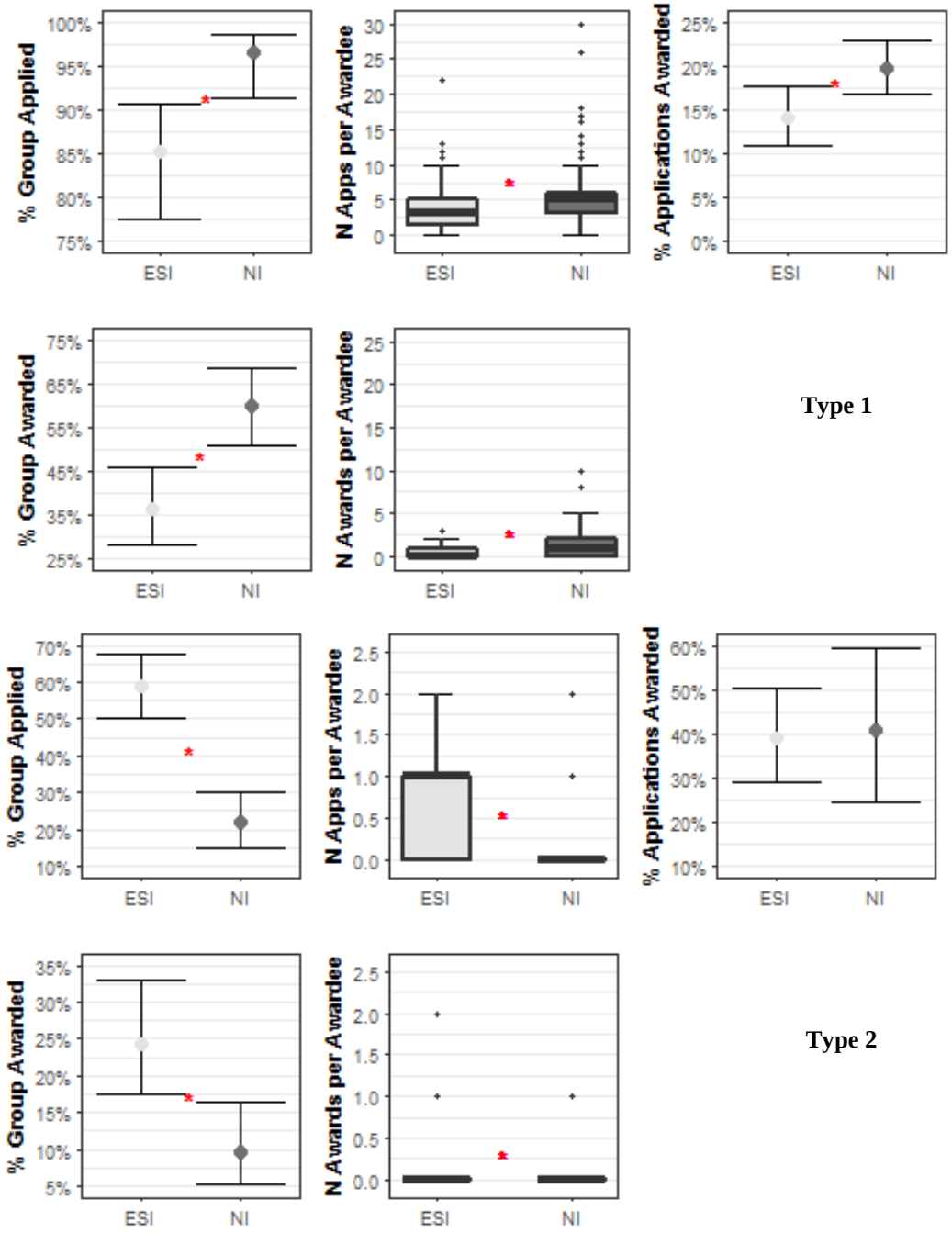
b. Received Funding

NI R01 Type 1 applications were also awarded at a significantly higher rate than were ESI applications. Thus, NI awardees received significantly more Type 1 R01 awards on average and the NI awardee group was funded by Type 1 awards at a significantly higher proportion than was the ESI R01 Awardee group.

R01 Type 2 applications were awarded at a similar rate, but NI awardees received significantly fewer R01 Type 2 awards. A significantly smaller proportion of the NI awardee group was funded by R01 Type 2 awards than was the ESI R01 Awardee group.

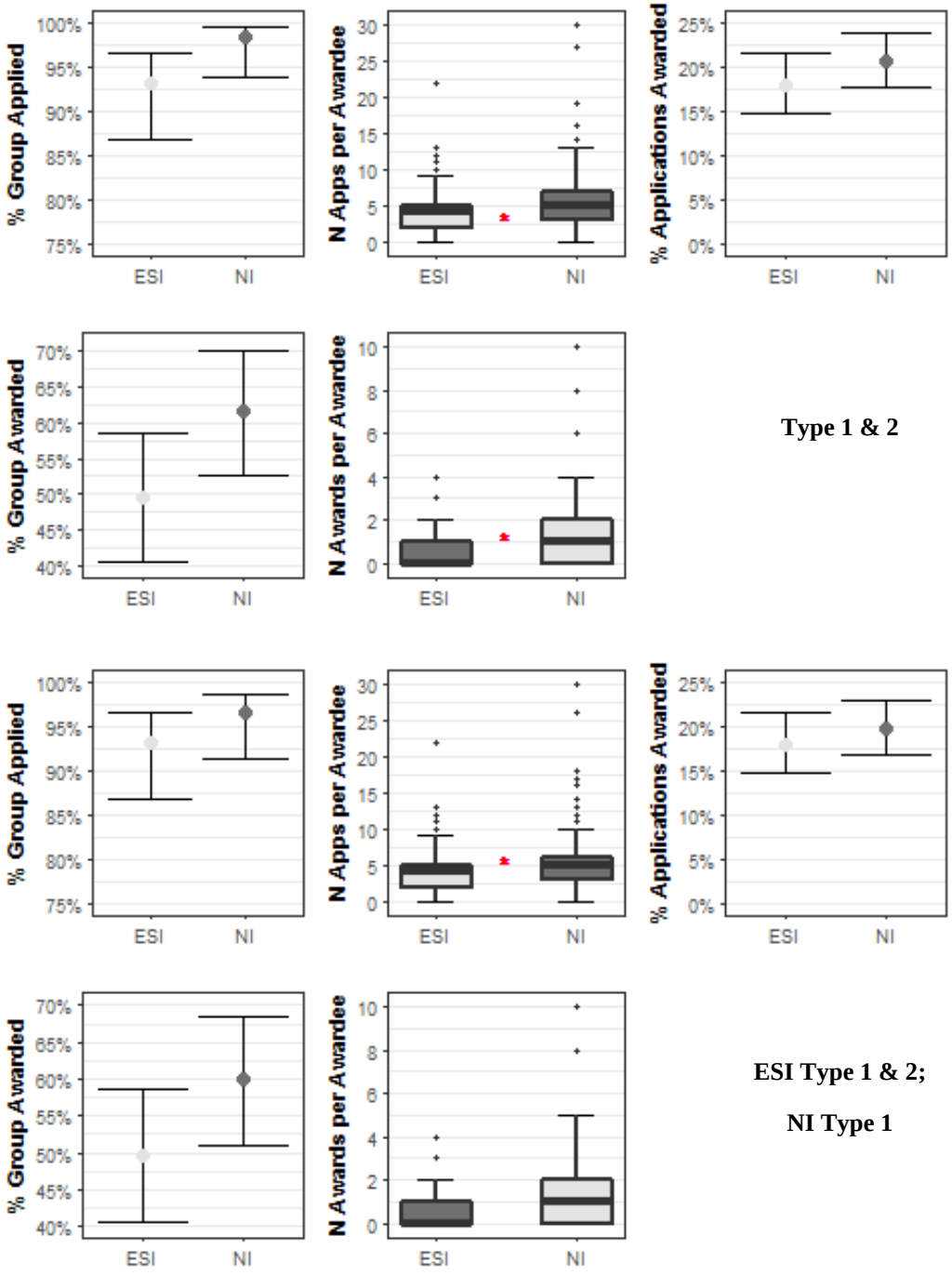
Ignoring type, applications from each group were awarded at a similar rate. NI awardees received more R01 awards on average than did ESI R01 Awardees, but ESI R01 Type 1 and Type 2 awards together outnumbered NI R01 Type 1 awards. Similar proportions of each group received any type of R01 funding.

[15] Two NI awardees received R01 Type 1 grants in the same year that they received their NI DP2 award. This created a discrepancy in the tabulation of R01 Type 1 awards due to selection criteria; however, it did not change the overall results and conclusions of the analysis.



* Indicates statistically significant difference.

Figure 34a. R01 Grants Applied for and Received by NI and ESI R01 Awardees



* Indicates statistically significant difference.

Figure 34b. R01 Grants Applied for and Received by NI and ESI R01 Awardees

Table 18a. R01 Type 1 Applications and Awards

Type 1	NI Awardees		ESI R01 Awardees		Test Statistic	p Value	Effect Size
	Statistic	**95% CI**	**Statistic**	**95% CI**			
Applications							
Mean (SD)	5.61 (4.70)	[4.70, 6.41]†	3.62 (3.41)	[2.97, 4.21]†			
Median	5.00	[5.00, 6.00]†	3.00	[3.00, 4.00]†	V = 1681.00	**<.001**	r = **0.24**
Proportion of Group Applied	96.52% (111/115)	[91.40%, 98.64%]‡	85.22% (98/115)	[77.60%, 90.56%]‡	$\chi^2_{(df=1)}$ = 6.86	.093	*OR* = 1.61
Awards							
Mean (SD)	1.10 (1.48)	[0.82, 1.36]†	0.50 (0.77)	[0.37, 0.63]†			
Median	1.00	[1.00, 1.00]†	0.00	[0.00, 0.00]†	V = 643.00	**<.001**	r = **0.26**
Percentage of Applications Awarded	19.69% (127/645)	[16.80%, 22.93%]‡	13.94% (58/416)	[10.94%, 17.60%]‡	$\chi^2_{(df=1)}$ = 5.41	**.020**	*Phi* = **0.07**
Percentage of Group Awarded	60.00% (69/115)	[50.86%, 68.49%]‡	36.52% (42/115)	[28.29%, 45.63%]‡	$\chi^2_{(df=1)}$ = 12.29	**<.001**	*OR* = **2.93**

Note. Bolded results are significant; OR = Odds Ratio.
† Bootstrapped Basic confidence intervals.
‡ Wilson score-test-based binomial confidence intervals.

Table 18b. R01 Type 2 Applications and Awards

Type 2	NI Awardees		ESI R01 Awardees		Test Statistic	p Value	Effect Size
	Statistic	95% CI	Statistic	95% CI			
Applications							
Mean (SD)	0.23 (0.47)	[0.15, 0.31]†	0.67 (0.62)	[0.56, 0.78]†			
Median	0.00	[0.00, 0.00]†	1.00	[1.00, 1.00]†	V = **1399.00**	**<.001**	r = **-0.35**
Proportion of Group Applied	21.74% (25/115)	[15.18%, 30.12%]‡	59.13% (68/115)	[49.99%, 67.68%]‡	$\chi^2_{(df=1)}$ = **32.07**	**<.001**	*OR* = **-0.12**
Awards							
Mean (SD)	0.10 (0.30)	[0.04, 0.15]†	0.26 (0.48)	[0.17, 0.35]†			
Median	0.00	[0.00, 0.00]†	0.00	[0.00, 0.00]†	V= **351.00**	**.001**	r = **-0.21**
Percentage of Applications Awarded	40.74% (11/27)	[24.51%, 59.27%]‡	38.96% (30/77)	[28.84%, 50.13%]‡	$\chi^2_{(df=1)}$ = 0.00	>.999	*Phi* = 0.02
Percentage of Group Awarded	9.57% (11/115)	[5.43%, 16.32%]‡	24.35% (28/115)	[17.42%, 32.94%]‡	$\chi^2_{(df=1)}$ = **8.83**	**.003**	*OR* = **-0.26**

Note. Bolded results are significant; OR = Odds Ratio.
† Bootstrapped Basic confidence intervals.
‡ Wilson score-test-based binomial confidence intervals.

Table 18c. R01 Types 1 and 2 Applications and Awards

Type 1 &2	NI Awardees		ESI R01 Awardees		Test Statistic	p Value	Effect Size
	Statistic	**95% CI**	**Statistic**	**95% CI**			
Applications							
Mean (SD)	5.84 (4.78)	[4.92, 6.66]†	4.29 (3.51)	[3.63, 4.90]†			
Median	**5.00**	**[5.00, 6.00]†**	**4.00**	**[4.00, 5.00]†**	***V* = 2060.00**	**0.010**	***r* = 0.17**
Proportion of Group Applied	98.26% (113/115)	[93.88%, 99.52%]	93.04% (107/115)	[86.87%, 96.43%]	$\chi^2_{(df=1)} = 2.50$	0.114	*OR* = 4.00
Awards							
Mean (SD)	1.20 (1.56)	[0.90, 1.46]†	0.77 (0.95)	[0.59, 0.93]†			
Median	**1.00**	**[1.00, 1.00]†**	**0.00**	**[-1.00, 0.00]†**	***V* = 1181.00**	**0.030**	***r* =** 0.14
Percentage of Applications Awarded	20.54% (138/672)	[17.65%, 23.75%]‡	17.85% (88/493)	[14.72%, 21.47%]‡	$\chi^2_{(df=1)} = 1.15$	0.284	*Phi* = 0.03
Percentage of Group Awarded	61.74% (71/115)	[52.61%, 70.11%]‡	49.57% (57/115)	[40.59%, 58.57%]‡	$\chi^2_{(df=1)} = 2.82$	0.093	*OR* = 1.61

Note. Statistically significant findings are in bold; OR = Odds Ratio.
† Bootstrapped Basic confidence intervals.
‡ Wilson score-test-based binomial confidence intervals.

Table 18d. NI Awardees Type 1 R01 and ESI R01 Awardee Types 1 and 2 R01 Applications and Awards

NI Type 1, ESI Type 1 & 2	NI Awardees		ESI R01 Awardees		Test Statistic	p Value	Effect Size
	Statistic	**95% CI**	**Statistic**	**95% CI**			
Applications							
Mean (SD)	5.61 (4.70)	[4.70, 6.42]†	4.29 (3.51)	[3.63, 4.90]†			
Median	5.00	[5.00, 6.00]†	4.00	[4.00, 5.00]†	V = **2154.50**	**.031**	r = **0.14**
Proportion of Group Applied	96.52% (111/115)	[91.40%, 98.64%]‡	93.04% (107/115)	[86.87%, 96.43%]‡	$\chi^2_{(df=1)}$ =0.75	.386	*OR* = 2.00
Awards							
Mean (SD)	1.10 (1.48)	[0.82, 1.36]†	0.77 (0.95)	[0.59, 0.93]†			
Median	1.00	[1.00, 1.00]†	0.00	[-1.00, 0.00]†	V = 1266.00	.113	r = 0.10
Percentage of Applications Awarded	19.69% (127/645)	[16.80%, 22.93%]‡	17.85% (88/493)	[14.72%, 21.47%]‡	$\chi^2_{(df=1)}$ = 0.50	.478	*Phi* = 0.02
Percentage of Group Awarded	60.00% (69/115)	[50.86%, 68.49%]‡	49.57% (57/115)	[40.59%, 58.57%]‡	$\chi^2_{(df=1)}$ = 2.02	.156	*OR* = 1.50

Note. Statistically significant findings are in bold; OR = Odds Ratio.
† Bootstrapped Basic confidence intervals.
‡ Wilson score-test-based binomial confidence intervals.

C. Summary of Findings

Overall, the two groups were similarly likely to apply for post-award funding, but NI awardees were more likely to submit DP1 and R01 Type 1 applications, whereas ESI R01 Awardees were better positioned and thus more likely to submit R01 Type 2 applications. With the exception of R01 Type 2 applications, NI awardees also consistently submitted more applications. Generally, applications were awarded at the same rate, but because of their higher submission rate, NI awardees tended to receive more awards, and the NI awardee group was generally more likely to be funded. Having already received an R01 Type 1 grant, ESI R01 awardees were better positioned to submit R01 Type 2 applications, although NI awardees seemed to compensate with more R01 Type 1 applications. This NI awardee finding might be anticipated as the NI award is a DP1 mechanism, thus requiring NI awardees to submit R01 Type 1 applications to continue their research.

7. Case Study Interviews

The case study interviews were designed to solicit detailed, anecdotal information from a subset of NI and ESI R01 Awardee survey respondents. Through a semi-structured interview process, the STPI team aimed to gather information about these individuals' perceptions of the award mechanism, their award research, and the impact of their awards on career progression. The results of these interviews are intended to supplement, corroborate, and provide context for findings gathered in the awardee survey and senior scientist review.

A. Methodology

1. Interview Format

The STPI team developed the case study protocol using both top-down and bottom-up approaches: from the top down, modifying the protocol used during the study STPI conducted of the NIH Director's Pioneer Award (NDPA); and from the bottom up, identifying awardee survey responses that might benefit from further clarification in an interview format. Interview questions addressed:

- The decision to apply,
- How the proposal was written,
- How the research was conducted,
- Award impact on collaboration and laboratory structure,
- Concurrent and follow-on funding,
- Tenure and other career impacts.

Interview questions are provided in Appendix G. Standard interview protocols were employed, interviews were conducted by phone, and each interview required 30–40 minutes of the interviewee's time. Clarification of comments was conducted as necessary by email.

2. Interviewee Selection

Through consultation with the trans-NIH High Risk Research Program Committee, and given the time and resource intensiveness of interviews, the STPI team conducted 30 interviews. Fifteen NI and 15 ESI R01 Awardee survey respondents were identified for each comparison group (Figure 34).

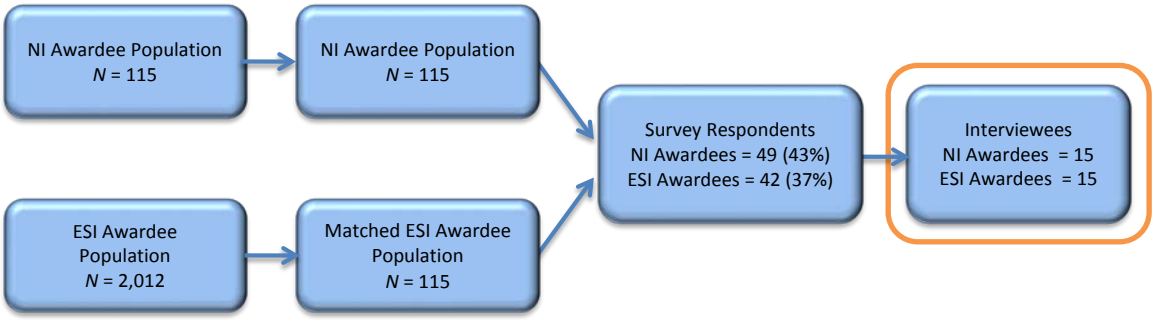


Figure 35. Study Populations and Interviewees

Because of NIH interest in the initial awardee survey findings on tenure, awardees who had not yet received tenure or supplied ambiguous answers on the awardee survey were included in the interviews. The additional interviewees were identified by a random selection algorithm. Names have been redacted to maintain the confidentiality agreement between STPI and the awardees.

3. Analysis

Semi-structured interviews generate qualitative, non-uniform responses and are often difficult to categorize. Interviewees responded to each question with differing degrees of specificity, so awardees' responses were subjectively evaluated and grouped according to similar themes. Some responses are quoted specifically in order to highlight specific points raised in the interviews.

B. Results

The following section is organized around five major topic areas: experience with NIH funding prior to award receipt and application considerations (Pre-Award); approach to research and objectives accomplished under the awards (Research Activities); other funding mechanisms supporting award research (Concurrent and Follow-on Funding); the effects of the awards on the career progression and scientific reputation of the awardees (Impact on Awardee); and NI awardee suggestions for NIH (NI Awardee Suggestions). Each section contains sub-sections built around specific interview questions.

1. Pre-Award

a. Prior to their NI and ESI R01 awards, what experience did awardees have with NIH funding?

Prior to receiving their NI or ESI R01 award, just over half (9/15) of NI awardees and approximately two thirds of ESI R01 (11/15) awardees had previously applied for NIH funding under various award mechanisms. For NI awardees, these mechanisms included the R01, R03, R21, K01, and K12 mechanisms; ESI R01 awardees applied under the R01, R03, R21, R33, K08, and F31 mechanisms. More NI awardees than ESI R01 awardees reported previously applying for R01 grants (4 NI awardees as compared to 2 ESI R01 awardees).

Approximately equal numbers of NI and ESI R01 awardees reported successfully obtaining NIH funding prior to their NI or ESI R01 Awards (4 NI awardees as compared to 5 ESI R01 awardees). Mechanisms under which NI awardees were funded included the K12 (1 individual), R21 (1 individual), and K01 (1 individual) mechanisms, while mechanisms under which the ESI R01 awardees were funded comprised the K08 (2 individuals), R03 (1 individual), R21 (1 individual), and F31 mechanisms (1 individual). In addition, one NI awardee reported receiving a K grant prior to receiving the NI award but did not specify which type.

b. Why did awardees choose to apply through the NI or ESI R01 award mechanism?

All NI awardees interviewed for the case studies indicated that they were attracted by the non-traditional grant mechanism offered by the NI award, specifically citing factors such as the lack of a preliminary data requirement, the essay format of the grant application, the focus on risk and innovation, and the flexibility of the award as attractive traits. These non-traditional aspects distinguished the NI award from the R01 mechanism, a determining factor for awardees who had difficulty obtaining R01s in the past and for awardees who had not previously applied for R01 funding but felt that their research was ill-suited for that or other traditional mechanisms. Only two awardees noted the prestige of the award in conjunction with their decision to apply, while only one mentioned the award amount.

In contrast, the most commonly cited factors in the application decision for ESI R01 awardees were the career importance of the R01 (5/15), the fit of the ESI R01 request for applications to the research interests of the awardee (5/15), and the size of the grant (4/15). When speaking about their decisions to apply to the R01 specifically rather than other NIH mechanisms such as the NI award, some ESI interviewees noted that they had sufficient preliminary data to apply through the R01 mechanism (4/15). Although approximately a third (6/15) of ESI R01 awardee interviewees said they were aware of the NI award mechanism at the time of their ESI R01 application, only two individuals indicated that they applied for the award. One interviewee specifically said that he felt his NI award application was unsuccessful because he had too much preliminary data. Interviewees who were aware of the NI award but chose not to apply did so either because they felt the award was too competitive to warrant an application or because they felt the R01 mechanism was a better fit for their research. When speaking about their decisions to apply, few of the ESI R01 Awardees focused on the ESI designation of their awards specifically, with only two mentioning that they felt that any advantage conferred by the designation influenced their decisions. Two interviewees indicated that the ESI R01 was the only grant available at the time that matched their research interests, and one individual disclosed that he was not aware that he was applying for an R01 with special review consideration for early stage investigators.

c. How did the research proposed in the NI/ESI R01 award application differ from previous awardee research?

Two thirds (10/15) of NI and approximately half (8/15) of ESI R01 awardees indicated that their award research was a new research direction for them. Some awardees considered their research a new direction because it was an entirely new topic area, while others classified their research as distinct from previous research because they were developing new methodologies or employing existing methodologies in novel ways.

All NI awardees interviewed for the case studies remarked that the applications they submitted for their NI awards differed from previous research proposals in terms of risk. Interviewees portrayed that risk in a variety of ways: the proposals were exploratory and not well-defined, they lacked preliminary data, they involved new or innovative methodological approaches, they challenged existing paradigms, or they tested unconventional theories or hypotheses.

In contrast, ESI R01 awardees generally suggested that they constructed their proposals as they would for other grants. Although one interviewee felt that the ESI designation allowed for some leniency on the preliminary data requirement, most ESI R01 awardees indicated that they applied for their awards as they would for a traditional grant. Many implied that the R01 was a critical but natural step in their career progression, noting no unique characteristics when describing their proposals. While approximately half (7/15) of the ESI R01 awardees indicated that their research was a continuation of previous research or research undertaken as a doctoral or post-doctoral student, three interviewees mentioned that their award was an opportunity to present themselves as independent researchers and therefore emphasized the importance of proposing a distinct research path.

"For the NI [award], I basically felt like I had the freedom to say, 'Hey look. We're going to try these very high risk, crazy things. We have some evidence we think they're going to work. We have some evidence to support the hypothesis. It may not work, but it's such an important question ..."

–NI awardee

"Knowing that I could be as bold and think in as far-reaching a manner as possible really encouraged me to go for it, to propose what I really wanted to do, what I thought we could accomplish. It allowed me to phrase the problem in a way that got to a fundamental, core problem in the field[…] The award, the opportunity, [and] the format of the award [were] an inspiration."

–NI awardee

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d. Did NI and ESI R01 awardees perceive their proposals as likely to be funded through traditional mechanisms?

Just under two thirds of (9/15) NI awardees submitted proposals similar to their NI award proposals prior to or concurrently with their NI applications. Most (6/9) of these applications were unsuccessful R01 applications, and interviewees suggested a number of potential explanations for their lack of success with traditional funding mechanisms. Awardees reasoned that these unsuccessful proposals were rejected for lack of preliminary data or for being too risky, too ambitious, too controversial, too exploratory, or insufficiently mature. Individuals who did not send their proposals elsewhere felt that these same concerns made their applications unlikely to be funded by other mechanisms. Many NI awardees also mentioned their youth and lack of established research programs among concerns about their ability to obtain alternative funding.

Interviewees indicated that the preliminary data requirements and acceptable level of risk for the ESI R01 were comparable to the traditional R01. One awardee was not aware of the ESI designation associated with his proposal at the time of application. Three others were aware of the designation but did not feel that it conferred any advantage to their applications.

2. Research Activities

a. Did NI and ESI R01 awardees conduct their award research differently?

When speaking about their research approach, all of the NI awardees highlighted the flexibility of the award mechanism. Most interviewees (13/15) focused specifically on the fact that they were not held strictly accountable to the research aims laid out in the initial proposals, noting that they felt free to take risky approaches, to change research directions, and to fail and redirect as necessary. Although this freedom was generally viewed as an asset, approximately half (8/15) of the NI awardees also noted that the high risk nature of the research and need to develop new methodologies translated to slow initial progress and delayed publications. Roughly half (7/15) of the interviewees spoke about the flexibility of their awards in terms of funding, specifically mentioning the availability of the award funds from the very first day of the award and the fact that they had full discretion in deciding how those funds were spent. Two awardees noted that receiving their awards removed typical burdens related to searching for funding and therefore allowed them to focus on research.

In contrast to the NI awardees, ESI R01 awardees did not indicate that their research approach varied greatly based upon the award mechanism. Two interviewees described their research approach using terms such as “step-wise” and “incremental.” While one interviewee mentioned feeling free to change research directions and another felt that he could alter his methodologies as needed, a third of interviewees (5/15) indicated that the only change to their research approaches from their previous research came from the increased independence associated with the first major award. One ESI R01 awardee indicated that receipt of his award allowed him to focus on research as opposed to grant-writing.

b. Did NI and ESI R01 awardees make laboratory or personnel changes to achieve their award research goals?

All NI and ESI R01 awardees interviewed for the case studies indicated that they used their funding to hire more or better qualified personnel. Most awardees hired post-doctoral researchers or brought on new graduate students (13/15 NI awardees and 11/15 ESI R01 awardees), while fewer (8/15 NI awardees and 6/15 ESI R01 awardees) hired technicians, research assistants, or specialists. Interviewees cited a variety of reasons for increased interest from post-doctoral and graduate students. Approximately half of the NI awardees emphasized the interesting or innovative nature of their research (7/15). In contrast, only three ESI R01 awardees mentioned the exciting nature of the scientific questions they were posing as explanation. A third of both NI and ESI R01 awardees suggested that the availability of stable funding was a key element in attracting graduate and post-doctoral students to their labs.

Although the responses regarding personnel changes were roughly equal across the NI and ESI R01 awardee groups, responses regarding laboratory expansion in terms of equipment were more disparate. Approximately half (7/15) of the NI but only two of the ESI R01 awardees used their funding to purchase new equipment.

3. Concurrent and Follow-on Funding

a. Did NI and ESI R01 award research receive funding through other mechanisms?

For the purpose of this analysis, the STPI team considered funding that coincided with the award period "concurrent funding" and funding that supported research initiated after the end of the NI award period "follow-on funding." Although approximately half (7/15) of the NI awardees interviewed for the case studies applied for concurrent NIH funding in the same research area as their award research, less than half (3/7) of those individuals were successful in obtaining that funding. In contrast, none of the ESI R01 awardees submitted grant applications for concurrent NIH funding in the area of their award research.

In terms of follow-on funding, the majority of NI (11/15) and ESI R01 awardees (12/15) indicated that they applied for, were in the process of applying for, or planned to apply for follow-on funding in the area of their award research. While over two thirds of the NI awardees (11/15) successfully obtained follow-on funding, only approximately one third (6/15) of ESI R01 awardees were able to do so. Roughly a third (6/15) of NI awardees received their follow-on funding in the form of the R01 mechanism, and two additional individuals received R21 funding to continue their NI award research. One NI interviewee unsuccessfully applied for a follow-on R01, and two more intended to apply in the future at the time of the case study interviews. Five NI awardees received follow-on funding related to their award research from organizations other than NIH, including the U.S. Department of Veteran's Affairs, the Gates Foundation, drug companies, and non-specified private foundations.

"It felt like a lot of review committees were waiting for the [New Innovator] award to expire. It was as if they were waiting to see what came out of the award."

–NI awardee

"People felt I was too well-funded… so that made it harder to get [an R01] until later in the [New Innovator award] timeline."

–NI awardee

Three ESI R01 awardees successfully renewed their R01s or obtained R01s closely related to their award research, while four other ESI R01 interviewees indicated that they applied for renewals but were unsuccessful. At the time of the case study interviews, six ESI R01 Awardees indicated that they were in the process of renewing or planned to apply for renewal of their R01 or a closely related R01 in the future. No ESI R01 awardees received follow-on R21s in the area of their award research. Three additional ESI R01 awardees received funding for projects related to their ESI R01 research from non-NIH sources; these sources included non-specified private foundations, the American Heart Association, and pharmaceutical company funding.

Although many NI awardees indicated that their awards were helpful in obtaining concurrent or follow-on funding, a number of interviewees identified challenges in securing that funding. One third (5/15) of awardees indicated that delays in publishing their high-risk research affected their ability to obtain follow-on funding. Three NI interviewees mentioned that they had to propose more conservative ideas to receive additional funding or had to maintain two separate lines of work: one for traditional research and one for more innovative approaches. Two awardees suggested that the loss of their ESI status was a detriment when competing with more-established labs for funding. One interviewee noted that review committees felt that he was too well-funded to receive additional grants, even though he was applying with proposals in different topic areas. Another awardee mentioned that he had difficulty proving to review committees that additional research he was proposing was distinct from his NI research because of the lack of highly specific aims in his NI grant. Finally, one interviewee noted that although, as a significant source of funding, the NI award provided confidence to other potential funding groups, an R01 would have likely achieved the same effect.

4. Impact on Awardee

a. How did the NI and ESI R01 awards impact the career progression of awardees in terms of tenure or promotion?

At the time of the case study interviews, two thirds (10/15) of the NI awardees interviewed were tenured at their institutions. Two awardees were promoted at their home institutions after

receipt of their awards, and one of those individuals was promoted to a tenure-track position. Another interviewee transferred institutions at the end of his award and was applying for tenure at the time of his interview. Only one interviewee indicated that he was not tenured and mentioned no promotions or plans to apply for tenure. The remaining awardee is employed by a non-tenure-granting organization.

Just over one third (6/15) of NI awardees noted that their awards positively affected their careers either in terms of tenure or promotion, although three of these individuals also acknowledged that they received R01s after their NI awards and that these awards were likely advantageous during the tenure process also. NI awardees who viewed their awards as beneficial for career advancement discussed factors such as the prestige of the award, the demonstration of ability to obtain funding, and the quality of the research associated with it. However, one (1/15) interviewee viewed her award as roughly equivalent to an R01 in terms of importance to her tenure committee and another indicated that it would be difficult to predict whether the NI award provided an advantage beyond an R01 in terms of tenure. The latter individual indicated elsewhere in his interview that the NI and R01 awards have roughly equivalent effects in terms of career.

Another subset (6/15) of NI interviewees indicated that while their awards were helpful in terms of career advancement, they also presented challenges:

- One interviewee stipulated that tenure was delayed due to loss of ESI status and the extended time it took to publish innovative NI research. This individual did not receive tenure until receiving an R01.
- Another awardee noted that the inability to renew the award was disadvantageous and said that having an R01 in addition to the NI award would have been an enormous advantage during the tenure process.
- One NI awardee felt that he needed current funding at the time of his tenure review, which occurred after the conclusion of his NI award period. Because receiving his NI award kept him from applying for, and ultimately receiving, R01s until the completion of award period, he felt that the NI award delayed his tenure process. However, he also indicated that, had he been eligible for tenure review during his NI award period, the NI award likely would have been sufficient for tenure.
- Finally, three individuals mentioned difficulties convincing their tenure committees to view the NI award as an R01 equivalent for the purposes of meeting tenure requirements.

Only one awardee viewed his award exclusively as a detriment during the tenure process; this individual cited the inability to renew the grant and low-impact factors due to delays in publishing high-risk research as explanation. One non-tenured interviewee suggested that his award had no impact on his tenure process and that demonstration of new funding would be required for tenure.

About half (7/15) of the ESI R01 awardee interviewees were tenured at the time of the case study interviews. One additional ESI R01 awardee was tenured before transferring to a position at

a non-tenure-granting institution. Two interviewees were employed by non-tenure-granting institutions but were promoted as the result of their awards. Two awardees transferred institutions and received tenure-track positions at their new universities. One individual remains on the tenure track but stipulated that tenure was delayed due to a natural disaster destroying the laboratory. Another interviewee was applying for tenure at the time of the interview. Finally, one awardee disclosed initial promotion after receiving the ESI R01 but was ultimately removed from the tenure track after failing to secure follow-on funding.

Nearly all of (14/15) of the ESI R01 awardees indicated that their awards had a positive influence on their career trajectories. Some interviewees (4/15) indicated that obtaining an R01 was necessary for career progression, with a subset of these individuals emphasizing the importance of renewability (2/15). Other (3/15) individuals mentioned that the requirement for tenure at their institutions was to demonstrate funding and funding stability but that the funding source did not necessarily have to be an R01. Other (7/15) awardees simply suggested that obtaining the grant was a significant boost to their careers but either indicated that there was no strict tenure requirement for funding or type of funding or did not reveal what those requirements were. The individual who was removed from the tenure track after failing to secure a renewal of the R01 implied that renewable funding was necessary for advancement but did not clarify whether that funding had to come in the form of an R01. When speaking about career impact, ESI R01 awardees tended to view their awards as equivalent to a traditional R01: one interviewee noted that "You need an R01, broadly speaking, during the first seven years of your career, whatever the R01 happens to be called."

b. Besides tenure or promotion, what other career impacts can be associated with the NI or ESI R01 awards?

The majority (11/15) of NI awardees felt that the NI award was recognized by their colleagues as prestigious, while none of ESI R01 awardees made similar statements about the prestige of the ESI R01 award. Although most NI awardees indicated that their awards were highly esteemed, one interviewee indicated that the perception of the award varied by institution. In contrast, while none of the ESI R01 awardees described their award as "prestigious," three interviewees indicated that their award was viewed as a sign of professional maturity by their colleagues or institutions, and one interviewee located in a non-university research institution indicated that, in general, NIH funding is highly regarded. One NI awardee suggested that in terms of increasing professional profile, the NI award likely conferred benefits beyond those that an R01 award could provide.

> *"When you are [an NI awardee] you stand out."*
>
> –ESI R01 awardee

Approximately half of NI (7/15) and a third (5/15) of ESI R01 awardees indicated that their respective awards led to an increase in speaking or panel invitations. However, a number of interviewees from both groups noted that any increase in invitations was an indirect effect. These individuals felt that it would be more accurate to attribute increases in invitations to the quality of the award research, increased publication rate, or increased visibility as independent investigators rather than to the award itself.

In terms of non-research responsibilities as faculty members, only one NI awardee and one ESI R01 awardee reported lower teaching burdens following receipt of their respective awards. These individuals clarified that increased funding levels allowed them to decrease their teaching loads at their universities.

All NI awardees and all but two ESI R01 awardees indicated that they expanded or strengthened their collaborative networks as a result of their awards. One awardee who indicated that requests for collaboration did not increase did note an increase in data-sharing requests. Awardees strengthened existing collaborations, were contacted more by investigators interested in collaborating, found that other researchers were more receptive to requests for collaborations, or some combination thereof. NI awardees credited the interesting and innovative nature of their research, their funding levels, and the high quality of resulting data and publications with this increase, while ESI R01 awardees suggested that establishing independence with their grants, their scientific findings, and the need for collaborative efforts to achieve research aims played a role in expanding and strengthening their networks.

5. NI Awardee Suggestions

When asked whether they had any additional comments they wanted passed on to NIH many (12/15) NI awardees offered suggestions related to the award and the award mechanism. Common suggestions included allowing a no-cost extension of the award (7/12) and creating a competitive renewal process for the grant (4/12). While some interviewees suggested that the NI award program should continue (2/12) or be expanded to support more researchers (1/12), others emphasized the importance of continuing to support researchers working on high-risk, high-reward projects by creating a mechanism similar to the NI award for mid-career researchers (4/12) or by altering existing mechanisms, such as the traditional R01 and the ESI R01, to better support innovation (2/12). One interviewee thought it was important that NIH focus on sustaining innovation among NI awardees but offered only a non-specific suggestion. Other suggestions included removing the award's impact on the investigator's ESI status (1/12) and developing ways to evaluate innovative research that accounts for the potential delay in publication because of the high-risk nature of the work (1/12).

C. Summary of Findings

The results of this case study analysis reveal that NI awardees generally differ from ESI R01 awardees in their motivations for applying and perceptions of the application process, their

approach to their award research, their ability to obtain concurrent and follow-on funding, and their impressions of the career impact of their awards. Awardees were, however, similar in several aspects, particularly those that bear some relationship to the early investigator status of both awardee groups. These similarities include that both groups tended to be new to NIH funding, used their grants to pursue new research areas, expanded their laboratories and collaborative networks to achieve their research aims, and, on the whole, viewed the awards as having a positive impact on their careers.

In accordance with the requirements of both the NI and ESI R01 Awards, which stipulate that awardees must be early stage investigators who have not previously received substantial NIH research grants, only approximately a third of interviewees indicated that they had successfully obtained NIH research funding prior to their award applications, and none had obtained major research grants. Although interviewees from both awardee groups tended to be relatively new to NIH funding, they differed in their motivations for applying through their respective award mechanisms and their approaches to their proposals. In speaking about their motivations to apply, NI awardees cited aspects that differentiated the NI award from traditional awards, such as the call for innovative or high-risk research and the lack of a preliminary data requirement, while ESI R01 awardees emphasized aspects that would also apply to a traditional R01, such as the career importance of the grant. The majority of both NI and ESI R01 awardees indicated that their proposals outlined research that they would consider a new research area, with some awardees emphasizing the importance of establishing an independent research path as a young investigator. All NI interviewees indicated that they approached the proposal in a riskier manner than they would a proposal for a traditional grant mechanism, whereas ESI R01 awardees generally suggested that they constructed their proposals as they would for any other grant. In addition, NI awardees believed that their research was unlikely to be funded by other mechanisms, primarily because of its high-risk nature and the lack of preliminary data. ESI R01 awardees did not voice similar concerns.

In terms of research approach, NI awardees highlighted the flexibility of the award mechanism, both in terms of funding and accountability to the research aims outlined in their proposals. In contrast, ESI R01 awardees generally indicated that they approached their research as they would any other project. The only difference from previous research, noted by a third of ESI R01 awardee interviewees, was the increased independence associated with obtaining the first major award as an independent investigator. Interviewees from both awardee groups suggested that they expanded their labs to achieve the research aims by hiring new or better qualified personnel, but more NI awardees than ESI R01 awardees mentioned that they purchased new equipment with their funds.

While more NI than ESI R01 awardees reported securing concurrent or follow-on NIH research funds in the same research area as their award research, NI awardees identified challenges in securing that funding. Notably, a third of NI interviewees suggested that delays in publishing their high-risk research affected their ability to obtain follow-on funding.

Nearly all ESI R01 awardees indicated that their awards had a positive impact on their career trajectories in terms of professional advancement. NI awardees were also generally positive about the impact of their awards on their career progressions, though they noted several detrimental aspects. Challenges identified included difficulties convincing tenure committees to view the NI award as an R01 equivalent for the purposes of tenure, inability to renew the award, and lower productivity due to delayed publication of high-risk research. Nevertheless, most NI awardees noted that their awards were viewed as prestigious, whereas ESI R01 awardees did not indicate that their awards were perceived as such. Fewer than half of interviewed awardees from both groups felt that their awards led to increased speaking and panel invitations, and only one NI and one ESI R01 awardee mentioned a decreased teaching burden associated with their awards. All awardees interviewed, with the exception of two ESI R01 awardees, believed that their collaborative networks were strengthened as a result of their awards.

When suggestions for improvements to the NI award program were solicited from NI awardees, the most common suggestions were to offer a no-cost extension or competitive renewal of the grant, or, more generally, to expand the number and type of NIH funding mechanisms that support innovative research.

8. Integration of Findings

This section assimilates the diverse results obtained through the surveys, interviews, and bibliometric and grant analyses into the three areas outlined in Figure 35, that is research, career, and award mechanism.

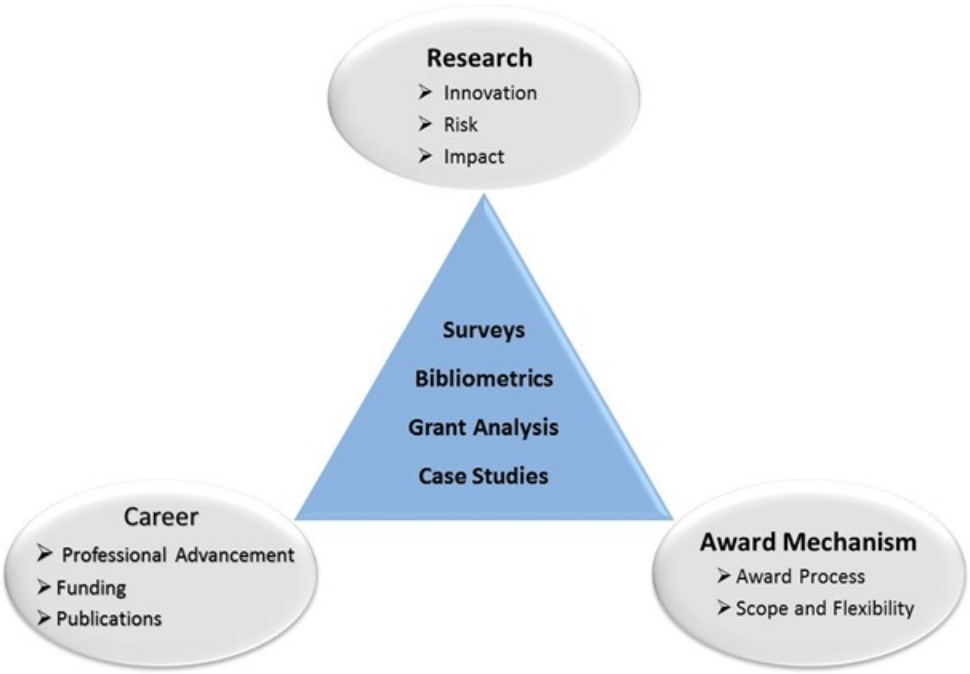


Figure 36. Key Research Topics and Methods

A. Research

The research component of the NI outcomes evaluation considers the extent to which research conducted by NI awardees was more innovative, higher risk, and more impactful than research conducted by an ESI R01 comparison group. Interdisciplinarity is often considered a characteristic of innovation, therefore these results are presented with the findings on innovation.[16] The STPI team integrated results from the awardee survey, senior scientist review, and case studies to address the constructs of innovation and risk.

[16] Blackwell, AF, Radical Innovation: crossing knowledge boundaries with interdisciplinary teams. University of Cambridge Technical Report No. 760.

Additionally, the NI award aimed to produce major advances in biomedical and biobehavioral research, and the definition of high risk used in this study invokes a requirement to produce major, meaningful results. Research impact related to the NI awards and its companion construct, productivity, were assessed using bibliometric tools.

1. Research Innovation

For the purposes of this report, innovative research is operationalized by the survey items listed in Table 19, to which NI and ESI R01 awardees and SSRs responded.

Although SSRs viewed NI awardees as more likely to develop a new technology or methodology than ESI R01 Awardees (Table 19), there were no statistically significant differences between NI and ESI R01 awardees' responses to these statements. Interestingly, SSRs viewed ESI R01 awardees as more likely to develop new ideas, and they evaluated ESI R01 awardee research as more rigorous than NI awardee research. The latter finding may be consistent with the belief that the structured research plan required in the R01 application produces more incremental, and hence rigorous, research.

In summary, NI awardees and SSRs agree that NI award research is more likely to involve a new phenomenon or approach; new, disparate, or multidisciplinary ideas; or the advancement of a theoretical concept. Senior scientists also viewed NI awardee research as more innovative and likely to revolutionize their fields of science.

Conclusion: Overall, NI awardees rated their research as more innovative than ESI R01 Awardees rated their research, and SSRs were more likely to rate NI research as more innovative than ESI research.

Table 19. Awardee Survey and SSR Results: Research Innovation

Survey Item	Awardee Survey	Senior Scientist Review
The research resulted in the formulation of a new idea	NI awardees > ESI R01 awardees	ESI R01 awardees > NI awardees
The research resulted in the discovery of a new phenomenon	NI awardees > ESI R01 awardees	NI awardees > ESI R01 awardees
The research resulted in new synthesis of disparate ideas	NI awardees > ESI R01 awardees	NI awardees > ESI R01 awardees
The research resulted in the advancement of a theoretical concept	NI awardees > ESI R01 awardees	NI awardees > ESI R01 awardees
The research resulted in the development of a new technology	No statistically significant difference	NI awardees > ESI R01 awardees
The research resulted in the development of a new methodology	No statistically significant difference	NI awardees > ESI R01 awardees

Survey Item	Senior Scientist Review
The research combined fundamental principles, models, or experiments in novel ways	NI awardees > ESI R01 awardees
The research pursued an approach that was contrary to the norm	NI awardees > ESI R01 awardees
The research applied cutting-edge approaches	NI awardees > ESI R01 awardees
The research will have a significant impact on the field	NI awardees > ESI R01 awardees
The research was innovative	NI awardees > ESI R01 awardees
The research cut across multiple disciplines	NI awardees > ESI R01 awardees
The research introduced novel theoretical ideas	NI awardees > ESI R01 awardees
The research introduced radically different tools	NI awardees > ESI R01 awardees
The research will revolutionize the field	NI awardees > ESI R01 awardees
The research was rigorous	ESI R01 awardees > NI awardees

2. Research Risk

The STPI team defined high-risk research as having an inherent, high degree of uncertainty and the capability to produce a major impact on important problems in biomedical or behavioral research.[17] High-risk research could involve ideas at odds with prevailing wisdom, use of unproven or extraordinarily difficult techniques, or research that is outside a scientist's demonstrated expertise or requires a unique combination of disciplines.

NI awardees were more likely to rate their research as involving new, novel, and/or multidisciplinary ideas. Senior scientists rated NI awardees as more likely to employ novel ideas and techniques, however, when evaluating research at odds with prevailing thinking, senior scientists rated NI and ESI R01 research about the same. In contrast to the senior scientist ratings, in the awardee survey, there were no significant differences between NI and ESI R01 awardees regarding the use of a novel technique or equipment in their research (Table 20).

Table 20. Awardee Survey and SSR Results: Research Risk

Survey Item	Awardee Survey	Senior Scientist Review
Research a significant departure from previous research	NI awardees > ESI R01 awardees	NA
Research required knowledge outside of field	NI awardees > ESI R01 awardees	NA
Research involved novel combination of ideas	NI awardees > ESI R01 awardees	NI awardees > ESI R01 awardees
Research at odds with prevailing thinking	NI awardees > ESI R01 awardees	No statistically significant difference
Research required novel technique or equipment	No statistically significant difference	NI awardees > ESI R01 awardees

The findings for innovation and risk were also supported by qualitative data derived from case study interviews. In response to open-ended questions, the NI awardees were more likely to

[17] Rita R. Colwell, Director of the National Science Foundation, Briefing to the Office of Legislative and Public Affairs, October 2003.

describe their research as innovative, exploratory, and higher risk, addressing ideas not yet conceptually mature, or representing a new research direction. Approximately the same number of NI and ESI R01 Awardees also characterized their research as a *new research direction*, perhaps in part because a first major funding award should demonstrate scientific independence.

Conclusion: Overall, NI awardee research is perceived by NI awardees and senior scientist reviewers as displaying more characteristics of high risk than ESI research.

3. Research Impact

To assess the potential of NI research to have a major scientific impact, the STPI team examined the extent to which the research could lead to, or was likely to lead to, advances in biomedical or behavioral research. Impact is frequently analyzed by average citations per publication and a variety of journal impact factors such as the H Index, which is based on the number of papers and citations; the RCR, an article-level, field-independent method that is used to identify influential papers; or IPP, which is based on the number of citations per paper published in a journal.

Productivity is closely linked to impact as a measure of the general output of an award. Productivity is assessed by the number of publications attributed to the award, the average number of publications per year, and the length of time between award and publication.

Using bibliometric approaches, the STPI team applied these measures of impact and productivity to publications citing the NI or ESI R01 awards as the source of funding for some, or all, of the research in the publication.

The STPI team determined that NI awardees had a higher average number of citations per publication attributed to their awards than did ESI R01 awardees. Although journal-based impact metrics have limitations, four of five established measures of impact—IPP, RCR, SNP and SJR—also indicate that NI awardees scored higher for attributed publications, indicating the potential for greater information dissemination and research impact (Table 21).

Table 21. Attributed Publication Bibliometric Analysis: Citation Rates and Journal Impact Factors

Average Citations per Publication	NI awardees > ESI R01 awardees
IPP	NI awardees > ESI R01 awardees
RCR	NI awardees > ESI R01 awardees
SNIP	NI awardees > ESI R01 awardees
SJR	NI awardees > ESI R01 awardees
H- Index	No statistically significant difference

Impact was also assessed through statements in the awardee survey and the senior scientist review that are relevant to more than one survey construct (Table 20 from innovation and risk sections above). In the awardee survey, NI awardees were significantly more likely than ESI R01 awardees to perceive their research as discovering a new phenomenon, synthesizing disparate ideas, a significant departure from previous research, or requiring a novel combination of ideas, all of which would have high impact on a field of science. From a review of three papers from each awardee, SSRs rated NI awardees' research as more likely to have significant impact on the field and to be innovative. They agreed with NI awardees that NI award-funded research was cutting edge; that it combined principles, models, and experiments in novel ways; and that it would introduce radically different tools and revolutionize fields of science.

The STPI analysis also demonstrated that, for attributed publications, the ESI R01 awardees were significantly more productive as measured by the number of publications attributed to their awards, the average number of publications per year, and the lag time between receipt of their awards and first publication of award research findings (Table 22).

Table 22. Attributed Publication Bibliometric Analysis: Number and Timing of Publications

Number of publications	ESI R01 awardees > NI awardees
Average annual publications	ESI R01 awardees > NI awardees
Time to first publication	ESI R01 awardees > NI awardees

These data could be explained in part by the fact that, in contrast to the NI award, R01 applications require preliminary data, much of which may be published or in the journal review process, or the possibility that the structure of the R01 application supports incremental and feasible research that produces publishable results more quickly. Several case study comments from NI awardees also provide insight because they stipulated that it took longer to set up their labs to pursue a new research directions, develop high risk methods, redirect research as necessary, and document novel research findings to publish in the most prestigious journals.

Conclusion: Overall, NI awardee-attributed publications had higher citation rates and journal impact factors than ESI R01 Awardee-attributed publications, suggesting higher research impact. NI awardees publish fewer attributed publications than ESI R01 awardees, annually and in total, and take longer to publish. This may be explained, in part, because more data may be required to publish innovative findings and more iterations of journal review are needed to publish in high impact journals.

4. Summary of Research Conclusions

- Overall, NI awardee research was viewed as more innovative and displaying more characteristics of high risk than ESI R01 research.
- NI awardees are not more interdisciplinary in their NI research than are ESI R01 awardees.
- NI award research publications have the potential for higher impact than ESI research publication, as measured by higher citation rates and journal impact factors.
- NI awardees score lower than ESI R01 awardees on bibliometric measures of productivity, as assessed for award-attributed publications.

B. Career

The career component of the NI outcomes evaluation considers the extent to which the NI award influenced the careers of awardees compared to the career impacts of a comparable, traditional NIH award. The STPI team used the awardee survey, NIH IMPAC II grant records, and case studies to assess characteristics of professional advancement and ability to obtain new funding.

1. Professional Advancement

To assess professional advancement, the STPI team analyzed indicators of laboratory and research expansion, professional recognition, and employment status.

- **Laboratory and Research Expansion.** In the Awardee Survey, 90–100% of the NI and ESI R01 awardees reported that they were able to expand their research scope into new disciplines, increase the size of their laboratories, and form new collaborations (Table 23). The survey findings were reinforced by the case study interviews, at which time all NI and ESI R01 awardees reported that they were able to hire more and/or better qualified personnel. Seven NI and two ESI R01 awardees reported that they bought new or better equipment.

Table 23. Awardee Survey Results: Research and Laboratory Indicators

Survey Item	Awardee Survey
Expanded focus of lab to new disciplines	No statistically significant difference
Expanded research lab	No statistically significant difference
Formed new collaborations	No statistically significant difference

- **Honors, Awards and/or Professional Recognition.** According to NI and ESI R01 awardee responses in the awardee survey, NI awardees were statistically more likely to have their research highlighted in the popular press, perhaps suggesting that the NI award research is more novel and noteworthy (Table 24). The NI and ESI R01 awardees were not statistically different in the percentage of awardees reporting honors and awards, recognition of their research on journal covers, or invitations to review grants and papers. In the case study interviews, half of the NI awardees and a third of the ESI R01 awardees received more speaking or scientific panel invitations than for previous research. Only one NI and one ESI R01 awardee reported that their awards led to a decrease in their teaching burden.

Table 24. Awardee Survey Results: Honors, Awards, and Recognition

Survey Item	Awardee Survey
Received honor/ award	No statistically significant difference
Popular press media coverage	NI awardees > ESI R01 awardees
Journal cover feature	No statistically significant difference
Asked to serve as regular reviewer	No statistically significant difference

Conclusion to laboratory, research, and recognition indicators: According to responses in the awardee survey, there were no statistically significant differences between the comparison groups in laboratory indicators or measures of professional recognition except that NI awardees were significantly more likely to have their research highlighted in the popular press, perhaps suggesting that the NI award research is more novel and newsworthy.

- **Tenure.** Based on the Awardee Survey data, there is no statistical difference in the number of NI and ESI R01 awardees reporting that they received tenure following receipt of their award (Table 25). Of the 13 NI awardees at tenure-granting institutions who were not tenured at the time of the survey, 9 had applied for tenure. Of the five ESI R01 awardees not tenured at the time of the survey, none had applied for tenure.

Table 25. Awardee Survey Results: Tenure Status

Survey Item	Awardee Survey
Received Tenure	No statistically significant difference
Applied for Tenure*	NI awardees > ESI R01 awardees

Note. *Awardees who had not received tenure, but were under tenure review when surveyed.

The STPI team explored these findings in more detail in the Case Study interviews. For the subset of NI and ESI R01 awardees interviewed in the case studies (February-March 2016), four of nine NI awardees and five of five ESI R01 awardees reported that they had not yet received tenure. Several NI awardees noted that the inability to renew their NI awards was disadvantageous because renewability was part of the rationale for the R01 condition for tenure at their institutions. One NI awardee stipulated that tenure was delayed because of the extended time it took to publish innovative research, and another was delayed by Hurricane Sandy damage to the research institution.

Conclusion: The NI award does not provide a tenure advantage or disadvantage over the ESI R01 award, although more NI awardees who did not have tenure at the time of the survey applied for tenure following receipt of their awards.

- **Employment Status.** The STPI team assessed employment status in the awardee survey by asking awardees whether they changed institutions after receiving their awards and the type of institutions by which they are currently employed. There was no statistical difference in the percentage of NI and ESI R01 awardees who changed institutions after receiving their awards (20% and 24% respectively), nor any statistical difference in the type of institution by which they are employed (Table 26). Eighty percent of NI awardees and 74% of ESI R01 awardees were employed by academic institutions, with the remaining 20–25% at medical institutions, at national laboratories, or in industry.

  Conclusion: Approximately the same percentage of NI and ESI R01 awardees changed institutions after receiving their awards. There was no statistical difference in NI and ESI R01 awardee employment, with the majority of respondents reporting employment at academic institutions.

Table 26. Awardee Survey Results: Current Employment

Survey Item	Awardee Survey
Academic institution	No statistically significant difference
Medical institution (university affiliation)	No statistically significant difference
Other*	No statistically significant difference

*National Laboratories, medical affiliations not associated with a university, and industry

2. Ability to Obtain New Funding

To determine whether NI and ESI R01 awardees differed in their ability to compete for NIH funding after their respective award, the STPI team examined NI and ESI R01 awardees application and award records in the IMPAC II database for all Type 1 NIH grants, only DP1 Type 1 awards, and several combinations of R01 Type 1 and Type 2 awards.

The data demonstrate that NI and ESI R01 awardees were similarly likely to apply for grants when all NIH grants were considered or when NI awardees applied for an R01 Type 1 grant and ESI R01 awardees applied for an R01 Type 1 or Type 2 grant (Table 27). NI awardees were significantly more likely to apply for DP1 and R01 Type 1 grants and significantly less likely to apply for a competitive renewal through the R01 Type 2 mechanism.

Table 27. Summary of the NI and ESI R01 Awardee Grant Analysis

	All NIH Type 1	DP1 Type 1	R01 Type 1	R01 Type 2	NI R01 Type1 and ESI R01 Type 1&2
Likelihood of applying	No statistically significant difference	NI awardees > ESI R01 awardees	NI awardees > ESI R01 awardees	ESI R01 awardees > NI awardees	No statistically significant difference
Median number of applications submitted	NI awardees > ESI R01 awardees	NI awardees > ESI R01 awardees	NI awardees > ESI R01 awardees	ESI R01 awardees > NI awardees	NI awardees > ESI R01 awardees
Median number of awards received	NI awardees > ESI R01 awardees	NI awardees > ESI R01 awardees	NI awardees > ESI R01 awardees	ESI R01 awardees > NI awardees	No statistically significant difference
Likelihood of being funded	NI awardees > ESI R01 awardees	NI awardees > ESI R01 awardees	NI awardees > ESI R01 awardees	ESI R01 awardees > NI awardees	No statistically significant difference

Compared to ESI R01 Awardees, NI awardees submitted significantly more applications for all NIH grants, DP1 grants, and R01 Type 1 grants; were awarded more grants in these categories; were significantly more likely to be funded; and received significantly more grants. In contrast, NI awardees submitted significantly fewer R01 Type 2 applications and received fewer grants.

Because the NI award is not renewable and the ESI R01 award is renewable, and as requested by the sponsor, the STPI team compared NI awardee R01 Type 1 grants with ESI R01 Type 1 and Type 2 grants. The team determined that the two groups were similarly likely to apply for grants in these categories. NI Awardees submitted more applications; however, there was no statistical difference in the mean number of applications awarded nor the likelihood of being funded.

The case study interviews further informed this analysis because approximately 30% of the 15 NI and 15 ESI R01 awardees had not applied for NIH support prior to their awards, and more NI awardees than ESI R01 awardees had previously applied for, but not received, R01 funding.

Conclusion: NI awardees are more likely to submit applications for all NIH Type 1 grants, DP1, and R01 Type 1 grants and to be funded. Although they apply for and receive fewer R01 Type 2 grants than ESI R01 awardees, NI awardees submit more total R01 Type 1 applications than ESI R01 awardees submit for R01 Type 1 and 2 grants. NI awardees are similar to ESI R01 awardees in the analysis that tests the number of R01 Type 1, and R01 Type 1 and Type 2, grants received, respectively.

3. Award Effects on Career Publication Record

To assess the broader effects of the NI award on the awardee's career, the STPI team used bibliometric approaches to compare several characteristics of NI and ESI R01 career publications, that is, all *pre-award* + 1 publications and all *post-award* – 1 publications. The team assessed impact and productivity, interdisciplinarity, and, as a measure of collaboration, co-author networks.

- **Impact and productivity.** The STPI team assessed the impact of the NI award on the awardees' career publications by analyzing the average citations per publication and journal impact factors, as described for research impacts above, and compared the results to those obtained for ESI R01 awardees.
- NI awardees had statistically higher average citation rates for the *pre-award* + 1 career publications but were not statistically different from ESI R01 awardees for *post-award* – 1 publications. The NI Awardees had statistically higher journal impact factors for *pre-award* + 1 and *post-award* – 1 career publications for three of the four factors evaluated in this study; however, the effect sizes were small, suggesting minimal meaningful difference between comparison groups. The H Index was not statistically different for either case (Table 28).

Table 28. Career Publication Bibliometric Analysis: Citation Rates and Journal Impact Factors

	Pre-award + 1	Post-award – 1
Average Citations per Publication	NI awardees > ESI R01 awardees	No statistically significant difference
IPP	NI awardees > ESI R01 awardees	NI awardees > ESI R01 awardees
SNIP	NI awardees > ESI R01 awardees	NI awardees > ESI R01 awardees
SJR	NI awardees > ESI R01 awardees	NI awardees > ESI R01 awardees
H- Index	No statistically significant difference	No statistically significant difference

When all publications are considered, NI and ESI R01 awardees published similar numbers of papers prior to and after their award, however NI awardees publish significantly more papers on an annual basis following receipt of their award than do ESI R01 awardees (Table 29).[18]

Table 29. Career Publication Bibliometric Analysis: Number and Timing of Publications

	Pre- award + 1	Post-award – 1
Number of publications	No statistically significant difference	No statistically significant difference
Average Annual Publications	No statistically significant difference	NI awardees > ESI R01 awardees

Conclusion: (1) There is no significant difference in the average number of citations for NI and ESI R01 awardee career publications *post-award* – 1; however, NI awardees have higher journal impact factors than ESI R01 awardees prior to and following their awards. This finding may suggest that NI awardees produce more impactful research before and after the NI award. (2) No meaningful difference between NI and ESI R01 awardees was identified for the number of career publications after receipt of the NI award, although the average number of NI awardee publications annually increased. To evaluate meaningful differences in the impact of the NI and ESI R01 awards on career publications, more

[18] See footnote 12 for statistical interpretation of this result.

elapsed time between the award and the analysis may be required than was available for this study.

- **Co-author networks.** Co-author networks provide insight into the breadth and type of research collaboration by assessing the number of individuals, institutions, and countries with whom the awardee is collaborating and publishing. The STPI team next analyzed the potential influence of the NI award on the awardees' collaborative network prior to and following receipt of NI awards.
- When the co-author network analysis was performed using the STPI-derived career publications database, there were no significant differences between NI and ESI R01 comparison groups for the average number of co-authors or unique co-authors and countries, nor any *pre-award* + 1 and *post-award* – 1 differences (Table 30).

Table 30. Career Publication Bibliometric Analysis: Coauthor Networks

	Pre-Award + 1	Post-Award – 1
Average number of coauthors per publication	No statistically significant difference	No statistically significant difference
Unique coauthors	No statistically significant difference	No statistically significant difference
Unique coauthor institutions	No statistically significant difference	No statistically significant difference
Unique coauthor countries	No statistically significant difference	No statistically significant difference

Case study interview comments support these bibliometric findings as both NI and ESI R01 awardees reported that their awards helped them strengthen existing or establish new collaborations, an underlying condition for expanding a co-author network.

Conclusion: Overall, NI and ESI R01 awardees were similar in the size and breadth of their co-author networks, a finding that may be consistent with the early career status of both groups of awardees. NI and ESI R01 awardees increased the size of their co-author networks following their awards.

Interdisciplinarity. As noted earlier in this report, *interdisciplinarity* describes a mode of research that integrates concepts, methods, or data from two or more bodies of specialized knowledge or research practice. This integration advances new fundamental knowledge or solves complex problems whose solutions are beyond the scope of a single field of research practice.

The STPI team next examined whether the NI award influenced the interdisciplinarity of awardee research following the NI award and compared the findings for the ESI R01 awardees. As a proxy for interdisciplinarity, the team analyzed the unique subject codes assigned to journals in which NI and ESI R01 awardees published their career papers. The number of unique subject codes assigned by to journals publishing NI award and ESI R01 *pre-award* + 1 and *post-award* – 1 career publications was not statistically different (Table 31).

Table 31. Career Publication Bibliometric Analysis: Interdisciplinarity

	Pre-award + 1	Post-award – 1
Total unique subject codes	No statistically significant difference	No statistically significant difference

Conclusion: There is no significant difference in interdisciplinarity for NI and ESI R01 awardee research for career publications as measured by this approach.

4. Summary of Career Impact Conclusions

- Professional Advancement:
  - The New Innovator Award did not provide an advantage or disadvantage to award recipients over the ESI R01 award, as measured by the research, laboratory, or most professional recognition indicators in this evaluation.
- Ability to Obtain Funding:
  - NI awardees are more likely to submit applications for all NIH Type 1 grants and DP1 and R01 Type 1 grants and to be funded.
  - NI awardees apply for and receive fewer R01 Type 2 grants than ESI R01 awardees.
  - NI awardees submit more R01 Type 1 applications than ESI R01 awardees submit for R01 Type 1 and Type 2 grants but are funded at a similar rate.
- Award effects measured through career publication record:
  - NI awardees have higher journal impact factors than ESI R01 awardees prior to and following their awards, however there was no difference in the citation rates for post-award career publications for the two groups.
  - NI and ESI R01 awardees wrote similar numbers of career publications after receipt of their awards, and the average number of NI awardee annual publications increased.
  - NI and ESI R01 awardees were similar in their co-author networks as well the interdisciplinarity of the research in their career publications.

C. Award Mechanism

The career component of the NI outcomes evaluation considers the extent to which the novel aspects of the NI award mechanism were perceived as beneficial to the awardee. The Awardee survey queried awardees about their reasons for applying for the NI and ESI R01 awards and the aspects of the award mechanism that they perceived to be beneficial to their research and careers. The STPI team used the case study interviews to understand the grant application history for this subset of awardees prior to their applying for the NI or ESI R01 awards and the reasons NI awardees chose to apply to the NI Funding Opportunity Announcement.

1. Award Process

As a measure of the alignment of NI awardee research with traditionally funded NIH research, the STPI team examined awardee perspectives on the likelihood that their research could fit the traditional NIH R01 research paradigm and review process.

In the Awardee Survey, NI awardees were more likely to report that their research was not typical NIH research and that their applications had little or no preliminary data (Table 32). They were less likely to report that their research aligned with a standing NIH study section or fell within the research interests of an NIH institute or center. All NI awardees interviewed in the case studies reported that they were attracted to the NI award mechanism because of the non-traditional NI award application process, emphasis on innovation and high risk, and/or the ability to submit ideas without preliminary data.

Table 32. Awardee Survey Results: Award Process

Survey Item	Awardee Survey
Overall, my research was different from what is typically funded through NIH	NI awardees > ESI R01 awardees
My research had little or no preliminary data when I submitted my application	NI awardees > ESI R01 awardees
My research had an NIH study section with appropriate scientific expertise	ESI R01 awardees > NI awardees
My research falls into the research interest of a single NIH institute/center	ESI R01 awardees > NI awardees

Interestingly, NI awardees still tried to have their research funded through traditional NIH mechanisms, although they were more optimistic that they would receive funding from sources outside of NIH (Table 33).

Table 33. Awardee Survey Results: NI Research Perspectives

Survey Item	Awardee Survey
I would have chosen to seek traditional NIH funding (R01, R21, etc.) for my research had the NI award program not existed	62% agree
My research was likely to be funded through traditional NIH mechanisms (R01, R21, etc.) if the NI award program did not exist	8% agree
My research was likely to be funded through sources other than the NIH	32% agree

Conclusion: NI awardees were more likely to perceive their research as non-traditional and inconsistent with the NIH grant process, and while they would have sought NIH funding for their NI award research, they believe that they would be more successful obtaining funding from non-NIH sources.

2. Scope and Flexibility of Awards

Through the Awardee Survey, the STPI team also queried awardees for their perspectives on the scope and flexibility of their awards. NI awardees were more likely to report that their awards provided the research and funding flexibility to perform innovative research; however, there was no statistical difference in the NI and ESI R01 awardees' perspective that their research direction changed from the original proposal (Table 34). Interestingly, in the case studies, NI awardees were almost twice as likely as ESI R01 awardees to report that the length of the award allowed for a change in research directions or methods.

Conclusion: NI awardees perceived their awards as having the flexibility and time to allow for non-traditional research; however, both awardee groups reported modification of their research proposals.

Table 34. Awardee Survey Results: Scope and Flexibility of Awards

Survey Item	Awardee Survey
The NI or ESI R01 award allowed me the freedom to pursue non-traditional research	NI awardees > ESI R01 awardees
The NI or ESI R01 award allowed for the flexible use of funding	NI awardees > ESI R01 awardees
The period of the NI or ESI R01 award was long enough for me to redirect research as ideas/methods evolved	NI awardees > ESI R01 awardees
Over the course of the grant period, my research idea changed significantly from what was initially proposed	No statistically significant difference

3. Summary of Award Mechanism Conclusions

- Award mechanism:
  - NI awardees were more likely to perceive their NI research as non-traditional and inconsistent with the traditional NIH grant process. They perceived their NI research as more consistent with non-NIH funding sources.
  - NI awardees utilized the novel aspects of the NI application process, such as the shorter research description and option to apply without preliminary data.
- Scope and flexibility:
  - NI awardees perceived their awards as having the flexibility and time to allow for non-traditional research, however both awardee groups reported modification of their research proposals.

9. Conclusions for Key Questions

Based on the integrated findings from the 2007–2009 NI awardees cohorts, the STPI team translated the integrated findings to answer the two key questions outlined in the Statement of Work and provide context for the conclusions. It is important to note that the STPI evaluation does not demonstrate causality, that is, that the New Innovator Award *caused* changes in the indicators and metrics evaluated, but rather the evaluation assesses the status of indicators for NI awardees compared to a group similar in characteristics and receiving a different but comparable award.

Key Question 1. Is the NI awardee research significantly more innovative, high-risk, or impactful than traditionally funded NIH research?

The STPI evaluation demonstrates that, for the metrics and time course employed in this evaluation, the New Innovator Award is successfully attracting and funding early career researchers who are proposing and conducting innovative, high-risk, and impactful research. This conclusion is reinforced by the awardee and SSR perspectives that NI awardee research is more innovative and high-risk than ESI R01 research and by bibliometric analysis of impact and productivity.

The STPI team acknowledges the time limitation of this evaluation. The NI awards were made in 2007–2009. As five-year awards, these early career investigators were 1–3 years post award, and the need for more time for innovative and high-risk research to mature, or the impact of the research to be realized, may be necessary. This consideration may be explained, in part, by the need to produce more data in order to publish innovative findings, and by the fact that more iterations of journal review are often needed in order to publish in high-impact journals and accrue citations. It is also possible that productivity, as measured by number of publications and time between award and first publication, may be counter to the goals of the New Innovator Award, which promotes a flexible, high-risk research plan and the ability to fail and re-direct research.

It is important to note that this study does not evaluate the maturity of the innovative research and whether it could be translated successfully to traditional NIH R01 funding. The STPI grant analysis suggests that NI awardees, as a group, were successful in applying for and receiving R01s, however a significant portion, 38%, had no Type 1 R01s following receipt of their NI award, compared to 50% for ESI R01 awardees.

Key Question 2. What are the impacts, both positive and negative, of NI awards on the careers of awardees compared to the career impacts of a comparable, traditional NIH award?

The STPI evaluation demonstrates that, for the metrics and time course employed in this evaluation, receipt of the New Innovator Award did not provide an advantage or disadvantage to NI awardees over the ESI R01 award, as measured by the research, laboratory, or most professional recognition indicators. This finding may be a function of the early career status of both awardees groups. Early career investigators at academic and research institutions, regardless of funding

mechanism, are focused on establishing an independent research program, expanding laboratory resources and collaborative networks, and publishing peer-reviewed papers, elements that are essential to career progression and tenure.

The STPI team also notes characteristics of NI awardees that may indicate a higher likelihood of career success beyond the time course of this analysis. For example, NI awardees have higher journal impact factors for their award-attributed and career publications than ESI R01 awardees, and they are more likely to submit applications for all NIH Type 1 grants, including the NIH Director's Pioneer Award (DP1), and to be funded. Additional studies would need to determine if the NI award attracts scientists more likely to be successful in the NIH system throughout their career.

The team identified no negative impacts of the NI award on career trajectory through the Awardees Survey. A few interviewees in the case study interviews noted that the NI award was not recognized at their institutions as meeting the tenure funding criterion because it was not seen as equivalent to an R01 and that lack of a no-cost extension hampered innovative research that needed to be redirected and required more than 5 years to complete.

In conclusion, the data reported in this evaluation show that the New Innovator Award has successfully attracted early career investigators who used the novel aspects of the NI award to propose and conduct innovative, high-risk, and impactful biomedical and biobehavioral research. The award does not significantly accelerate or impede the career trajectory of NI awardees.

Appendix A.
Literature Review

The STPI team conducted an updated literature review to determine whether there had been any advances in methodology since the May 2011 *Feasibility Study of an Outcome Evaluation of the National Institutes of Health's New Innovator Award Program* (2011 Feasibility Report) in regard to:

- Defining key terms: innovative, creative, interdisciplinary, impactful;
- Operationalizing empirical measurement of these terms;
- Employing new methodologies to evaluate innovative or high-risk research programs and scientists.

Methodology

To conduct this update to the literature review, the STPI team first downloaded the citations and abstracts of the following papers from *Web of Knowledge*:

- All papers referenced in Chapter 2, Literature Review of the 2011 Feasibility Report and in Appendix A of that study ("Indicators of Innovative Research and Researcher's Career") [Total: 23];
- Papers published since January 2011 that cite the 23 papers in the 2011 Feasibility Report [Total: 2450];
- Papers published since January 2011 by authors cited in the 2011 Feasibility Report who study scientific research [Total: 380].

These papers were filtered by the following keyword searches:

1. Title and abstract: "Research OR Scien" [Total: 1944];
2. Title and abstract: "Innovat OR Creativ OR Transformat OR Frontier OR Interdisciplin OR Novel OR Breakthrough" [Total: 834],
   - "High-risk" and "high risk" had five results total; these were examined manually and were not found to be relevant to the NI evaluation;

3. Title: "Learn OR Teach OR Student OR Industry OR Employee OR Team OR Education OR region OR China OR Work OR Product"[19] [Total: 273].

A total of 413 papers were identified by both search 1 *and* 2, but *not* 3. The titles and abstracts of these 413 papers were manually examined to identify potentially informative studies, and those that were identified as potentially useful were read in full by the STPI team. Twelve papers were ultimately deemed relevant for the evaluation of the NI (Table A-1).

Table A-1. Papers Down-selected From Literature Review

Title; Author	Contributed To
"Creative accomplishments in science: definition, theoretical considerations, examples from science history, and bibliometric findings." (Heinze 2013)	Definition of Creativity in the context of scientific research
"Patent Quality and Research Productivity: Measuring Innovation with Multiple Indicators*." (Lanjouw and Schankerman 2004)	Analysis of the innovativeness of research outcomes
"Beyond breakthrough research: Epistemic properties of research and their consequences for research funding." (Laudel and Glaeser 2014)	Analysis of the impact of research funding programs on research outcomes
"A topic model approach to measuring interdisciplinarity at the National Science Foundation." (Nichols 2014)	Analysis of interdisciplinarity of research outputs
"Innovation as a knowledge-based outcome." (Quintane et al. 2011, B. Sebastian Reiche, and Petra A. Nylund. 2011)	Definition of Innovation in the context of scientific research
"Characterizing researchers to study research funding agency impacts: The case of the European Research Council's Starting Grants." (Thomas and Nedeva 2012)	Definition of Innovation in the context of scientific research; approaches to analyzing grant programs
"Evaluating transformative research programmes: A case study of the NSF Small Grants for Exploratory Research programme." (Wagner and Alexander 2013)	Definition of Innovation in the context of scientific research; approaches to analyzing grant programs
"Funding acknowledgement analysis: an enhanced tool to investigate research sponsorship impacts: the case of nanotechnology." (Wang and Shapira 2011)	Methods for the identification of research outcomes
"Career-based influences on scientific recognition in the United States and Europe: Longitudinal evidence from curriculum vitae data." (Youtie et al. 2013, Thomas Heinze, Philip Shapira, and Li Tang. 2013.)	Measuring creativity of researchers using career information
"Scientometric analysis of physics (1979–2008): A quantitative description of scientific impact." (Zheng et al. 2011, YunTao Pan, and XiaoYuan Zhao. 2011)	Analysis of impact of research outputs

[19] Search Filter 3 represents keywords observed during manual review to be common in the titles of irrelevant papers.

Results

Innovative Research

Traditionally, the term *innovative* has been defined as being related to, but distinct from, *creativity* (described below). Amabile et al. (1996) defines innovation as the successful implementation of creative ideas within an organization. Researchers often see innovation as the *usage* or *diffusion* of creative ideas.

For this report, innovation is defined as *duplicable knowledge considered new in the context it is introduced to and demonstrated useful in practice*.[20]

This definition is operationalized by:

- Capturing "considered new in the context it is introduced" by measuring creativity and/or interdisciplinarity, while
- Capturing "demonstrated as useful in practice" by measuring impact.

Creative Research

The multi-dimensional aspects of creativity have been described by Simonton (1997) as "the output of ideas that are both original and adaptive," by Ochse (1990) as including the production of an object or idea, and by Amabile et al. (1996) as involving heuristic discovery of solutions rather than algorithmic tasks or thinking.

From these historical examples and the current literature review, the STPI team defines creativity as ideas and artifacts that are both scientifically valuable and plausible, and novel and surprising.[21]

This definition is operationalized by using a typology of creative research outcomes described in a previous paper by Heinze et al. as:[22]

- Formulation of a novel idea (or set of ideas) that could instigate a new cognitive frame or advance theories to a new level of sophistication;

[20] Eric Quintane, R. Mitch Casselman, B. Sebastian Reiche, and Petra A. Nylund, "Innovation as a Knowledge-Based Outcome," *Journal of Knowledge Management* 15, no. 6 (2011): 928–47.

[21] Thomas Heinze, "Creative Accomplishments in Science: Definition, Theoretical Considerations, Examples from Science History, and Bibliometric Findings," *Scientometrics* 95, no. 3 (Jun 2013): 927–40.

[22] Thomas Heinze, Philip Shapira, Jacqueline Senker, and Stefan Kuhlmann. 2007. "Identifying creative research accomplishments: Methodology and results for nanotechnology and human genetics," *Scientometrics* 70 (1):125–152.

- Discovery of new empirical phenomena that could stimulate the generation of new theories;
- Development of a new methodology, enabling empirical testing of theoretical problems;
- Invention of novel instruments that could instigate new search perspectives and research domains;
- New integration of formerly disparate ideas into general theoretical laws enabling analyses of diverse phenomena within a common cognitive frame.

Interdisciplinary Research

Academics have argued that researchers who sit at the intersection of various social networks inherently come across diverse ideas and are able to synthesize these varieties into new ideas (Burt 2009, 2004). Several observational studies have found evidence supporting this "between-ness notion," in which researchers who broker networks generally performed better by some measure (Cross and Cummings 2004; Rodan and Galunic 2004). Even more recently, a study found that creative pieces of work were most likely to be produced by researchers who produce high numbers of publications, synthesize a broad range of ideas, engage disconnected peers, and widely disseminate findings (Heinze and Bauer 2007). With this evidence, the STPI team conducted an analysis that sought to measure these "predictors of creativity": productivity, network brokerage, information dissemination, and topical synthesis. While there is little clarification in the difference between *interdisciplinarity* and *multidisciplinarity* in the literature, both terms refer to the number of disparate bodies of specialized knowledge utilized in a single effort (Porter et al. 2007; Wagner et al. 2011). The complexity of differentiating terms is highlighted by Heinze et al. (2007), who considered multidisciplinarity one dimension of research creativity.

In terms of publication data, interdisciplinarity may be analyzed through (1) cited references of a publication set (the body of knowledge the research draws from), (2) the publication set itself (body of knowledge), or (3) works citing the publication set in question (body of knowledge citing the research).

For this report, *interdisciplinarity* is defined as a mode of research by teams or individuals that integrates perspectives/concepts/theories and/or tools/techniques and/or information/data from two or more bodies of specialized knowledge or research practice. Its purpose is to advance fundamental understanding or to solve problems whose solutions are beyond the scope of a single field of research practice.[23]

[23] David Roessner, Alan L. Porter, Nancy J. Nersessian, and Stephen J. Carley, "Validating Indicators of Interdisciplinarity: Linking Bibliometric Measures to Studies of Engineering Research Labs," *Scientometrics* 94.2 (2013): 439–468.

This concept is operationalized through an assessment of the number of unique subject codes associated with a research publication.

Impactful Research

Traditionally, impactful research is that which is widely disseminated and utilized in other experimental studies. Citation rates (Heinze and Bauer 2007; Azoulay, Zivin, and Manso 2009) and journal impact factors, such as the H-index, measure different combinations of citation, productivity, and impact. All factors have strengths and limitations; however, in combination, they provide an overall measure of research impact.

For this report, *impact* is defined as the contributions to research through publications, including diffusion and appropriation of new knowledge, theories, methodologies, models, and facts; the formation and development of specialties and disciplines; the diversification of the type of research conducted (basic, applied, strategic); and the development of interdisciplinary, intersectoral, and international research.[24]

The definition is operationalized using the following typology of impacts of awardees' research:

- Publications number and impact factor,
- Creative research outcomes,
- Impacts on the field of research,
- Impact on the researcher, including the development of new research directions.

[24] B. Godin and C. Doré, "Measuring the Impacts of Science: Beyond the Economic Dimension," Montreal: INRS (2004).

Appendix B.
Topic Modeling Results

Topic	Label	Topic Terms Prime	Coherence	Prevalence
t.83	long_term	term_goal, relevance_long, data_hypothesis, long_term, term_objective	0.44	1.368095093
t.53	quit_attempt	nicotine, quit, cigarette, smoke, smoking_cessation	0.43	0.414172683
t.17	nervous_system	tsc, astrocyte, glia, oligodendrocyte, tsc_tsc	0.4	0.941572064
t.22	neutralizing_antibody	cervical_cancer, hpv_infection, antibody_response, genital_tract, immunized	0.39	0.560678438
t.62	heart_failure	myocyte, arrhythmia, myocardium, left_ventricular, heart_development	0.36	0.728263955
t.78	african_american	african_american, black, racial, hispanic, racial_ethnic	0.36	0.711088855
t.71	gene_expression	microrna, mir, ribosome, rna_binding, small_rna	0.35	0.757958935
t.77	hiv_infection	haart, influenza_virus, antiretroviral, virus_infection, antiretroviral_therapy	0.3	0.981961226
t.33	risk_factor	cvd, cvd_risk, cardiovascular_risk, artery_disease, disease_cvd	0.29	0.716986511
t.59	endothelial_cell	vessel, vegf, smooth_muscle, vsmc, vascular_endothelial	0.29	0.920444203
t.65	synaptic_plasticity	synaptic, synaptic_plasticity, cholinergic, glutamate_receptor, glutamatergic	0.29	1.151947936
t.36	dna_methylation	histone, hdac, dna_methylation, acetylation, post_translational	0.28	0.512084453
t.72	virulence_factor	aureus, aeruginosa, virulence_factor, bacterial_infection, otiti	0.27	1.200699481
t.43	visual_cortex	perceptual, visual_cortex, auditory_cortex, attentional, visual_processing	0.26	1.703121071
t.68	immune_response	dendritic_cell, adaptive_immune, treg, hla, innate_adaptive	0.25	1.872516776
t.79	inflammatory_response	pro_inflammatory, microglial, infiltration, endotoxin, il_induced	0.25	0.99589731
t.4	seeking_behavior	cannabinoid, ethanol, alcohol_consumption, marijuana, alcohol_dependence	0.24	0.905105762
t.11	cell_death	apoptotic, autophagy, caspase, hsp, bcl	0.24	0.659901224
t.76	type_diabete	insulin_resistance, overweight, weight_loss, adiponectin, leptin	0.24	1.147675578
t.69	growth_factor	ecm, engineered_tissue, mmp_mmp, tissue_engineered, ecm_protein	0.23	0.882527104

Topic	Label	Topic Terms Prime	Coherence	Prevalence
t.80	estrogen_receptor	thyroid, testosterone, estradiol, contraceptive, menopausal	0.23	0.53625148
t.87	liver_disease	hcv, liver_disease, bile, nafld, hbv	0.23	0.421952421
t.16	protein_kinase	protein_kinase, pi_akt, phosphorylation_site, akt_pathway, threonine	0.22	0.877735491
t.54	oxidative_stress	ros, reactive_oxygen, nadph, nadph_oxidase, mitochondrial_dysfunction	0.22	0.692956988
t.45	quality_life	ill_patient, cardiac_surgery, preoperative, impact_quality, poor_quality	0.21	0.9678862
t.32	kidney_disease	ckd, kidney_disease, gvhd, aki, podocyte	0.2	0.648823903
t.50	breast_cancer	colorectal, colorectal_cancer, colon_cancer, cancer_common, human_breast	0.2	0.971664381
t.31	neural_cell	newborn, prenatal, postpartum, pregnant, premature_infant	0.19	0.587058912
t.57	stem_cell	stem_cell, progenitor_cell, pluripotent, neural_stem, regenerative_medicine	0.19	1.294289095
t.66	metal_ion	endosomal, membrane_fusion, metal_ion, endosome, cargo	0.19	0.761681254
t.18	circadian_clock	sleep, circadian, clock, circadian_clock, apnea	0.18	0.415418342
t.90	social_behavior	adhd, asd, autism_spectrum, emotion_regulation, deficit_hyperactivity	0.18	0.740789295
t.24	signaling_pathway	adenosine, gpcr, tgf_signaling, downstream_signaling, transforming_growth	0.17	1.466952461
t.48	blood_pressure	ang, eno, ang_ii, renin, angiotensin_ii	0.17	0.523679464
t.56	gene_expression	transcriptional_regulatory, gene_activation, response_element, mediated_transcription, repressing	0.16	1.272624064
t.85	human_genome	natural_selection, sequence_data, genome_sequence, sequence_alignment, sequencing_technology	0.16	1.239154555
t.1	risk_factor	incident, nhs, evaluate_association, nurses_health, based_cohort	0.15	2.554997426
t.12	small_molecule	molecule_inhibitor, identify_small, selective_inhibitor, molecule_drug, improved_therapeutic	0.15	1.329969884
t.20	fatty_acid	dietary, fatty_acid, ppar, dietary_intake, dietary_factor	0.15	0.587870302
t.29	hiv_risk	hiv_risk, sti, hiv_prevention, sexual_risk, risk_hiv	0.15	0.871513971
t.89	mouse_model	balb, mice_exhibit, type_wt, mice_lack, engineered_mouse	0.15	1.605519791
t.35	gap_junction	ion_channel, gap_junction, potassium, ca_influx, intracellular_ca	0.14	0.708186129
t.52	bone_formation	bdnf, msc, bone_formation, bone_mass, bone_health	0.14	0.455327057
t.60	proposed_study	father, girl, boy, children_year, early_childhood	0.14	1.147859528
t.73	depressive_symptom	depressive, mdd, antipsychotic, bipolar_disorder, major_depression	0.14	0.941601546

Topic	Label	Topic Terms Prime	Coherence	Prevalence
t.86	immune_response	wound, hnscc, squamous_cell, dermal, skin_cancer	0.14	0.349454222
t.3	cell_cycle	tumor_suppressor, myc, ubiquitin_ligase, cycle_progression, protein_degradation	0.13	0.880182966
t.14	candidate_gene	snp, haplotype, genetic_variant, qtl, nucleotide_polymorphism	0.13	2.018609397
t.61	air_pollution	cftr, pollution, asthmatic, cystic_fibrosis, air_pollution	0.13	0.468282075
t.75	cell_division	centrosome, spindle, chromosome_segregation, cell_shape, actin_filament	0.13	0.606572278
t.81	age_related	exercise_training, related_cognitive, cognitive_aging, aerobic_exercise, mci	0.13	0.946508094
t.88	prostate_cancer	prostate_cancer, metabolomic, prostate_tumor, molecular_signature, spectrometry_based	0.13	0.873166731
t.2	tumor_cell	glioma, brain_tumor, gbm, anti_tumor, glioblastoma	0.12	1.464117267
t.34	dna_damage	dna_repair, telomere_length, dsb, genomic_instability, repair_pathway	0.12	0.819402378
t.44	immune_response	malaria, parasite, mosquito, dengue, tick	0.12	0.670180675
t.55	cell_migration	cell_migration, chemotaxi, cell_motility, cadherin, migrating	0.12	0.679662401
t.25	immune_response	mortality_morbidity, billion_dollar, states_estimated, mortality_worldwide, million_people	0.11	1.426399361
t.27	high_resolution	scanner, spect, phantom, contrast_agent, imaging_system	0.11	1.600204388
t.30	randomized_controlled	randomized_controlled, crc_screening, rct, randomly_assigned, usual_care	0.11	2.268161092
t.64	clinical_trial	pharmacogenetic, routine_clinical, patients_enrolled, patient_characteristic, survival_patient	0.11	1.961323483
t.84	health_care	medicaid, insurance, care_provider, quality_care, medical_record	0.11	1.748892542
t.6	spinal_cord	neuropathic, chronic_pain, trigeminal, neuropathic_pain, extremity	0.1	0.890427645
t.7	drug_resistance	acquired_resistance, multi_drug, drug_interaction, multidrug_resistant, resistant_bacteria	0.1	0.562548365
t.13	protein_interaction	protein_protein, directed_mutagenesis, sialic, sialic_acid, binding_affinity	0.1	1.782328245
t.51	molecular_mechanism	functional_importance, biochemical_analyse, precise_molecular, characterize_key, play_critical	0.1	5.510764728
t.58	epithelial_cell	crohn, coliti, ibd, probiotic, microbiota	0.1	0.562415699
t.19	brain_injury	brain_injury, cbf, traumatic_brain, ischemic_stroke, cerebral_ischemia	0.09	0.764742184
t.47	hair_cell	glaucoma, ocular, photoreceptor, cochlear, vocal	0.09	0.641869381
t.70	blood_cell	hif, vhl, lay_foundation, chronic_obstructive, hypoxia_inducible	0.09	0.432370896

Topic	Label	Topic Terms Prime	Coherence	Prevalence
t.5	side_effect	double_blind, placebo_controlled, randomized_placebo, phase_clinical, mg_daily	0.08	1.461619227
t.8	genetic_screen	caenorhabditi, caenorhabditis_elegan, fruit_fly, genetically_tractable, drosophila_melanogaster	0.08	1.611795974
t.10	birth_defect	zebrafish, cilia, pax, congenital_heart, hedgehog_signaling	0.08	1.150376824
t.37	membrane_protein	conformational, ray_crystallography, protein_structure, plasmon, energy_transfer	0.08	1.231246124
t.41	lung_injury	lung_injury, pulmonary_fibrosis, nsclc, gefitinib, human_lung	0.08	0.764154383
t.42	statistical_method	informatic, develop_statistical, freely, open_source, machine_learning	0.08	2.321732189
t.28	atherosclerotic_lesion	pancreatic_cancer, lupus, sle, hdl, rheumatoid	0.07	0.432703001
t.38	white_matter	white_matter, executive, dti, functional_magnetic, imaging_fmri	0.07	1.333901172
t.63	aav_vector	aav, raav, aav_vector, encapsulated, viral_vector	0.07	0.691507287
t.9	cell_cycle	mathematical_model, computational_modeling, spatio_temporal, computer_model, systems_biology	0.06	1.612374865
t.15	specific_aim	supported_preliminary, effects_observed, hypothesis_activation, mechanisms_chronic, vivo_preliminary	0.06	4.290345774
t.21	real_time	quantum, point_care, quantum_dot, miNIturized, tunable	0.06	1.891335384
t.23	proposed_research	positive_impact, significant_expected, guided_strong, research_relevant, expected_advance	0.06	1.956050879
t.49	natural_product	natural_product, chemical_synthesis, catalyst, active_site, chiral	0.06	1.065434174
t.67	physical_activity	ses, fund, psychosocial_factor, risk_protective, structural_equation	0.06	1.513117635
t.46	chronic_stress	bladder_cancer, ptsd, chronic_stress, hpa, stress_disorder	0.05	0.392222734
t.74	bcr_abl	tuberculosis, aml, mtb, abl, bcr	0.05	0.369524926
t.82	data_sharing	data_sharing, interdisciplinary_team, data_analyse, excellence, medical_school	0.05	1.418328945
t.26	radiation_therapy	igf, radiation_induced, fdg, positron, positron_emission	0.03	0.360459346
t.39	neurodegenerative_disease	prion, prp, abeta, disease_pd, lateral_sclerosis	0.03	1.178083073
t.40	health_literacy	lrp, literacy, nkt, health_literacy, suicidal_behavior	0.01	0.270636993

Appendix C.
Survey Respondent Characteristics

Table C-1. Respondent Characteristics: Gender

	NI and ESI R01 Awardee Populations	Survey Respondents	Matched Survey Respondents
Gender			
Male	63%	54%	47%
Female	37%	46%	53%
N	230	91	38
Pre-Award Publications			
NI Awardees	26.03 (21.09)	24.12 (11.23)	22.00 (8.87)
ESI R01 Awardees	27.20 (20.25)	27.60 (17.88)	28.95 (17.40)
Institution Type			
Institution of Higher Education	81%	80%	74%
Research Organization	7%	10%	16%
Independent Hospital	12%	10%	11%
Degree Type			
Basic	77%	79%	84%
Clinical	6%	7%	5%
Basic–Clinical	17%	14%	10%
N	230	91	38
Award Year			
2007	26%	24%	21%
2008	27%	23%	16%
2009	47%	53%	63%
N	230	91	38

Appendix D.
NI Awardee Survey

Page One

NIH New Innovator Evaluation

Welcome and thank you for taking part in this survey provided to you by the IDA Science and Technology Policy Institute (STPI) on behalf of the National Institutes of Health (NIH). STPI is a federally funded research and development center that has been contracted by NIH to assess the NIH's New Innovator Award (NIA) program. Your feedback is an invaluable component of this process.

Purpose of the Survey

You have been contacted because you were the recipient of a New Innovator Award. We would like to know about the grants funded through the NIA program, the results of the research, and your perspectives on the award and your research results.

Confidentiality Statement

STPI is independent of the NIH and has been contracted to collect these data. All responses will be kept confidential and protected to the extent possible by law.

Only aggregate data will be presented to the NIH. Your decision to participate is voluntary and will have no effect on your current or future relationship with the NIH.

Instructions for the Survey

Please have a current version of your CV available for reference.

The survey is divided into four sections:

Section 1-Research Outputs: You will be asked to identify research outputs and to provide names of experts who you would consider appropriate to review your most important NIA research outputs. Research outputs are publications, technologies/techniques, inventions/patents, or any other output that can be directly attributed to your award.
Section 2-Awardee Research Perspectives: Your perspective on the body of work that resulted from your award and the NIA program.
Section 3-Additional Funding: Information on any additional funding you have received.
Section 4-Career Progression: Information about your career progression since receiving your NIA was awarded.

The collection of this information is estimated to average 20 minutes, including the time for

reviewing instructions, searching existing data sources, gathering the data needed, and completing and reviewing the survey.

If you would like to review the NIA Funding Opportunity Announcement, please see the following link: http://commonfund.nih.gov/newinnovator

Follow-Up Interview
After submission, STPI staff may call you for a short (~30 minute) phone interview to discuss your responses.

Inquiries and Concerns
If you have questions or concerns about completing this survey, please contact us at NIAoutcomes@ida.org.

Thank you for your valuable contribution to this process.

- ○ Yes, I wish to participate
- ○ No, I do not want to participate

(untitled)

1. Disregarding spelling or grammatical errors, please report the ID number associated with any citation that is not supported by your NIA, separating entries with a comma. (Example: 1,5,7 would be recorded if these publications were not supported by your NIA). If all of the citations are correct, please type 'NA' to continue. In the next section, you will be able to add additional outputs. *

(untitled)

2. Considering only those research outputs that were formally supported by your award, do you have any additional **journal publications**, **manuscripts in preparation**, **invited presentations/papers**, or **books (or other one-time publications)** to report? *

- ○ Yes, I have additional outputs to report.
- ○ No, I do not have any additional outputs to report.

3. Please provide the citation for each additional publication: article title, journal, and year of publication. If you have multiple publications to report, click "Add Another Publication" for each additional publication and enter the requested information for that publication. **Please, enter only one publication at a time.**

Publication Type *

- ○ Journal publication
- ○ Manuscript in preparation
- ○ Invited presentations/papers
- ○ Book (or one time publication)

Citation for publication

Add Another Publication

(untitled)

4. Are there any **technologies/techniques**, **inventions/patents**, or any **other research outputs** (Example: data, databases, software) that can be directly attributed to your award? To be directly attributed, the research output must be based upon or incorporate, at least in part, knowledge gained from research associated with your NIA award, whether or not it was financially supported by the award. *

- ○ Yes, I have additional outputs to report.
- ○ No, I do not have any additional outputs to report.

5. Please provide a reference or description for each additional non-publication research output. This reference, or description, should allow the research output to be uniquely identified. If you have multiple non-publication research outputs to report, click "Add Another Research Output" for each additional output and enter the requested information. **Please enter only one research output at a time.** *

Type of output

- ○ Technology
- ○ Technique
- ○ Patent
- ○ Invention
- ○ Other (explain in description)

Description of output

Add Another Research Output

(untitled)

Publications

Additional Outputs

6. Top Three Research Outputs from NIA-Funded Research

Copy and paste your three selections into the corresponding text boxes below. *

Output 1

Output 2

Output 3

(untitled)

7. Considering the degree to which the research **supported** by your NIA was risky, creative, and innovative, please indicate the extent to which you agree or disagree with the following statements: *

	Rating *					
	Strongly Disagree	Somewhat Disagree	Neither Agree Nor Disagree	Somewhat Agree	Strongly Agree	Not Applicable
One or more of the ideas underlying the research						

was at odds with the prevailing thinking of the time.	○	○	○	○	○	☐
The research required the use of equipment or a technique that was novel.	○	○	○	○	○	☐
The research required knowledge of fields outside of my area of expertise.	○	○	○	○	○	☐
The research involved a novel combination of ideas, disciplines, or approaches.	○	○	○	○	○	☐
The research is a significant departure from my previous research focus.	○	○	○	○	○	☐

8. Considering the potential or realized outcomes of your NIA research, please indicate the extent to which you agree or disagree with the following statements: *

	Strongly Disagree	Somewhat Disagree	Neither Agree Nor Disagree	Somewhat Agree	Strongly Agree
The research resulted, or will potentially result, in the formulation of a new idea.	○	○	○	○	○
The research resulted, or will potentially result, in the discovery of a new phenomenon.	○	○	○	○	○
The research resulted, or will potentially result, in the development of a new methodology.	○	○	○	○	○
The research resulted, or will potentially result, in a novel invention that led to a new technology.	○	○	○	○	○
The research resulted, or will potentially result, in a new synthesis of disparate ideas.	○	○	○	○	○
The research resulted, or will potentially result, in the advancement of a theoretical concept.	○	○	○	○	○

9. Describe any other potential or realized outcomes that resulted from your NIA?

(untitled)

10. Considering various aspects of the research supported by your NIA, please indicate the extent to which you agree or disagree with the following statements: *

	Strongly Disagree	Somewhat Disagree	Neither Agree Nor Disagree	Somewhat Agree	Strongly Agree
My research falls into the research interest of a single NIH Institute/Center.	○	○	○	○	○
My research had an NIH study section with appropriate scientific expertise.	○	○	○	○	○
My research had little or no preliminary data when I submitted my NIA application.	○	○	○	○	○
Over the course of the grant period, my research idea changed significantly from what was initially proposed.	○	○	○	○	○
Overall, the research was different from what is typically funded through NIH.	○	○	○	○	○

11. Comparing other funding mechanisms to your NIA award, please indicate how much you agree or disagree with the following statements: *

	Strongly Disagree	Somewhat Disagree	Neither Agree Nor Disagree	Somewhat Agree	Strongly Agree
My research was likely to be funded through traditional NIH mechanisms (R01, R21, etc.) if the NIA program did not exist.	○	○	○	○	○
My research was likely to be funded through sources other than NIH.	○	○	○	○	○
I would have chosen to seek traditional NIH funding (R01, R21, etc.) for my NIA research had the NIA program not existed.	○	○	○	○	○

12. Considering the various aspects of the NIA program, indicate the extent to which you agree or disagree with the following statements: *

	Strongly Disagree	Somewhat Disagree	Neither Agree Nor Disagree	Somewhat Agree	Strongly Agree
The NIA allowed for flexibility in the use of funding.	○	○	○	○	○
The NIA allowed me the freedom to pursue non-traditional research.	○	○	○	○	○
The period of the NIA was long enough for me to redirect research as ideas/methods evolved.	○	○	○	○	○

(untitled)

13. Since you received your NIA, have you been awarded other grants larger than $50,000? *

- ○ Yes
- ○ No

14. Please provide the following information for each award received. If you have multiple awards to report, select "Add additional award" for each award and enter the requested information *

Funding Agency

Agency Type

Public agency

Private agency

Grant Number

Estimated Award Amount

$

Award Date

Add additional award

(untitled)

15. Which of the following best describes your current employment? *

- I am employed by an **academic institution**.
- I am employed by a **medical institution** affiliated with a University.
- I am employed by a **medical institution** that is **not** affiliated with a University.
- I am employed by a **private foundation** or **non-governmental organization**.
- I am employed in **industry** or work for a **corporation**.
- Other-Please Specify

*

16. What is your current job title? Please include academic rank, if applicable. *

Title:

17. Are you in the same scientific discipline reported on your NIA application? *

- Yes, I am in the same discipline.
- No, I am not in the same discipline.

18. What is your new discipline and what caused this transition? *

(untitled)

19. Below is a list of changes that may have occurred since your NIA was awarded; please indicate whether or not the change took place for you. *

	Yes, this occurred.	No, this did not occur.
I received an award/honor.	○	○
I was promoted.	○	○
I received tenure.	○	○
I am applying for tenure.	○	○
I expanded my research lab.	○	○
I formed new partnerships/collaborations.	○	○
I expanded my research focus to new disciplines.	○	○
I changed institutions.	○	○
My research has been featured in the popular press/media.	○	○
My research has been featured on the cover of an academic journal.	○	○
I have been invited to serve as a regular reviewer for a journal.	○	○
I have been invited to serve as a journal or book editor.	○	○

20.

Other Career Development (Optional)

Add Another

21. Please list the awards/honors you received. If you have multiple awards/honors to report, select "Add another award" to enter each award.

Award

Add another award

22. Is there any additional information you would like to report?

(untitled)

23. An important component of the NIA evaluation is the expert review panel and STPI will identify reviewers who can contribute a knowledgeable and complete review of your NIA research. These individuals will represent a mix of perspectives on the science covered by your NIA.

If you would like to provide the names and contact information for possible reviewers, please do so in the space provided below.

	First Name	Last Name	Email
Reviewer One			
Reviewer Two			
Reviewer Three			
Reviewer Four			
Reviewer Five			

Appendix E.
ESI R01 Awardee Survey

Page One

Early Stage Investigator Survey

Welcome and thank you for taking part in this survey provided to you by the IDA Science and Technology Policy Institute (STPI) on behalf of the National Institutes of Health (NIH). STPI is a federally funded research and development center that has been contracted by NIH to assess aspects of the Early Stage Investigator (ESI) award process. The ESI designation is assigned to a researcher who has completed his or her terminal research degree or medical residency within the past 10 years and has not yet been awarded a substantial, competing NIH research grant. Your feedback is an invaluable component of this process.

Purpose of the Survey

You have been contacted because you meet the criteria of an ESI and have received your first substantial grant award (ESI award). We would like to know about the R01 grant you have received, the results of the research, and your perspectives on the award and your research results.

Confidentiality Statement

STPI is independent of the NIH and has been contracted to collect these data. All responses will be kept confidential and protected to the extent possible by law.

Only aggregate data will be presented to the NIH. Your decision to participate will have no effect on your current or future relationship with the NIH.

Instructions for the Survey

The survey is divided into four sections:

Section 1-Research Outputs: You will be asked to identify research outputs and to provide names of experts who you would consider appropriate to review your most important ESI research outputs. Research outputs are publications, technologies/techniques, inventions/patents, or any other output that can be directly attributed to your award.
Section 2-Awardee Research Perspectives: Your perspective on the body of work that resulted from your award and the ESI process.
Section 3-Additional Funding: Information on any additional funding you have received.
Section 4-Career Progression: Information about your career progression since receiving your ESI was awarded.

The collection of this information is estimated to average 20 minutes, including the time for reviewing instructions, searching existing data sources, gathering the data needed, and

completing and reviewing the survey.

If you would like to review the ESI R01 Funding Opportunity Announcement, please see the following link: http://grants.nih.gov/grants/new_investigators/

Follow-Up Interview
After submission, STPI staff may call you for a short (~30 minute) phone interview to discuss your responses.

Inquiries and Concerns
If you have questions or concerns about completing this survey, please contact us at ESIoutcomes@ida.org.

Thank you for your valuable contribution to this process.

- ○ Yes, I wish to participate
- ○ No, I do not want to participate

Page 2 - Outputs

1. Disregarding spelling or grammatical errors, please report the ID number associated with any citation that is not supported by your ESI award, separating entries with a comma. (Example: 1,5,7 would be recorded if these publications were not supported by your ESI award). If all of the citations are correct, please type 'NA' to continue. In the next section, you will be able to add additional outputs. *

Page 3 - Outputs

2. Considering only those research outputs that were formally supported by your award, do you have any additional **journal publications**, **manuscripts in preparation**, **invited presentations/papers**, or **books (or other one-time publications)** to report? *

- ○ Yes, I have additional outputs to report.
- ○ No, I do not have any additional outputs to report.

3. Please provide the citation for each additional publication: article title, journal, and year of publication. If you have multiple publications to report, click "Add Another Publication" for each additional publication and enter the requested information for that publication. **Please, enter only one publication at a time.**

Publication Type *

- ○ Journal publication
- ○ Manuscript in preparation
- ○ Invited presentations/papers
- ○ Book (or one time publication)

Citation for publication

Add Another Publication

Page 4 - Outputs

Page description:

4. Are there any **technologies/techniques**, **inventions/patents**, or any **other research outputs** (Example: data, databases, software) that can be directly attributed to your award? To be directly attributed, the research output must be based upon or incorporate, at least in part, knowledge gained from research associated with your ESI award, whether or not it was financially supported by the award. *

- ○ Yes, I have additional outputs to report
- ○ No, I do not have any additional outputs to report

5. Please provide a reference or description for each additional non-publication research output. This reference, or description, should allow the research output to be uniquely identified. If you have multiple non-publication research outputs to report, click "Add Another Research Output" for each additional output and enter the requested information. **Please enter only one research output at a time.**

Type of output

Technology ○

Technique ○

Patent ○

Invention ○

Other (explain in description) ○

Description of Output

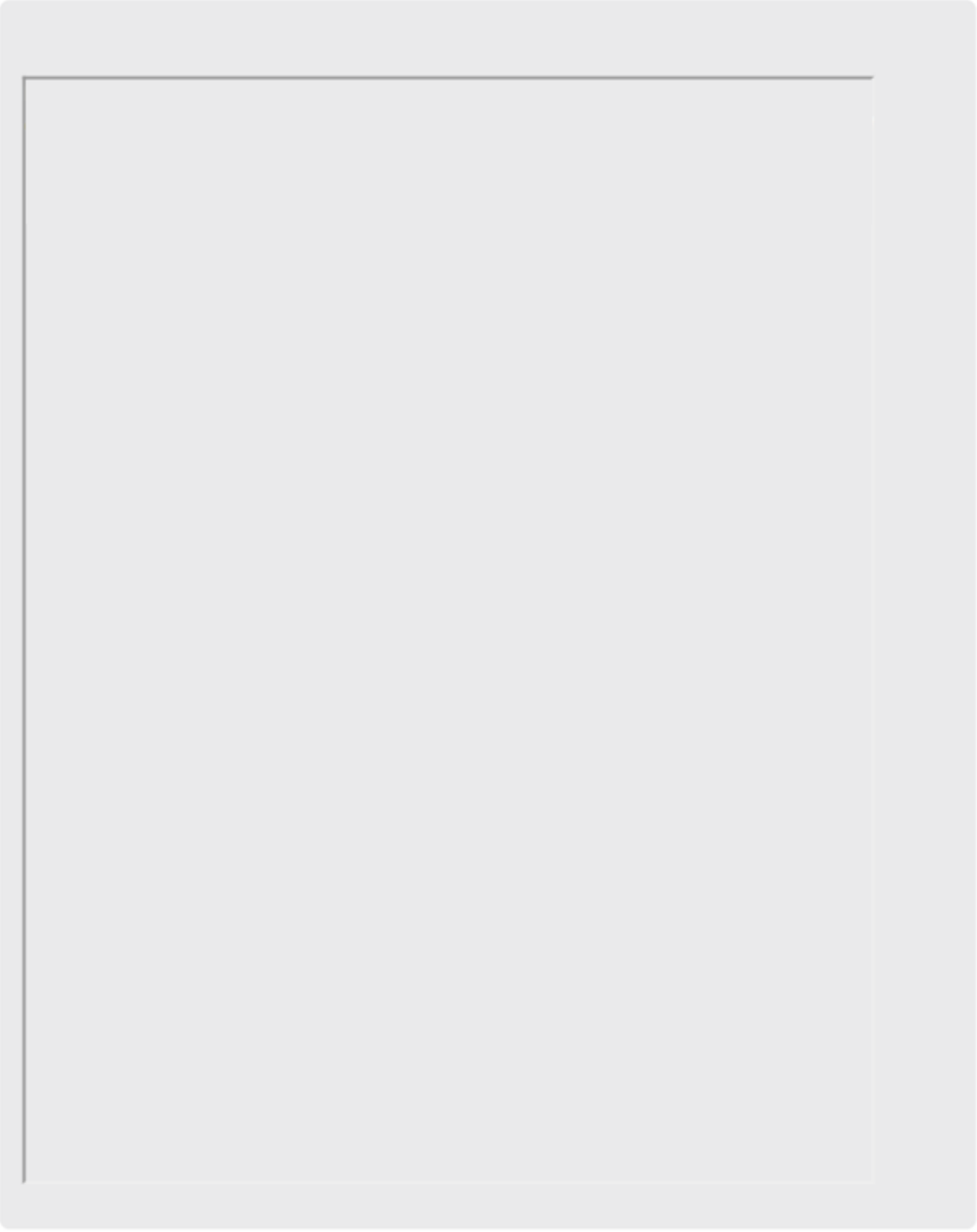
Add Another Research Output

Page 5 - Outputs

Page description:

Top Three Research Outputs from ESI-Funded Research

Below are all of the research outputs reported above. In no particular order, please select the three outputs that **best represent** what you achieved with ESI funding. Copy and paste the full text from your three selections into the corresponding text boxes below.



Publications

Additional Outputs

6. Top Three Research Outputs from ESI-Funded Research

Copy and paste your three selections into the corresponding text boxes below.
*

Output 1

Output 2

Output 3

Page 6 - Rating research

Page description:

Section Two- Awardee Perspectives on Research

In this section, you will be asked about your perspectives on your ESI research and the ESI process. Take into account the entire body of work that resulted from your ESI award when making judgments. There are no right or wrong answers to these questions.

7. Considering the degree to which the research supported by your ESI award was risky, creative, and innovative, please indicate the extent to which you agree or disagree with the following statements: *

	Rating					
	Strongly Disagree	Somewhat Disagree	Neither Agree Nor Disagree	Somewhat Agree	Strongly Agree	Not Applicable
One or more of the ideas underlying the research was at odds with the prevailing thinking of the time.	○	○	○	○	○	☐
The research required the use of equipment or a technique that was novel.	○	○	○	○	○	☐
The research required knowledge of fields outside of my area of expertise.	○	○	○	○	○	☐
The research involved a novel combination of ideas, disciplines, or approaches.	○	○	○	○	○	☐

The research is a significant departure from my previous research focus.	○	○	○	○	○	☐

8. Considering the potential or realized outcomes of your ESI R01, please indicate the extent to which you agree or disagree with the following statements: *

	Strongly Disagree	Somewhat Disagree	Neither Agree Nor Disagree	Somewhat Agree	Strongly Agree
The research resulted, or will potentially result, in the formulation of a new idea.	○	○	○	○	○
The research resulted, or will potentially result, in the discovery of a new phenomenon.	○	○	○	○	○
The research resulted, or will potentially result, in the development of a new methodology.	○	○	○	○	○
The research resulted, or will potentially result, in a novel invention that led to a new technology.	○	○	○	○	○
The research resulted, or will potentially result, in a new synthesis of disparate ideas.	○	○	○	○	○
The research resulted, or will potentially result, in the advancement of a theoretical concept.	○	○	○	○	○

9. Describe any other potential or realized outcomes that resulted from your ESI award.

Page 7 - Rating research

10. Considering various aspects of the research supported by your ESI research, please indicate the extent to which you agree or disagree with the following statements: *

	Strongly Disagree	Somewhat Disagree	Neither Agree Nor Disagree	Somewhat Agree	Strongly Agree
My research falls into the research interest of a single NIH Institute/Center.	○	○	○	○	○
My research had an NIH study section with appropriate scientific expertise.	○	○	○	○	○
My research had little or no preliminary data when I submitted my ESI application.	○	○	○	○	○
Over the course of the grant period, my research idea changed significantly from what was initially proposed.	○	○	○	○	○
Overall, the research was different from what is typically funded through NIH.	○	○	○	○	○

11. Comparing other funding mechanisms to your ESI R01 award, please indicate how much you agree or disagree with the following statements: *

	Strongly Disagree	Somewhat Disagree	Neither Agree Nor Disagree	Somewhat Agree	Strongly Agree
The ESI award allowed for flexibility in the use of funding.	○	○	○	○	○
The ESI award allowed me the freedom to pursue non-traditional research.	○	○	○	○	○
The period of the ESI award was long enough for me to redirect research as ideas/methods evolved.	○	○	○	○	○
My research was likely to be funded through sources other than NIH.	○	○	○	○	○

---

12. Since you received your ESI Award, have you been awarded other grants larger than $50,000? *

- ○ Yes
- ○ No

13. Please provide the following information for each award received. If you have multiple awards to report, select "Add additional award" for each award and enter the requested information *

Funding Agency

Agency Type

Public Agency

Private Agency

Grant Number

Estimated Award Amount

$

Award Date

Add additional award

Page 9 - Career

14. Which of the following best describes your current employment? *

- I am employed by an **academic institution**.
- I am employed by a **medical institution** affiliated with a University.
- I am employed by a **medical institution** that is **not** affiliated with a University.
- I am employed by a **private foundation** or **non-governmental organization**.
- I am employed in **industry** or work for a **corporation**.
- Other-Please Specify

*

15. What is your current job title? Please include academic rank, if applicable. *

Title

16. Are you in the same scientific discipline reported on your ESI application? *

- Yes, I am in the same discipline.
- No, I am not in the same discipline.

17. What is your new discipline and what caused this transition?

Page 10 - Career

18. Below is a list of changes that may have occurred since your ESI was awarded; please indicate whether or not the change took place for you. *

	Yes, this occurred	No, this did not occur
I received an award/honor.	○	○
I was promoted.	○	○
I received tenure.	○	○
I am applying for tenure.	○	○
I expanded my research lab.	○	○
I formed new partnerships/collaborations.	○	○
I expanded my research focus to new disciplines.	○	○
I changed institutions.	○	○
My research has been featured in the popular press/media.	○	○
My research has been featured on the cover of an academic journal.	○	○
I have been invited to serve as a regular reviewer for a journal.	○	○
I have been invited to serve as a journal or book editor.	○	○

19.

Other Career Development (Optional)

Add Another

20. Please list the awards/honors you received. If you have multiple awards/honors to report, select "Add another award" to enter each award.

Award One

Add Another Award

21. Is there any additional information you would like report?

(untitled)

22. An important component of the evaluation is the expert review panel and STPI will identify reviewers who can contribute a knowledgeable and complete review of your research. These individuals should represent a mix of perspectives on the science covered by your ESI.

If you would like to provide the names and contact information for possible reviewers, please do so in the space provided below.

	First Name	Last Name	Email
Reviewer One			
Reviewer Two			
Reviewer Three			
Reviewer Four			
Reviewer Five			

Appendix F.
Senior Scientist Reviewer Survey

Page One

New Innovator Award Evaluation

Welcome and thank you for taking part in the expert review of the research outcomes funded through NIH. This survey is provided to you by the IDA Science and Technology Policy Institute (STPI) on behalf of the National Institutes of Health (NIH). Your feedback is an invaluable component of this review process.

Purpose of this Survey
The goal of the expert review is to inform the evaluation of NIH's New Innovator Award (NIA) program.

Your review will assist STPI in evaluating the type and degree of research risk and the level of innovativeness of selected awards.

Survey Instruction
Each packet of research outputs you received was marked with a unique identifier. For each packet of research outputs, you will answer approximately 20 questions assessing the extent to which the research was innovative and high risk, high reward. These packets of outputs may be associated with either a NIA awardee or an awardee from a matched comparison group.

Key Definitions
The terms "innovative" and "high risk, high reward" refer to research that possesses an inherent, high degree of uncertainty and has the potential to produce a major impact on important problems in biomedical/behavioral research. Research risk can be defined in the following ways:

- Conceptual Risk: one or more fundamental ideas underlying the research were at odds with the prevailing wisdom of the time.
- Technical Risk: the research required use of equipment or a technique in a novel way.
- Experiential Risk: the research required knowledge beyond the researcher's previously demonstrated area of expertise.
- Multidisciplinary Risk: the research involved an unprecedented combination of perspectives, disciplines, or approaches.

Non-Disclosure Agreement
All non-public information that you receive as part of this review shall be deemed proprietary information. It is understood that until either (a) the information is made public through publication in a journal or (b) you are given specific written approval by NIH, you will treat the information as confidential; not use the information except to answer the questions provided; and not disclose the information to a third party - both during the review and thereafter.

Please enter your initials in the text box below to indicate your acceptance of the terms of the non-disclosure agreement.

Initials

Confidentiality Agreement
STPI is independent of the NIH and has been contracted to collect these data. All responses will be kept confidential and your responses will be protected to the extent possible by law.

Only aggregate data will be presented to the NIH. Your decision to participate is voluntary and will have no effect on your current or future relationship with the NIH.

Inquiries and Concerns
If you have questions or concerns about completing this survey, please contact us at jmary@ida.org. Thank you for your valuable contribution to this process.

- ○ Yes, I agree to participate
- ○ No, I do not want to participate

(untitled)

1. Considering the **risk** associated with the research packet you reviewed, please indicate the extent to which you agree/disagree with the following statements:

	Strongly Disagree	Somewhat Disagree	Neither Agree Nor Disagree	Somewhat Agree	Strongly Agree
One or more of the fundamental ideas underlying the research was at odds with the prevailing wisdom of the time.	○	○	○	○	○
The research required the use of equipment or a technique that was novel.	○	○	○	○	○
The research involved a unique and unprecedented combination of perspectives, disciplines, or approaches.	○	○	○	○	○

2. Considering the **potential or realized outcomes** associated with the packet of research you reviewed, please rate the extent to which you agree/disagree with the following statements:

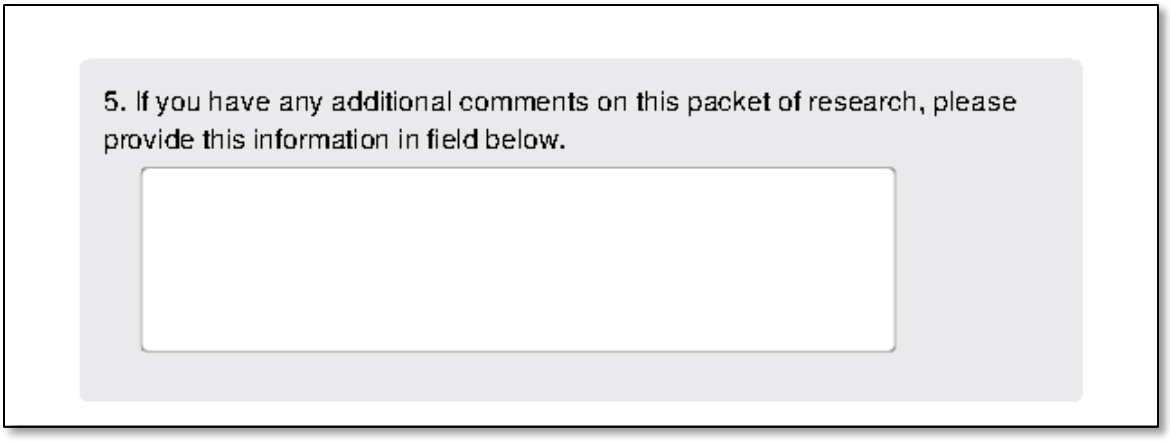
	Strongly Disagree	Somewhat Disagree	Neither Agree Nor Disagree	Somewhat Agree	Strongly Agree
The research resulted in the formulation of a new idea.	○	○	○	○	○
The research resulted in the discovery of new phenomena.	○	○	○	○	○
The research resulted in the development of a new methodology.	○	○	○	○	○
The research resulted in the invention of novel instruments.	○	○	○	○	○
The research resulted in the synthesis of disparate ideas.	○	○	○	○	○
The research resulted in the significant advancement of theoretical concepts.	○	○	○	○	○

3. Considering the **innovativeness** associated with the packet of research outputs, to what extent do you agree or disagree with the following statements?

	Strongly Disagree	Somewhat Disagree	Neither Agree Nor Disagree	Somewhat Agree	Strongly Agree
The research introduced novel theoretical ideas.	○	○	○	○	○
The research applied cutting-edge approaches.	○	○	○	○	○
The research combined fundamental principles, models, or experiments in novel ways.	○	○	○	○	○
The research pursued an approach that was contrary to the norm.	○	○	○	○	○
The research will revolutionize the field.	○	○	○	○	○
The research introduced radically different tools.	○	○	○	○	○
The research cut across multiple disciplines.	○	○	○	○	○
The research will have a significant impact on the field.	○	○	○	○	○
The research was rigorous.	○	○	○	○	○
The research was innovative.	○	○	○	○	○

4. How aligned is your own research expertise with that of the research in the packet as a whole.

Not at all Aligned	Somewhat Unaligned	Somewhat Aligned	Very Aligned
○	○	○	○



The five questions of this survey were iterated three times, allowing each senior scientist reviewer to evaluate three packets of research outputs.

Appendix G.
Case Study Interview Questions

NI Awardee Interview Questions

Thank you for taking the time to speak with us. To give you some background the Science and Technology Policy Institute has been asked by the National Institutes of Health to evaluate the scientific and career outcomes of their New Innovators Award. The primary objective of this evaluation is to assess whether the award fosters high risk, innovative research and to determine the impacts of the award on researchers' careers. Over the course of today's conversation, we hope to expand information we gathered though the survey we previously sent out to awardees like you.

STPI will keep your responses today confidential and report them to NIH qualitatively and without attribution.

We would like to record this discussion to make sure we accurately reflect your comments. Once your comments are transcribed, we will delete the recording.

Would you still like to participate in this interview?

Your decision to apply

1. Have you applied for NIH funding prior to applying for the NIA?
2. Why did you choose to apply for the NIA?
    a. Were there special characteristics of the NIA that were appealing?
        1) Possible characteristics: innovativeness, high risk, flexibility, no preliminary data, more funding, different mechanism, good fit for the person's research
3. Did you send, or consider sending, the research proposal submitted to the NIA to other agencies?
    a. If yes, what was the outcome?

How you wrote your proposal

1. Did the NIA allow you to propose research in a way that you think would not have been possible with traditional NIH funding mechanisms? What was different?
2. When writing your proposal, did you choose your topic or methods differently because of the NIA requirements for innovation and risk? How so?
3. Took more chances, changed research design, tried new methods

4. Was the research very different from what you were doing up to that point? How so?

How you conducted your research

1. Was your NIA research a new research direction for you?
2. Did the NIA mechanism change how you conduct your research?
    a. Let me take more risks, made it easier to change directions, made it harder because I had to figure things out as I went, allowed for failure and restart, let me expand my research program faster.

Understanding NIA impact

Collaborations

1. Was your NIA research part of an existing collaboration or a new single investigator effort?
2. Have other researchers reached out to collaborate with you in your NIA research area, or were they more receptive to collaboration when you contacted them?
3. Do you think that the NIA award helped you to strengthen existing collaborations? Open avenues to new collaborations?

Laboratory structure

1. Did you make changes to your lab to achieve the goals of your NIA research? For example, were there changes in the number or type of personnel, research roles, training, or equipment?
    a. Personnel: postdocs, students, other technically skilled persons
    b. Were the postdocs and other technically skilled persons added in areas of science or expertise that were new to your lab? Or did you re-direct or re-train existing staff?
2. Did the NIA award attract more postdocs and students to your lab? Did the innovativeness of the NIA research attract more postdocs and students to your lab?

Concurrent funding and follow-on grants

1. Did you apply for *concurrent* funding in the area of your NIA grant? In other areas of research?
    a. What was the outcome? Do you think the NIA played a role in that outcome?
2. Have you received follow-on funding in your NIA research area?
    a. What was the outcome? Do you think the NIA played a role in that outcome?
    b. If you applied for or received NIH grants in other research topics, do you think the NIA played a role in that outcome?

c. Did you change your overall research path following your NIA? Did this impact your funding?

    1) Away from previous research, toward more high risk research

Tenure and career

1. Where were you in the tenure track when you received your NIA? Where are you currently?
2. Do you think the NIA
    a. had an impact on your tenure process? Do you think that would be different if you had received an R01 instead?
    b. is recognized by your colleagues as prestigious and provides more recognition in your institution?
        1) opportunities to give invited talks, chair sessions at national meetings, publish more, etc.
3. Has the NIA affected other non-research aspects of your career, such as teaching, placement on university and national society committees?
4. Were there any other career changes that have occurred since receiving your NIA? Are they related to the NIA award or to the research it funded?
5. Do you think the NIA provided more benefits to your career than other NIH mechanisms? To your research?

In conclusion

1. Is there anything else you'd like the NIH to know about the NIA award and your experience with it?

Thank you again for taking the time to speak with us. We have taken detailed notes on your answers to make sure they were captured accurately. May we contact you by email is we have any follow up questions?

If you have any questions or would like to add any additional comments, please do not hesitate to contact us though (Ryan, Chris, Joseph) who contacted you to set up this interview.

ESI R01 Awardee interview questions

Thank you for taking the time to speak with us. To give you some background, the Science and Technology Policy Institute has been asked by the National Institutes of Health to evaluate the scientific and career outcomes of early career investigators. The primary objective of this evaluation is to assess whether the award fosters high risk, innovative research and to determine the impacts of the award on researchers' careers. Over the course of today's conversation, we hope to expand information we gathered though the survey we previously sent out to awardees like you.

STPI will keep your responses today confidential and report them to NIH qualitatively and without attribution.

We would like to record this discussion to make sure we accurately reflect your comments. Once your comments are transcribed, we will delete the recording.

Would you still like to participate in this interview?

Your decision to apply

1. Did you apply for NIH funding prior to applying for the ESI R01?
2. Why did you choose to apply for the ESI R01?
    a. Were there special characteristics of the ESI R01 that were appealing?
        1) Possible characteristics: more funding, longer funding period, important for tenure, flexibility, good fit for the person's research
3. Were you aware of any special NIH awards such as the New Innovator Award?
4. Did you send, or consider sending, the research proposal submitted to the ESI R01 to other agencies?
    a. If yes, what was the outcome?

How you wrote your proposal

1. Did the ESI R01 allow you to propose research in a way that you think would not have been possible with other NIH funding mechanisms? What was different?
2. When writing your proposal, did you choose your topic or methods differently because of the ESI R01 requirements? How so?
    a. Changed research design, tried new methods, had more preliminary data, scoped the research to match an FOA
3. Was the research very different from what you were doing up to that point? How so?

How you conducted your research

1. Was your ESI R01 research a new research direction for you?
2. Did the ESI R01 mechanism change how you conduct your research?
    a. Let me take more risks, made it easier to change directions, made it harder because it was my first big award, let me expand my research program faster.

Understanding ESI R01 impact

Collaborations

1. Was your ESI R01 research part of an existing collaboration or a new single investigator effort?
2. Have other researchers reached out to collaborate with you in your ESI R01 research area, or were they more receptive to collaboration when you contacted them?
3. Do you think that the ESI R01 award helped you to strengthen existing collaborations? Open avenues to new collaborations?

Laboratory structure

1. Did you make changes to your lab to achieve the goals of your ESI R01 research? For example, were there changes in the number or type of personnel, research roles, training, or equipment?
    a. Personnel: postdocs, students, other technically skilled persons
    b. Were the postdocs and other technically skilled persons added in areas of science or expertise that were new to your lab? Or did you re-direct or re-train existing staff?
2. Did the ESI R01 award attract more postdocs and students to your lab? Did the ESI R01 research attract more postdocs and students to your lab?

Concurrent funding and follow-on grants

1. Did you apply for *concurrent* funding in the area of your ESI R01 grant? In other areas of research?
    a. What was the outcome? Do you think the ESI R01 played a role in that outcome?
2. Have you received follow-on funding in your ESI R01 research area?
    a. What was the outcome? Do you think the ESI R01 played a role in that outcome?
    b. If you applied for or received NIH grants in other research topics, do you think the ESI R01 played a role in that outcome?
    c. Did you change your overall research path following your ESI R01? Did this impact your funding?
        1) Away from previous research, toward more high risk research, toward more collaborative research

Tenure and career

1. Where were you in the tenure track when you received your ESI R01? Where are you currently?
2. Do you think the ESI R01

a. had an impact on your tenure process? Do you think that would be different if you had not received your R01?

b. is recognized by your colleagues as a sign of scientific/professional maturity and provides more recognition in your institution?

1) opportunities to give invited talks, chair sessions at national meetings, publish more, etc.

3. Has the ESI R01 affected other non-research aspects of your career, such as teaching, placement on university and national society committees?

4. Were there any other career changes that have occurred since receiving your ESI R01? Are they related to the ESI R01 award or to the research it funded?

5. Do you think the ESI R01 provided more benefits to your career than other NIH mechanisms? To your research?

In conclusion

1. Is there anything else you'd like the NIH to know about the ESI R01 award and your experience with it?

Thank you again for taking the time to speak with us. We have taken detailed notes on your answers to make sure they were captured accurately. May we contact you by email is we have any follow up questions?

If you have any questions or would like to add any additional comments, please do not hesitate to contact us though (Ryan, Chris, Joseph) who contacted you to set up this interview.

Appendix H.
Statistical Model for Senior Scientist Review Analysis

The proposed model is discussed in terms of impact, but the model is fit to all 20 survey items independently. The basic structure of the model is adapted from Johnson and Albert (1999). The Likert scale data are numbered Strongly Disagree as 1 through Strongly Agree as 5.

Assume that each packet has an underlying impact that can be measured. Let Z_i denote the impact of packet i. Further assume that the packet impacts are independent. To establish a scale, let $Z_i \sim$ Normal (0, 1). Assume also that the expert has some "measurement error" (σ_j^2) when evaluating the impact of packet i. We then denote t_{ij} as expert j's view of awardee I, with $t_{ij} \sim$ Normal(Z_i , σ_j^2). Neither Z_i nor t_{ij} are observed. What is observed is the discretized impact scale of each expert, where the Likert response is the bin that contains the assessed impact. As every expert has a different impact scale, let γ_{jl} be the bin cutoff for expert j and take the leftmost cutoff (l=6) to be negative infinity and the rightmost cutoff to be positive infinity. Bins l=2,…,5 are assumed to be ordered. Therefore, the rating for each awardee i by expert j has likelihood $\Phi(\gamma_{jl}, Z_i, \sigma_j^2) - \Phi(\gamma_{jl-1}, Z_i, \sigma_j^2)$, where Φ is the standard normal cumulative distribution function (Figure H-1).

As this model is fit using a Bayesian approach, prior distributions are required for all parameters. The expert-specific cutoffs, γ_j, must be ordered but otherwise have a flat non-informative prior. The σ_j^2 are given an InverseGamma(10, 3) priors. Standard Markov chain Monte Carlo techniques are used to obtain parameter estimates based on the expert responses. Of main concern were the group (ESI/NIA) means which drive the true impacts, Z_i. Taking the Bayesian approach provides a straightforward means to test whether the NIA group had a larger mean than the ESI group for each survey question.

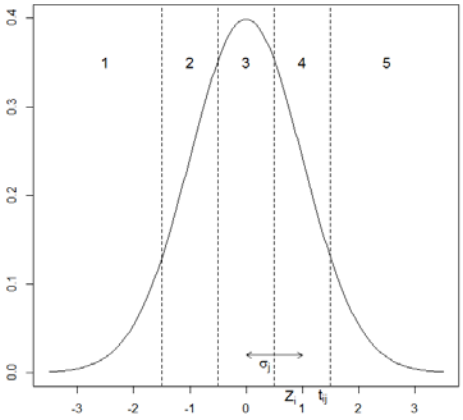


Figure H-1. Bayesian Ordinal Model

Appendix I.
Effect Size Overview

Effect sizes are an important metric in understanding and making inferences from statistical analyses. Broadly, an effect size can be thought of as a quantitative measure for the strength, or magnitude, of an observed phenomenon. In the familiar example of an independent sample *t* test, a *p* value provides information about the probability of the existence of a given effect, or larger effect, given that the observed means were sampled from distributions with identical population means. The effect size provides information to inform any decisions about whether the effect of the variable is meaningful in the context of the study. A variable could be statistically significant but have such a small effect size that it is deemed trivial. Importantly, effect sizes, unlike *p* values, are not dependent on sample size (outside of asymptotically approaching the true population effect size).

Throughout this report, effect sizes are given in the context of the NI-ESI data, measuring the size of differences between the two groups. The following examples of effect sizes are therefore directly related to this context.

r – Rank Correlation

$$r = \frac{z}{\sqrt{n_1 + n_2}}$$

$$\text{where } z = \frac{R - \mu_R}{\sigma_R}, \qquad \mu_R = \frac{n_1(n_1 + n_2 + 1)}{2}, \qquad \sigma_R = \sqrt{\frac{n_1 n_2 (n_1 + n_2 + 1)}{12}}$$

r, the rank correlation, is the effect size used for understanding the results of a Wilcoxon rank sum test. Rank correlation has the same scale as classical Pearson's correlation, ranging in values from –1 to 1. In a Wilcoxon rank sum test, two samples are compared to see whether they come from the same underlying distribution. In the formula above for *r*, the numerator is the z-score from the test, taken from the original *R* test statistic for the rank sum test, and its associated distribution values.

Partial Eta Squared (η_p^2)

Partial eta squared is an effect size understood in the context of an ANOVA (analysis of variance) table. ANOVA allows comparison of the means of two or more samples concurrently. The common symbol of ANOVA is SS, sum of squares. Depending on the subscript associating

SS, it refers to the sum of the squared deviations from a mean (for all the data, for a group, etc.). Using this notation, partial eta squared is:

$$\frac{SS_{between}}{SS_{between} + SS_{error}}$$

$SS_{between}$ refers to the sum of the squared differences between means of the groups of interest and the overall mean of the data. SS_{error} refers to the difference of the total sum of squares (the sum of the squared difference between all observations and the mean of all the data) and $SS_{between}$. This effect size can thus be understood as the variance explained by a given variable (identified by a group) of the variance remaining after excluding variance explained by other predictors.

Odds Ratio

The odds ratio is an effect size that is appropriate when studying the relationship between two groups and an event. Letting G1 and G2 be groups 1 and 2 respectively, and letting P refer to proportion, the odds ratio formula is then:

$$OR = \frac{PG1}{1 - PG1} \Big/ \frac{PG2}{1 - PG2}$$

The formula can be interpreted as the odds of an event occurring for group 1 divided by the odds of an event occurring for group 2, where PG1 and PG2 are the proportion of each group to which the event occurred.

Cohen's *d*

$$d = \frac{\bar{x}_1 - \bar{x}_2}{s}$$

$$\text{where } s = \frac{\sqrt{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}}{n_1 + n_2 - 1}$$

Cohen's *d* is an effect size for the difference between two sample means. In this case it is the difference of the two sample means divided by the pooled standard deviation (s). Essentially, the difference of the two means is being normalized over the standard deviation of all of the data, giving a more standardized assessment of the sample mean difference.

Phi Coefficient

$$\phi = \sqrt{\frac{\chi^2}{N}}$$

The Phi coefficient is an effect size used commonly in chi-squared tests. Within the square-root, the numerator is the chi-squared test statistic and is related to the assessment of whether observations of two variables are independent of each other. The denominator is the total sample size. The Phi coefficient gives a measure for the strength of association between two variables,

and although it is related to *r* (the formula for *r* reduces to ϕ when the two variables are binary), there is no standardized scale for it.

Benchmarks

Although it is always wise to interpret an effect size in the context of the analysis being performed, below are a set of benchmarks for some of the effect sizes discussed.

Size of effect	ϕ	Cohen's *d*	*r*	Odds Ratio	η_p^2
Small	.1	.2	.1	1.45	.01
Medium	.3	.5	.3	3.45	.06
Large	.5	.8	.5	9	.13

Source: http://core.ecu.edu/psyc/wuenschk/docs30/EffectSizeConventions.pdf.

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An Evaluation of the National Institutes of Health Director's New Innovator Award Program for Fiscal Years 2007–2009

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S C I E N C E & T E C H N O L O G Y P O L I C Y I N S T I T U T E

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Executive Summary

The National Institutes of Health (NIH) New Innovator (NI) Award Program was created in FY 2007 to support promising new investigators who were proposing innovative, high-risk, high-reward research. NI awards are targeted to early stage investigators who are defined as investigators within 10 years of their terminal research degree or medical residency and who have not yet received a substantial NIH research grant, such as the NIH R01 grant. NIH awarded 115 NI awards in FY 2007–2009; however, 120 early career investigators submitted an NI award application in this same timeframe, scored well in review, but did *not* receive funding. The NIH Office of the Director contracted with the IDA Science and Technology Policy Institute (STPI) to assess potential differences between the 120 award finalists in comparison to the 115 NI awardees.

This report complements and extends the companion STPI report *Outcome Evaluation of the National Institutes of Health Director's New Innovator Award Program for FY 2007–2009* by analyzing career and research indicators for finalists with respect to those measured for awardees.

A team of STPI researchers used a mixed-methods approach to assess the career trajectory, publication patterns, and funding for finalists compared to awardees who did receive the award. The primary assessment tools used in this approach were as follows:

- Survey finalists on their perceptions of their career progression and productivity since they submitted their NI award applications
- Bibliometric analysis to assess changes in productivity, impact, coauthor network, and interdisciplinarity among finalists
- Grant analysis to assess the ability of finalists to secure NIH funding after their NI applications

Data obtained through the survey, bibliometric analyses, and grant analyses assessed characteristics of professional advancement, funding, and career publications of finalists and awardees before and after the NI application submission or award receipt. The data indicate that:

- With the exception of journal cover recognition, there were no statistically significant differences in finalist and awardee perceptions of their career status as measured by indicators of research and laboratory expansion, receipt of tenure, and employment status.
- For all NIH grants, DP1 grants awarded through the NDPA program, and combinations of R01 Type 1 and Type 2 grants assessed in this report, finalists and awardees were similar in the proportion of the group funded, percent of applications awarded, or average number of awards received. They differ in that finalists submit more R01 Type 2 applications than do awardees; however, awardees submit more DP1 applications. Finalists received DP1 grants at the same rate as awardees.

- For measures of research impact, finalists had lower journal impact scores for career publications than did awardees; however, their productivity, as measured by the number of publications and average annual publications, was similar to awardees.
- Finalists and awardees have similar co-author networks and display similar degrees of interdisciplinarity in their career publications.

In conclusion, the most significant difference between finalists and awardees is noted for journal impact factors; however, STPI acknowledges the controversies that surround the use of impact factors as a measure of the potential impact of research results in a corpus of publications. Awardees scored higher on the journal impact factors for their career publications than did finalists, suggesting that awardee research overall has the hallmarks of research that is more likely to advance biomedical and bio-behavioral science.

Contents

1. Introduction

The National Institutes of Health (NIH) New Innovator (NI) award program was created in FY 2007 to support promising new investigators who were proposing innovative, high-risk, high-reward (HRHR) research. NI awards are intended for early stage investigators who are defined as investigators within 10 years of their terminal research degree or medical residency and who have not yet received a substantial NIH research grant, such as the NIH R01 grant or equivalent.[1] NIH awarded 115 NI awards in FY 2007–2009. These individuals are designated NI awardees. In this same timeframe, 120 early career investigators submitted NI award applications, scored well in review, but did *not* receive funding. These individuals are designated NI award finalists. The NIH Office of the Director contracted with the IDA Science and Technology Policy Institute (STPI) to assess potential differences between the 2007–2009 NI Award finalists in comparison to the 2007–2009 NI awardees.

This report complements and extends the *Outcome Evaluation of the National Institutes of Health Director's New Innovator Award Program for FY 2007–2009* (hereafter the NI awardee outcomes evaluation) by analyzing career and research indicators for finalists with respect to those measured for awardees.

A. Background on the NI Award Program

The NI award program is the second program within the High Risk Research Initiative operated by the NIH Office of the Director to support innovative biomedical and behavioral research. The NI program was modeled after the successful NIH Director's Pioneer Award (NDPA); however, the NI award is open only to early stage investigators. The NDPA and NI award programs differ from the traditional NIH R01 award in that the NDPA and NI programs' review criteria emphasize the creativity and innovative thinking of the investigator, their applications are relatively brief, neither program requires preliminary data, and their review processes are conducted by *ad hoc* committees of extramural reviewers rather than the traditional study sections operated by the Center for Scientific Review. Additionally, the NI Award proposals do not require a detailed budget submission, and the funds are disbursed in total at the beginning of the grant. Each NI award allocates the total 5 years of funding ($1.5 million total direct costs) at the time of award. Although the amount of funding is similar in value to 5-year R01 grants, the NI award disbursal approach allows for more flexible use of funds and modification of research direction based upon research results. All of these differences are designed to encourage and enable innovative and higher risk biomedical and behavioral research.

[1] Grants considered equivalents include activity codes R23, R29, R37, and U01.

B. Scope of this Evaluation

To identify the group of finalists who met the criteria for inclusion in this assessment, The STPI team received a list from the NIH Office of the Director of 135 finalists who applied for NI awards in response to the 2007–2009 NI Funding Opportunity Announcements. From this list, duplicate finalists were removed if they applied for and received finalist consideration for more than one year of the award. Further, all 2007–2009 finalists who subsequently received an NI award were excluded from the finalist group. The STPI team identified 120 NI award finalists from the 2007–2009 cohorts using this procedure.

To determine effects on finalists' and awardees' careers and research, the STPI team used a methodology similar to the one employed in the NI awardee outcomes evaluation. This mixed-methods approach used a survey, bibliometric analysis, and grant analysis to assess the career trajectory, publication patterns, and funding for finalists who *did not* receive the NI award compared to awardees who *did* receive the award. In the team's experience, a mixed methods approach compensates for the limitations inherent in any single method by providing multiple data streams that can be integrated into overarching findings. The team also used the definitions of high risk, innovativeness, and interdisciplinarity established in the NI awardee outcomes evaluation.

An overview of the methods applied to the Finalist cohort is provided in the subsections that follow. Additional details can be found in Chapters 2–4, and methodologies applied to the awardee cohort are detailed in the NI awardee outcomes evaluation.

1. Finalist Survey

The purpose of the survey was to query finalists on their perceptions of their career progression and productivity since they submitted their NI award application. Surveys allow an analyst to collect answers to specific questions that cover a diverse range of topics using multiple formats.

2. Bibliometric Analysis

Bibliometric analyses were performed on all papers published by finalists before their NI award application date plus 1 year (*pre-application* + 1) and one year after their NI award application date through March 2016 (*post-application* – 1). This analysis assessed changes in productivity (e.g., total publications), impact (e.g., SCImago or IPP), coauthor network (e.g., average coauthor per publication), and interdisciplinarity (unique subject codes).

3. Grant Analysis

To assess the ability of finalists to secure NIH funding after their NI application, the team derived grant information from the IMPAC II database and analyzed all NIH Type 1 (new competitive grants) applications submitted and grants received by finalists, as well as the number of DP1 applications and awards. R01 Type 1 and Type 2 (competitive renewals) applications and awards were also analyzed.

C. Overview of the Report

This report is divided into 5 chapters. Following the introduction (Chapter 1), Chapters 2–4 detail the methods and results for the finalist survey, bibliometric analysis, grant analysis, respectively. Chapter 5 summarizes the findings, and Appendix A contains the finalist survey.

2. Finalist Survey

The finalist survey queried this group of 120 investigators on their perceptions of their career using indicators of laboratory expansion, scientific recognition, and employment. The extent to which finalists *differed* from awardees in terms of these questions is both a subjective and objective matter, as these data are either perspectives and opinions of finalists or information not readily accessible through other means.

Those who completed the survey were designated survey respondents.

A. Methods

The finalist survey contained 14 questions pertaining to career progression that were analogous to questions assessing professional advancement in the awardee survey to allow for comparison of responses. The finalist survey was organized and administered using the approach outlined in Chapter 3 of the NI awardee outcomes evaluation. The finalist survey can be found in Appendix A, and the awardee survey can be found in the NI Awardee Outcomes Evaluation, Appendix D.

Both surveys were created using Survey Gizmo, a web-based survey design suite that allows survey designers to create and administer online surveys.[2] Potential respondents are sent a survey link tailored to a customizable and user-specific survey either through Survey Gizmo's email interface or through pasting the survey link into an email and contacting potential respondents directly.

Four weekly solicitation requests were sent by email to NI finalists and awardees. The first three requests were sent automatically through the Survey Gizmo system. The fourth reminder was a personal reminder sent from a member of the evaluation team. Survey respondents were removed from the reminder list if they completed the survey or declined to participate. Importantly, NI finalists and awardees were unaware of other surveyed groups. That is, finalists were unaware that they were an NI comparison group, and the awardee group was unaware of the finalist comparison group. This approach allows for survey responses to be a more accurate measure of attitudes and opinions without respect to a baseline of comparison.

Chi-square tests were conducted to assess if there were group differences across global job indicators and other career indicators.

[2] For information, go to SurveyGizmo.com, www.surveygizmo.com

B. Results

In the following sections, statistical analyses are presented for each section of the survey. Statistics are reported in tables, rather than the body of the text, for clarity.

The response rate from finalists, while low, was anticipated as one is asking the finalists to invest time in completing a survey for an award they did *not* receive (Table 1). The 30% finalist response rate is still within acceptable range for survey responses (detailed in STPI analysis on survey response rates and reported in the NIH NI Award briefing #6, 08 January 2015).

Table 1. Response Rates by Group

Group	Number Contacted (Population)	Number Agreeing to Participate (Response Rate)	Number Declining to Participate (Declination Rate)	Number That Did Not Respond (No Response Rate)
Finalists	120	36 (30%)	10 (9%)	74 (62%)
Awardees	115	49 (43%)	11 (9%)	52 (45%)

C. Perspectives on Career Advancement

1. Current Employment

There were no statistically significant differences in current employment between finalists and awardees, $\chi^2_{(1)} = 0.67$, $p = .414$, $\varphi = .09$ (Table 2).

Table 2. Current Employment by Group

Current Employment	Finalists	Awardees
Academic Institution	69%	80%
Medical Institution (University Affiliation)	19%	10%
Other*	11%	10%

* National Laboratories, medical affiliations not associated with a university, industry.

2. Laboratory Indicators

There were no statistically significant group differences in the percent of finalists and awardees who reported expanding their research laboratories, forming new collaborations, or expanding the focus of their laboratories to new scientific disciplines (Table 3).

Table 3. Laboratory Indicators by Group

Laboratory Indicator	Finalists	Awardees	χ^2	*p*	φ
Expanded Research Lab	78%	92%	2.32	.127	.17
Formed New Collaborations	97%	100%	2.42	.876	.02
Expanded Focus of Lab to new Disciplines	81%	90%	0.80	.371	.10

3. Career Indicators

There was a statistically significant group difference between finalists and awardees who reported being featured on a journal cover, as a larger percentage of awardees reported having their research featured on a journal cover. There were no statistically significant group differences in the percent of respondents who reported receiving an honor/award, popular press media coverage, or being asked to serve as a regular reviewer (Table 4).

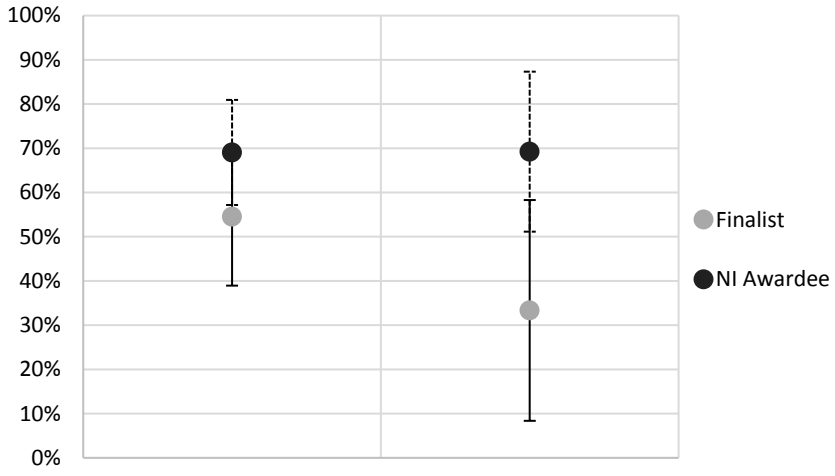
Table 4. Career Indicators by Group

Career Indicator	Finalists	Awardees	χ^2	*p*	φ
Received Honor/Award	69%	86%	2.39	0.122	0.17
Popular Press Media Coverage	56%	76%	2.89	0.089	0.18
Journal Cover Feature	**17%**	**41%**	**4.62**	**0.032**	**0.23**
Asked to Serve as Regular Reviewer	75%	82%	0.22	0.638	0.05
Changed Institutions	24%	26%	<0.001	0.999	<0.001

Note: Bolding indicates statistical significance.

$p < .05$

There was no statistically significant difference between finalists and awardees in the percentages applying for or receiving, tenure since their submission of the NI application or receipt of the NI award (Figure 1).



NI Awardee *n; Finalist n*:	33; 42	13; 15
Observed Power:	0.25	0.47
Effect Size *Phi*:	0.15	0.36
p:	0.294	0.130
χ^2:	1.09	2.30

Figure 1. Tenure Status of Finalists and Awardees at Tenure-Granting Institutions

4. Summary of Career Indicators

Overall, there were few statistically significant differences between the finalist and awardee groups regarding career and laboratory indicators. A larger percentage of the awardee group reported having their research featured on a journal cover than the finalist group.

3. Bibliometric Analysis

The statistical assessment of scholarly publications and books, bibliometric analysis, has long been a cornerstone in program evaluations (Narin 1987). Unlike surveys, bibliometric analysis provides an alternative way to quantify research outputs without expert reviewers. The bibliometric analysis was performed on the 115 NI and 120 NI finalists.

The STPI team created four broad categories of analysis for each awardee's research portfolio: *productivity*, *impact*, *coauthor network*, and *interdisciplinarity*. Productivity measures the general output of research products by a researcher. Impact is meant to tap into the "information dissemination" factor and indicates the perception of research quality by the two "gates" of peer-review—publishers (journal prestige) and peer researchers (citations). The rationale behind these metrics is that prestigious journals will inevitably reach a wider audience and publications with high citations counts have inherently been read by many. Interdisciplinarity captures the breadth of knowledge being engaged by an awardee's research. Lastly, analysis of each awardee's coauthor network measures the spread of their collaboration network across individuals, institutions, and countries, indicating their ability to broker collaboration networks.

Bibliometric analysis assesses the effect of applying for or receiving the NI award on finalists' and awardees' careers by comparing an individual's career publications before and after the NI award decision, that decision being to award funding or decline to fund (henceforth referred to as *pre-decision* and *post-decision* publications).

While bibliometric analysis provides a method for more objectively evaluating career publications, they do have some notable caveats (Ismail et al. 2009):

1. *Publication data can be messy and incomplete*. Not only do the range of publications and journals vary based on the chosen dataset, but identifying correct author names and affiliations can also be difficult. Particularly with common names (e.g., John Smith), multiple authors may be publishing under the same name, making the task of identifying the correct set of publications attributed to the author of interest difficult and time-consuming.
2. *Citation counts and other bibliometric analyses are not necessarily unbiased*. Studies have shown that citation count measures can be biased against early researchers, who lack the established record of publications to gain significant citation counts. Additionally, researchers cite other papers for a broad range of reasons and the consistency in citation behavior (e.g., providing background, criticizing previous work, and paying "homage" to field pioneers) can vary from researcher to researcher. Lastly, researchers have noted that bibliometric analysis can often struggle to entirely capture the "quality" of papers.

To reduce error in the publication sets, the team followed a consistent methodology, as detailed in the next section.

A. Methods

1. Career Publication Analysis

Career publication analysis allows for the analysis of an awardee's entire publication portfolio and has the advantage of a pre-decision and post-decision analysis and analysis by group. Further, the effects of applying for or receiving the NI award can be considered in terms of the change in research quality pre- and post-decision.

2. Programming Language

The STPI team used *R* (R Core Team 2016), a programming language and environment for statistical computing and graphics. Based on the *S* language and environment, the software is part of the GNU Project. R also has the advantage of being designed specifically for data handling and data manipulation and for possessing a diverse library of open-source packages intended to supplement and enhance the baseline capabilities of the language. *R* was used to ingest publication metadata and perform relevant analyses.

3. Obtaining Correct Scopus Author IDs and Publication Sets

Career publications and finalist and awardee names and institutions were queried against the Scopus publication database. When searching authors using name and affiliated institution, Scopus occasionally returns multiple author IDs. It is possible for an author's publication set to be split into two or more author IDs, particularly if the author has switched institutions or published under a different name. The STPI team determined which author IDs were correct for each author of interest.

A multistep process was followed using the *R* programming environment:

1. Searches that returned a single author ID were assumed correct.
2. Searches that returned multiple author IDs were assumed correct if all the returned institutions for the author were the same.
3. Searches that returned multiple author IDs with non-identical institutions were assumed correct if all the returned institutions could be matched to the authors' affiliated institutions found in the finalist/awardee database.
4. Remaining search results with multiple author IDs were checked by hand. The STPI team conducted an online search to determine which returned author IDs were correct.

The correct author IDs were then compiled into a list that was then used to query the Scopus application program interface (API) for all publications affiliated with those authors. [3] Each author ID query returned publications in XML files, which were then parsed using *R*.

4. Qualities Assessed

Seeking to quantify the four measured research qualities—productivity, impact, coauthor network, and interdisciplinarity—the STPI team leveraged a range of bibliometric techniques Table 5 outlines the metrics included in each of these research qualities.

[3] For information, see Esevier.com, "Scopus APIs," https://www.elsevier.com/solutions/scopus/features/api.

Table 5. Research Quality Categories and Associated Metrics

Research Quality	Metric	Description
N/A	Total Publications	Raw count of publications.
	Publication Delay Relative to Award	Time lag between award start and publication date.
	Annual Publications	Time-normalized rate of publication in the form of average publications per year.
Productivity & Impact	Average Citations per Publication	Average count of citations per publication.
	H-Index	A metric proposed by Hirsch (2005) that is defined as the number of papers (*h*) with at least *h* citations each.
	Impact per Publication (IPP)	Also known as raw impact per paper, this number denotes the average number of citations per paper published in a journal (Moed 2010). These data are provided by Scopus for each journal.
	Journal Source-Normalized Impact per Publication (SNIP)	Similar to IPP, but normalized to account for differences in citation rates between fields of study (Moed 2010). These data are provided by Scopus for each journal.
	SCImago Journal Ranking (SJR)	A computed ranking score that is calculated using citation weighting schemes and eigenvector centrality (González-Pereira, Guerrero-Bote, and Moya-Anegón 2010). These data are provided by Scopus for each journal.
Coauthor Network	Average Coauthors per Publication	Average number of other authors on a given publication.
	Unique Coauthors	Count of unique authors that awardee has published with.
	Unique Coauthor Affiliations	Count of unique coauthor institutions and countries. Captures how many different countries and institutions have been collaborated with.
Interdisciplinarity	Unique Journal Subject Codes	Count of unique journal subject matter/field indicators, as provided by Scopus.

a. Career Publication Analysis

An analysis on career publications is presented for each research output and quality metric. These analyses were conducted as within-subject, doubly multivariate GLM-repeated measures analyses, with two within subject variables (*group*: *awardee*, *finalist*; *time*: *pre-decision* + 1, *post-*

decision + 1)[4] across all measures of research quality and outputs. *pre-decision* + 1 publications refer to all publications published before one year after receipt of award. *Post-decision* +1 publications refer to all publications published at least one year following the award decision. Due to severe positive skew for several bibliometric analyses that likely violate the assumption of normality, the data were transformed using a natural log transformation. Thus, all career publication analyses are presented in log units.

A doubly multivariate GLM-repeated measures analysis allows for the estimation of several effects, including the main effects for *group* and *time*, as well as the group-by-time interaction. A statistically significant main effect of *group*, ignoring other main effects and the interaction, indicates statistically significant group differences on a bibliometric outcome. A statistically significant effect of *time*, in the absence of other effects, indicates statistically significant increases or decreases in a bibliometric outcome from *pre-decision* + 1 to *post-decision* + 1. A statistically significant *group*-by-*time* interaction indicates group differences in bibliometric outcomes that vary from *pre-decision* + 1 to *post-decision* + 1. For example, it may be the case that awardees have a number of publications similar to that of finalists awardees before receiving their award, but had significantly more publications following the award than did finalists. In the presence of a statistically significant interaction, main effects are omitted.

B. Results

In the following sections, statistical analyses are presented for each of the research qualities for career publications.

1. Research Productivity and Impact

a. Number of Publications

The STPI team analyzed the total number of publications to understand researcher productivity—defined as the raw production of research outputs.

Overall, there was no statistically significant effect of *group*, $F_{(1, 228)} = 0.15$, $p = .697$, $\eta^2_p = .001$. There was a statistically significant effect of *time* $F_{(1, 228)} = 62.53$, $p < .001$, $\eta^2_p = .215$; awardees and finalists had more total publications *post-decision* + 1 compared to *pre-decision* + 1, $M_{\log(post\text{-}decision + 1) - \log(pre\text{-}decision + 1)} = 0.339$, 95% CI [0.225, 0.424]. There was no statistically significant *group*-by-*time* interaction for total career publications, indicating that group differences in total publications did not vary significantly over time (Figure 2).

[4] A one-year lag was introduced to ensure that publications in press or preparation before the NI decision were counted as pre-decision publications. Ultimately, finalists did not receive the NI award, while awardees received the NI award.

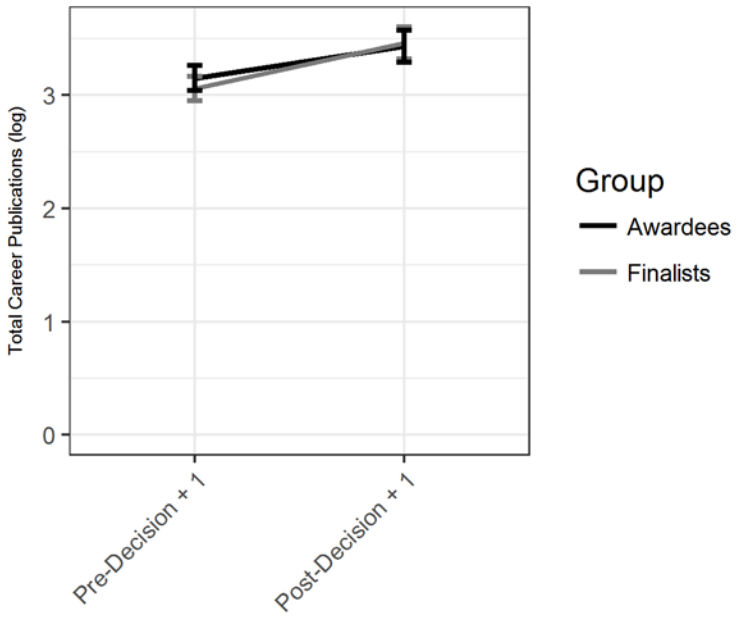


Figure 2. Total Career Publications

b. Annual Publication Production

There was a statistically significant *group*-by-*time* interaction for average annual publications, $F_{(1, 228)} = 8.288$, $p = .004$, $\eta^2_p = .035$, indicating that group differences in annual publications varied from *pre-decision* + 1 to *post-decision* + 1 publications. Follow up simple effects analyses were conducted to tease apart this interaction. Regarding average annual publications, compared to finalists NIA awardees had slightly fewer, though not significantly, *pre-decision* + 1 average annual publications, $M_{\log(awardee) - \log(finalist)} = -0.049$, $p = .123$, 95% CI [–0.135, 0.037], but slightly more, though not significantly, *post-decision* + 1 average annual publications, $M_{\log(awardee) - \log(finalist)} = 0.115$, $p = .123$, 95% CI [–0.031, 0.261] (Figure 3).

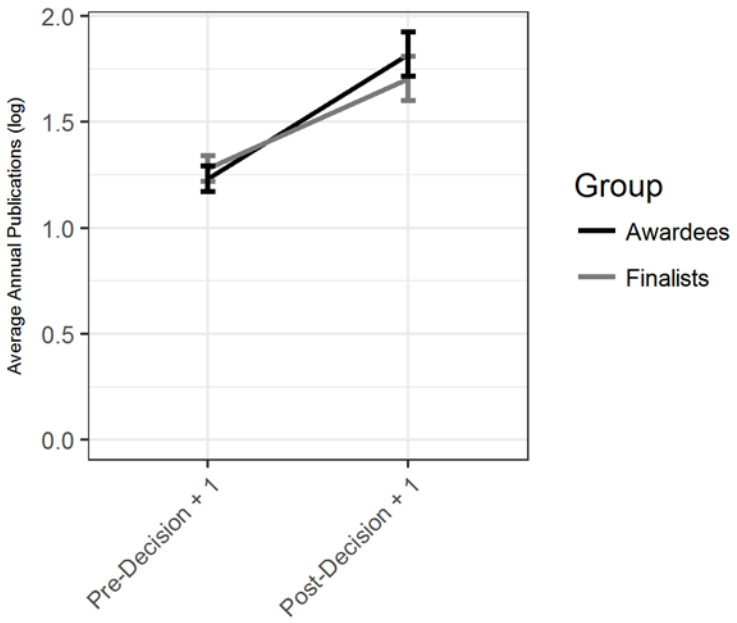


Figure 3. Average Annual Publications

The team used citations and journal ranking metrics to better understand the impact of research produced by finalists and awardees. Both metrics provide a proxy for understanding of the relevance and quality of the published research—citations indicate reception among fellow researchers, while journal rankings indicate the perception of the research by academic publishers.

c. Citation Count

There was a statistically significant *group*-by-*time* interaction for average number of citations per publications, $F_{(1, 228)} = 9.216$, $p = .003$, $\eta^2_p = .039$, indicating that group differences in average citation rates varied for *pre-decision* + 1 and *post-decision* + 1 publications. Follow up simple effects analyses were conducted to tease apart this interaction. Awardees tended to have more average citations per publication than finalists for *pre-decision* + 1 publications, $M_{\log(awardee) - \log(finalist)} = 0.338$, $p < .001$, 95% CI [0.139, 0.538], but there was no statistically significant *group* difference in average citations per publications for *post-decision* + 1 publications, $M_{\log(post\text{-}decision + 1) - \log(pre\text{-}decision + 1)} = 0.063$, $p = .505$, 95% CI [–0.124, 0.250] (Figure 4).

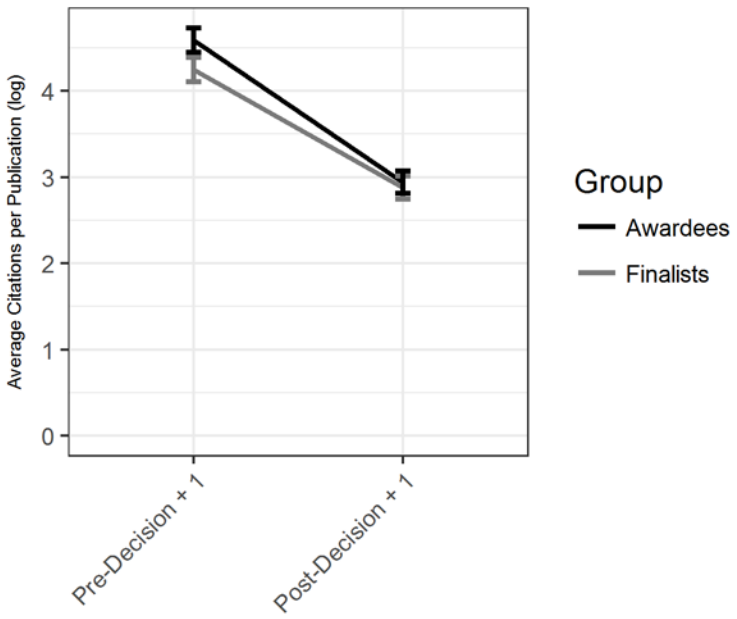


Figure 4. Average Citations per Publication

d. H Index

There was a statistically significant *group*-by-*time* interaction, $F_{(1, 228)} = 28.899$, $p < .001$, $\eta^2_p = .112$, indicating that group differences in H-indexes significantly varied from *pre-decision* + 1 to *post-decision* + 1. Follow up simple effects analyses were conducted to tease apart this interaction. Compared to finalists, awardee H-indexes were marginally higher at *pre-decision* + 1, $M_{\log(awardee) - \log(finalist)} = 0.109$, $p = .069$, 95% CI [–0.009, 0.226], but significantly lower at *post-decision* + 1, $M_{\log(awardee) - \log(finalist)} = –0.292$, $p < .001$, 95% CI [–0.453, –0.131] (Figure 5).

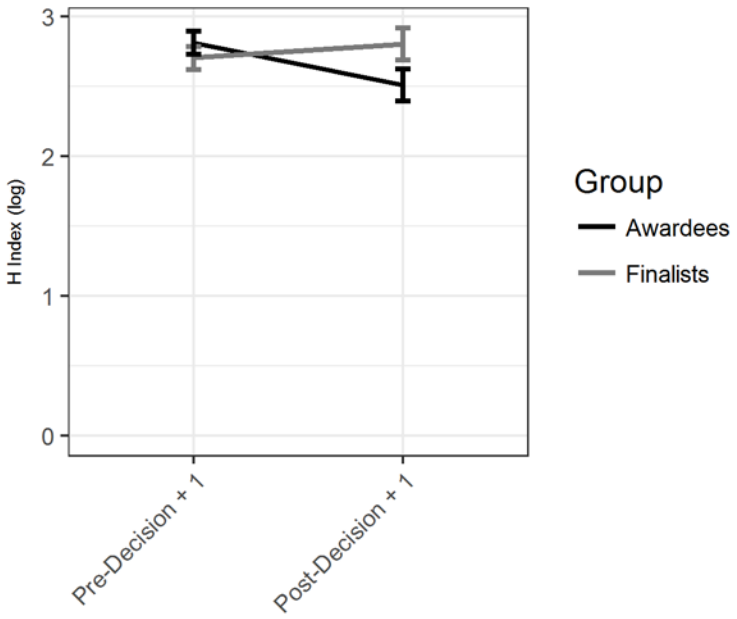


Figure 5. H-Index

2. Journal Impact Factor and Ranking

The STPI team calculated the average journal impact factor of each finalist and awardee. The team used three journal impact factors: (1) *Impact Per Publication (IPP),* which measures the average number of citations per journal publication, and (2) *Source-Normalized Impact Per Publication (SNIP),* which normalizes the IPP metric to account for differences between research fields and (3) *SCImago Journal Ranking (SJR),* which emphasizes the sources used by prestigious journals and creates weights associated with levels of prestige.

a. IPP Journal Metric

Overall, awardees tended to publish in journals with larger IPPs than did finalists, $F_{(1, 228)} = 23.287$, $p < .001$, $\eta^2_p = .093$, $M_{\log(awardee) - \log(finalist)} = 0.264$, 95% CI [0.156, 0.372]. Further, there was a statistically significant effect of *time*, $F_{(1, 228)} = 20.949$, $p < .001$, $\eta^2_p = .084$, such that finalists and awardees tended to publish *post-decision* + 1 publications in journals with smaller IPPs, $M_{\log(post\text{-}decision\ +1) - \log(pre\text{-}decision\ +1)} = -0.113$, 95% CI [–0.162, –0.064]. There was no statistically significant *group*-by-*time* interaction, $F_{(1, 228)} = 0.731$, $p = .393$, $\eta^2_p = .003$, indicating that group differences in IPP did not vary significantly over time (Figure 6).

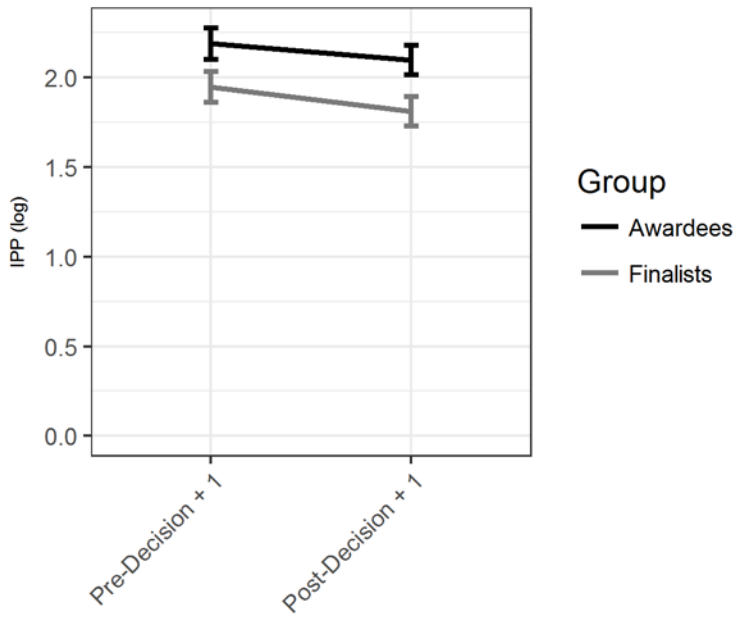


Figure 6. Average Impact per Publication (IPP)

b. SNIP Journal Metric

There was a statistically significant effect of *g*roup, $F_{(1, 228)} = 15.541$, $p < .001$, $\eta^2_p = .064$, such that awardees tended to publish in journals with larger SNIPs than did finalists, $M_{\log(awardee) - \log(finalist)} = 0.121$, 95% CI [0.061, 0.181]. Further, there was a statistically significant effect of *time*, $F_{(1, 228)} = 29.511$, $p < .001$, $\eta^2_p = .115$, such that finalists and awardees tended to publish *post-decision* + 1 publications in journals with smaller SNIPs, $M_{\log(post\text{-}decision\ +1) - \log(pre\text{-}decision\ +1)} = -0.090$, 95% CI [–0.123, –0.058]. There was no statistically significant *group*-by-*time* interaction, $F_{(1, 228)} = 0.371$, $p = .543$, $\eta^2_p = .002$, indicating that *group* differences in SNIP did not vary significantly over time (Figure 7).

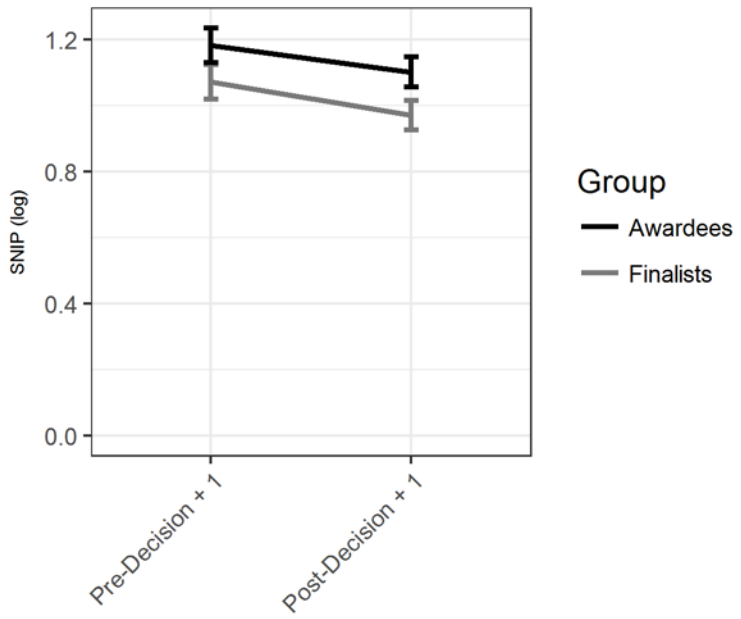


Figure 7. Average Source-Normalized Impact per Publication (SNIP)

c. SCImago Journal Ranking (SJR)

There was a statistically significant effect of *group*, $F_{(1, 228)} = 5.372$, $p = .021$, $\eta^2_p = .023$, such that awardees tended to publish in journals with larger SJRs than did finalists, $M_{\log(awardee) - \log(finalist)} = 0.145$, 95% CI [0.022, 0.268]. Further, there was a statistically significant effect of *time*, $F_{(1, 228)} = 23.346$, $p < .001$, $\eta^2_p = .093$, such that finalists and awardees tended to publish *post-decision* + 1 publications in journals with smaller SJRs, $M_{\log(post\text{-}decision\ +1) - \log(pre\text{-}decision\ +1)} = –0.119$, 95% CI [–0.168, –0.071]. There was no statistically significant *group*-by-*time* interaction, $F_{(1, 228)} = 0.933$, $p = .335$, $\eta^2_p = .004$, indicating that *group* differences in SJRs did not vary significantly over *time* (Figure 8).

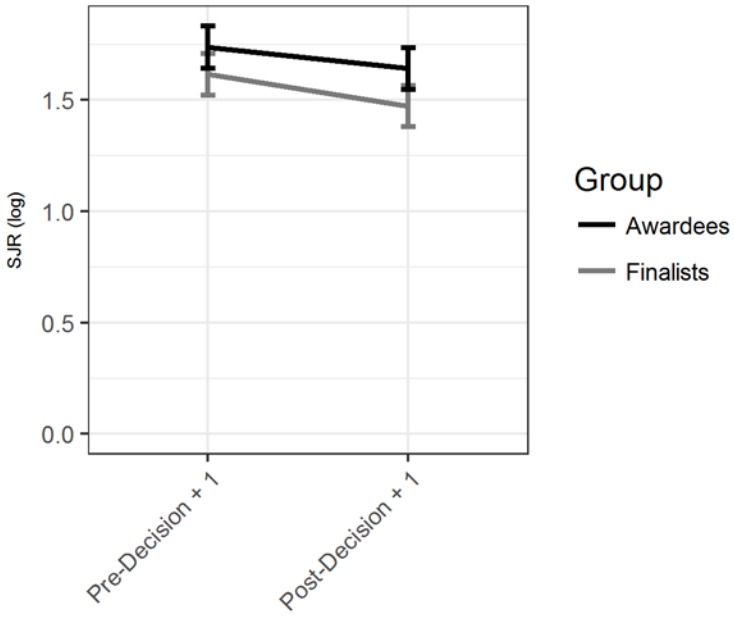


Figure 8. Average SCImago Journal Ranking (SJR)

d. Summary of Findings: Research Productivity and Impact

The results from the bibliometric analysis on productivity metrics indicate that both finalists and awardees increased publications over time. Additionally, finalists and awardees had similar annual career publications following the award.

The results from the bibliometric analysis on impact metrics indicate that awardees had more citations per publication than finalists for publications predating the NI award decision, but the *group*s had similar citation rates for publications published after the NI decision. Finalists and awardees also differed significantly in the degree to which their publication H-indexes changed over time; finalists and awardees had similar H-indexes *pre-decision* + 1, while finalists had larger *post-decision* + 1 decision H-indexes. Main effects for most measures of impact suggest that awardees published more impactful research both pre- and post-decision compared to finalists.

3. Collaboration

To better understand size and breadth of research collaborations, the STPI team analyzed the coauthor networks displayed by finalist's and awardee's career publications.

a. Average Authors per Paper

Finalists and awardees did not differ significantly in average number of coauthors per paper, $F_{(1, 228)} = 1.753$, $p = .187$, $\eta^2_p < .008$. There was a statistically significant effect of *time*, $F_{(1, 228)} = 67.399$, $p < .001$, $\eta^2_p = .228$, such that both finalists and awardees tended to have more coauthors per publication on *post-decision* + 1 publications, $M_{\log(\textit{post-decision} +1) - \log(\textit{pre-decision} +1)} = 0.242$, 95%

CI [0.184, 0.300]. There was no statistically significant *group*-by-*time* interaction, $F_{(1, 228)} = 2.648$, $p = .105$, $\eta^2_p = .011$, indicating that the relationship between *group* and average co-authors per publication did not vary significantly across *time* (Figure 9).

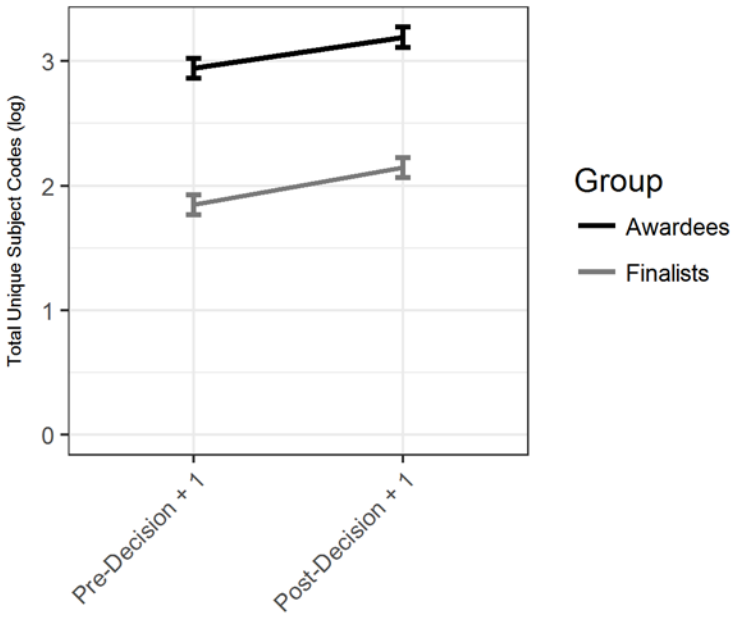


Figure 9. Unique Journal Subject Codes

b. Number of Unique Coauthors

There was a statistically significant *group*-by-*time* interaction, $F_{(1, 228)} = 9.346$, $p = .003$, $\eta^2_p = .039$, indicating that group differences in the number of unique coauthors significantly varied from *pre-decision* + 1 to *post-decision* + 1. Follow-up simple effects analyses were conducted to tease apart this interaction. The number of unique coauthors was significantly higher for awardees compared to finalists at *pre-decision* + 1, $M_{\log(awardee) - \log(finalist)} = 0.266$, $p = .009$, 95% CI [0.068, 0.465], but there was no significant *post-decision* + 1 difference, $M_{\log(awardee) - \log(finalist)} = -0.043$, $p = .739$, 95% CI [–0.296, 0.210] (Figure 10).

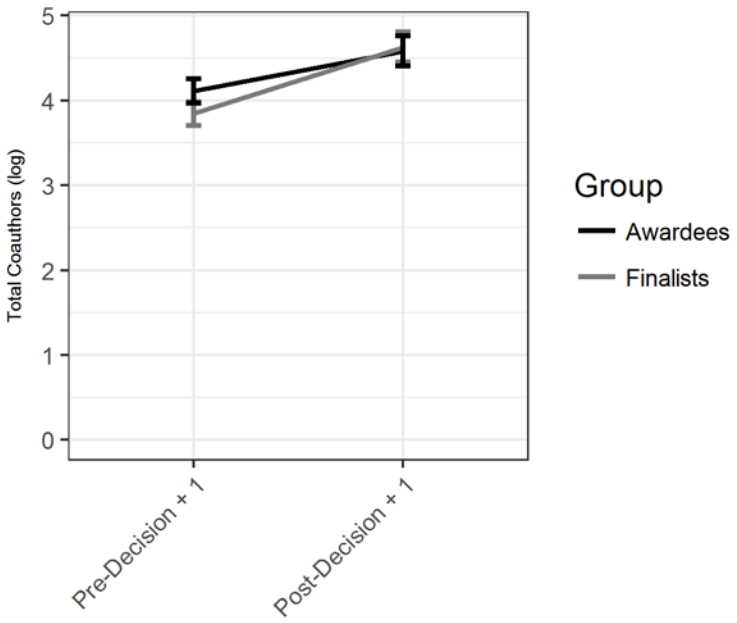


Figure 10. Number of Unique Coauthors

c. Coauthor Affiliations

The STPI team evaluated the institutions and countries in each finalist's and awardee's coauthor network as a measure of the size and breadth of their research collaborations.

d. Number of institutions engaged in grant supported research

1) Total Number of Institutions

There was a statistically significant *group*-by-*time* interaction, $F_{(1, 228)} = 6.517$, $p = .011$, $\eta^2_p = .028$, indicating that *group* differences in the number of total institutions significantly varied from *pre-decision* + 1 to *post-decision* + 1. Follow-up simple effects analyses were conducted to tease apart this interaction. Compared to finalists, the number of unique institutions was slightly, though not significantly higher for awardees at *pre-decision* + 1, $M_{\log(awardee) - \log(finalist)} = 0.134$, $p = .121$, 95% CI [–0.036, 0.304], but slightly, though not significantly, lower for awardees at *post-decision* + 1, $M_{\log(awardee) - \log(finalist)} = –0.125$, $p = .319$, 95% CI [–0.370, 0.121] (Figure 11).

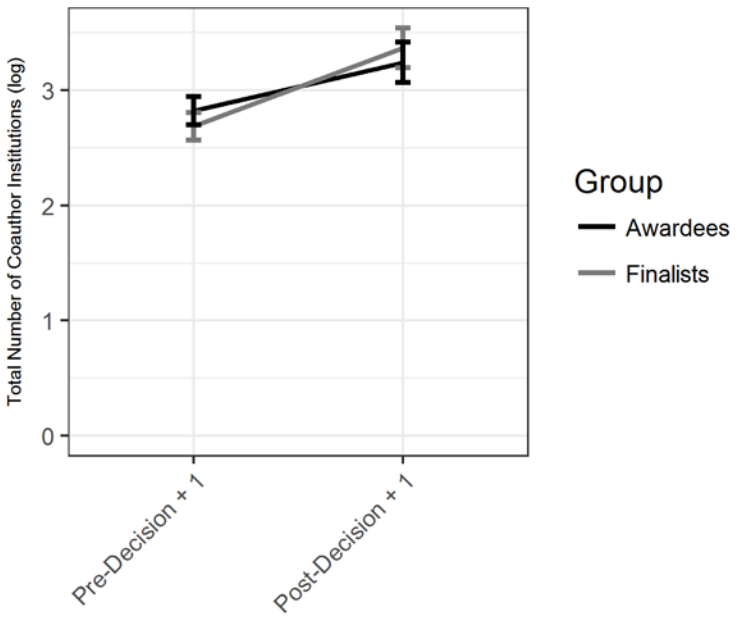


Figure 11. Number of Unique Institutions in Coauthor Network

2) Average Number of Institutions

There was no statistically significant effect of *group*, $F_{(1, 228)} = .951$, $p = .330$, $\eta^2_p < .004$ on number of institutions. There was a statistically significant effect of *time*, $F_{(1, 228)} = 100.895$, $p < .001$, $\eta^2_p = .307$, such that finalists and awardees tended to have a higher average number of institutions in their network following the award, $M_{\log(post\text{-}decision\ +1)\ -\ \log(pre\text{-}decision\ +1)} = 0.170$, 95% CI [0.136, 0.203]. There was no statistically significant *group*-by-*time* interaction, $F_{(1, 228)} = 2.499$, $p = .115$, $\eta^2_p = .011$, indicating that the relationship between *group* and average number of institutions did not vary significantly from *pre-decision* + 1 to *post-decision* + 1 (Figure 12).

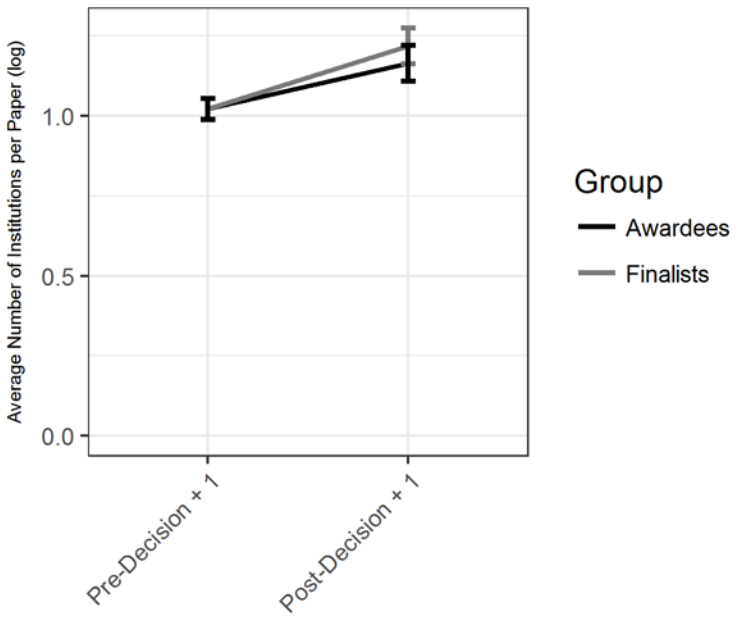


Figure 12. Average Number of Institutions in Coauthor Network

e. Number of countries engaged in research

1) Number of Unique Countries

There was a statistically significant *group*-by-*time* interaction, $F_{(1, 228)} = 5.441$, p = .021, η^2_p = .023, indicating that *group* differences in the number of total countries significantly varied from *pre-decision* + 1 to *post-decision* + 1. Follow-up simple effects analyses were conducted to tease apart this interaction. Compared to finalists, the number of unique countries was slightly, though not significantly, higher for awardees at *pre-decision* + 1, $M_{\log(awardee) - \log(finalist)} = 0.134$, $p = .121$, 95% CI [–0.036, 0.304], but slightly, though not significantly, lower at *post-decision* + 1, $M_{\log(awardee) - \log(finalist)} = –0.125$, $p = .319$, 95% CI [–0.370, 0.121] (Figure 13).

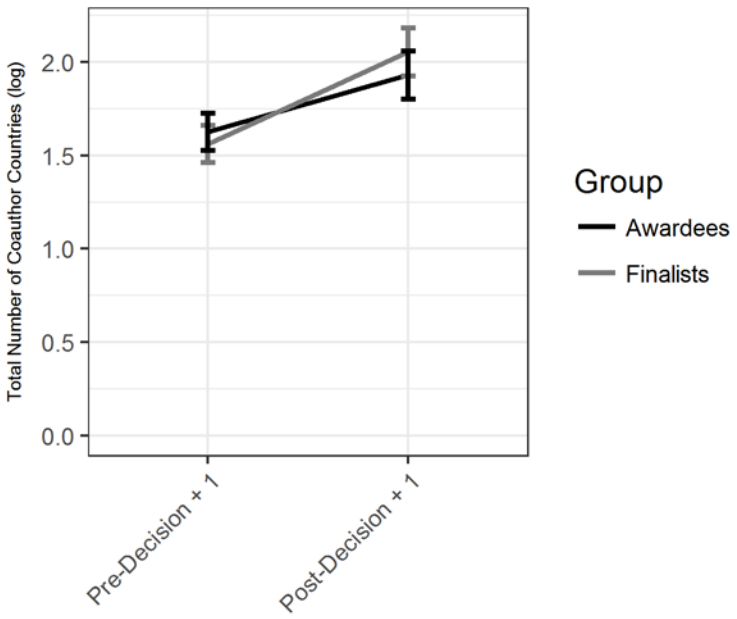


Figure 13. Number of Unique Countries in Coauthor Network

2) Average Number of Countries

There was a statistically significant effect of *group*, $F_{(1, 228)} = 6.251$, p = .013, $\eta^2_p = .027$, indicating that awardee research engaged fewer countries on average than did finalist research, $M_{\log(awardee) - \log(finalist)} = -0.038$, 95% CI [–0.068, –0.008]. There was also a statistically significant effect of *time*, $F_{(1, 228)} = 46.808$, $p < .001$, $\eta^2_p = .017$, such that finalists and awardees tended to have more countries in their network following the award, $M_{\log(post\text{-}decision\ +1) - \log(pre\text{-}decision\ +1)} = 0.066$, 95% CI [0.047, 0.084]. There was no statistically significant *group*-by-*time* interaction, $F_{(1, 228)} = 2.175$, $p = .142$, $\eta^2_p = .009$, indicating that the relationship between *group* and total countries did not vary significantly from *pre-decision* + 1 to *post-decision* + 1 (Figure 14).

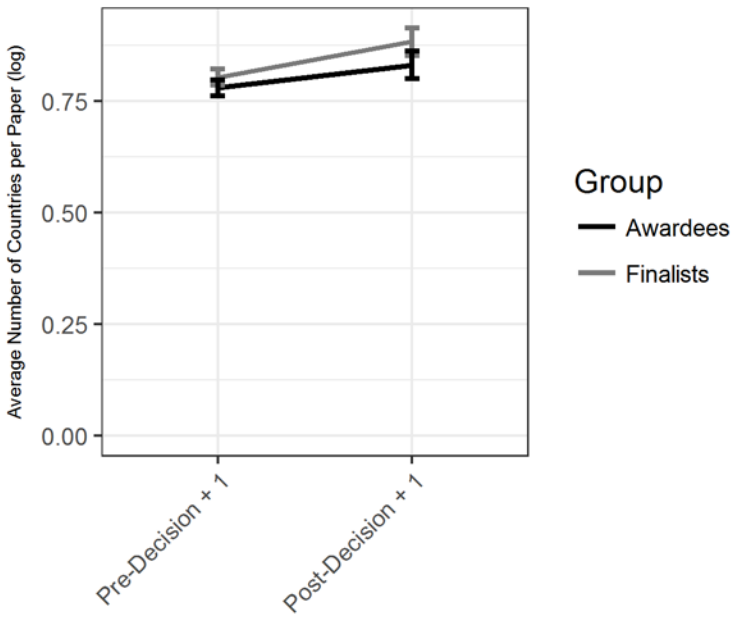


Figure 14. Average Number of Countries in Coauthor Network

f. Summary of Findings: Co-author Network

Awardees had more authors per paper on average than finalists both *pre and post-decision* +1 suggesting a broader array of research collaborators. Awardees had more total co-authors *pre-decision* + 1 but the groups had similar numbers of total co-authors post-decision. Finalists tended to have more countries per publication than awardees, while total co-author institutions and countries were comparable for the two groups.

4. Interdisciplinarity

a. Journal Subject Codes

There was a statistically significant effect of *group*, $F_{(1, 228)} = 444.529$, $p < .001$, $\eta^2_p = .661$ on the number of unique subject codes, such that awardee publications had more unique subject codes than did finalist publications, $M_{\log(awardee) - \log(finalist)} = 1.071$, 95% CI [0.971, 1.171]. There was also a statistically significant effect of *time* ($F_{(1, 228)} = 100.996$, $p < .001$, $\eta^2_p = .307$), such that both finalists and awardees tended to have more total subject codes *post-decision* + 1, $M_{\log(post\text{-}decision +1) - \log(pre\text{-}decision +1)} = 0.274$, 95% CI [0.221, 0.328]. There was no statistically significant *group*-by-*time* interaction, $F_{(1, 228)} = 0.821$, $p = .366$, $\eta^2_p = .004$, indicating that the relationship between *group* and total unique subject codes did not vary significantly from *pre-decision* + 1 to *post-decision* + 1.

b. Summary of Findings: Interdisciplinarity

Awardee research had more total subject codes both *pre-* and *post-decision* + 1 than finalists. Overall, total subject codes increased from *pre-decision* +1 to *post-decision* + 1 (Figure 15).

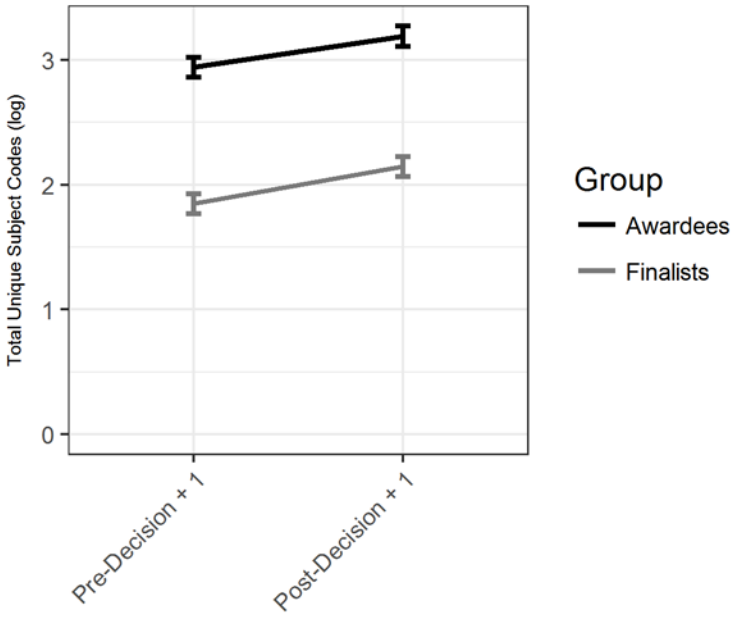


Figure 15. Subject Codes

C. Summary of Bibliometric Findings

Overall, findings from the bibliometric analysis provided mixed results. In terms of research impact, awardees tended have more impactful publications both *pre-* and *post-decision* + 1, with the exception of H-index, whereas finalists had larger *post-decision* + 1 H-indexes than awardees. Awardees and finalists co-author networks were similar in terms of total co-authors, institutions, and countries involved in research. Awardees tended to have more co-authors on a per paper basis for *pre-decision* + 1 publications, while finalists had more co-author countries on a per paper basis than awardees. Awardee research had more total subject codes both *pre-* and *post-decision* + 1 than did finalists.

4. Grant Funding Analysis

The ability to compete successfully for grant funding is often necessary for the continuation of biomedical and biobehavioral research. To examine the ongoing funding status of the finalists and awardees, the STPI team analyzed the number of grant applications submitted by the NI awardees and NI finalists over a period of 8 years following the award decision and the number of those applications that were funded.

A. Methodology

Finalist and awardee grant information was obtained from the IMPAC II database. The STPI team used the *R* software environment to extract records for applications on which the 120 finalists and 115 NI awardees were listed as Principal Investigators (PIs). Records of 2,411 grant applications remained after (1) restricting analyses to Type 1 and Type 2 competitive applications, (2) removing Type 1 applications for the original project for which the investigator applied, (3) removing applications submitted before the original application project start date or after 8 years of the original application project start date, (4) keeping one record per distinct awardee, type, and project (i.e., resubmissions were not counted as a new application).

The STPI team then compared (1) the proportion of the finalist and awardee groups that applied; (2) the average number of applications submitted by finalists and awardees; (3) the rate at which each groups' applications were awarded; (4) the average number of awards received by finalists and awardees; and (5) the proportion of each awardee group that received one or more awards. These comparisons were made for Type 1 applications for any NIH grant, Type 1 applications for DP1 grants, and Type 1, Type 2, and Type 1 and 2 combined for R01 applications.

To test significant differences between the proportion of awardees who applied and were awarded funding, the team used binomial proportion tests. Two sample proportion tests and Fisher's Exact tests (for small expected frequencies) assessed the degree to which the finalist and awardee group variable was related to the proportion of applications awarded. Wilcoxon rank-sum tests for independent samples assessed differences in the number of applications submitted and awarded for each group. All tests were two-tailed with α critical = 0.05. Significance levels were not adjusted for multiple comparisons.

B. Results: NI Awardee and Finalist Post-Decision Grant Applications and Awards

1. All NIH NI Awardee and Finalist Applications and Awards

a. Applied for Funding

The STPI team first examined all Type 1 applications for any NIH grant submitted by finalists and awardees. Each comparison is illustrated in Figure 16, and descriptive statistics and statistical

test results are provided in Table 6. Finalists and awardees were equally likely to apply for an NIH grant, as there was no significant difference in the proportion of each awardee group that submitted at least one application. Finalists and awardees also submitted a similar number of applications.

b. Received Funding

Finalist and awardee applications were awarded at a similar rate. Thus, finalists and awardees also received a similar number of awards. The resulting proportion of each group who were funded did not differ significantly.

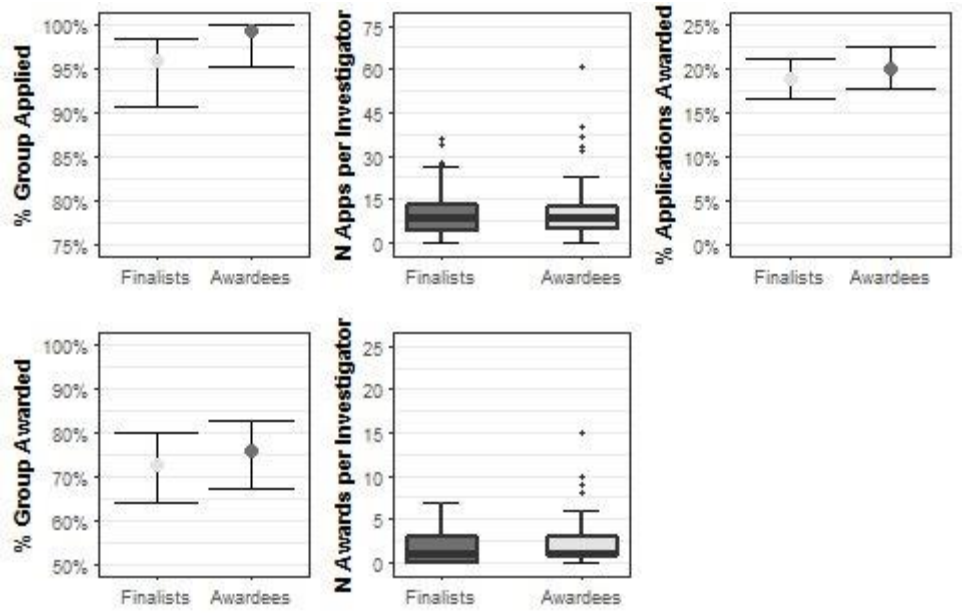


Figure 16. All NIH Grants Applied for and Received by Finalists and Awardees

Table 6. All NIH Grant Applications and Awards Summary

All NIH Grants	NI Finalists		NI Awardees		Test Statistic	p Value	Effect Size
	Statistic	95% CI	Statistic	95% CI			
Applications							
Mean (SD)	9.55 (7.21)	[8.22, 10.80]†	10.17 (8.70)	[8.50, 11.64]†			
Median	8	[7.00, 9.00]†	8.00	[6.00, 9.00]†	W =6725.00	.737	r =0.02
Proportion of Group Applied	95.83% (115/120)	[90.62%, 98.21%]‡	99.13% (114/115)	[95.24%, 99.96%]‡	$\chi^2_{(df = 1)}$ =1.41	.235	*Phi* =0.10
Awards							
Mean (SD)	1.78 (1.75)	[1.46, 2.09]†	2.03 (2.23)	[1.59, 2.41]†			
Median	1	[0.00, 1.00]†	1.00	[0.00, 1.00]†	W =6560.00	.505	r =0.04
Percent of Applications Awarded	18.67% (214/1146)	[16.52%, 21.03%]‡	19.93% (233/1169)	[17.74%, 22.32%]‡	$\chi^2_{(df = 1)}$ =0.51	.475	*Phi* =0.02
Percent of Group Awarded	72.50% (87/120)	[63.91%, 79.70%]‡	75.65% (87/115)	[67.06%, 82.58%]‡	$\chi^2_{(df = 1)}$ =0.16	.688	*Phi* =0.04

† Bootstrapped Basic confidence intervals.
‡ Wilson score-test-based binomial confidence intervals.

2. DP1 Grants

a. Applied for Funding

Regarding DP1 applications, a significantly higher proportion of NI awardees than finalists applied. In addition to being more likely to apply, NI awardees also submitted significantly more applications. Comparisons are illustrated in Figure 17 and all descriptive statistics and statistical test results are provided in Table 7.

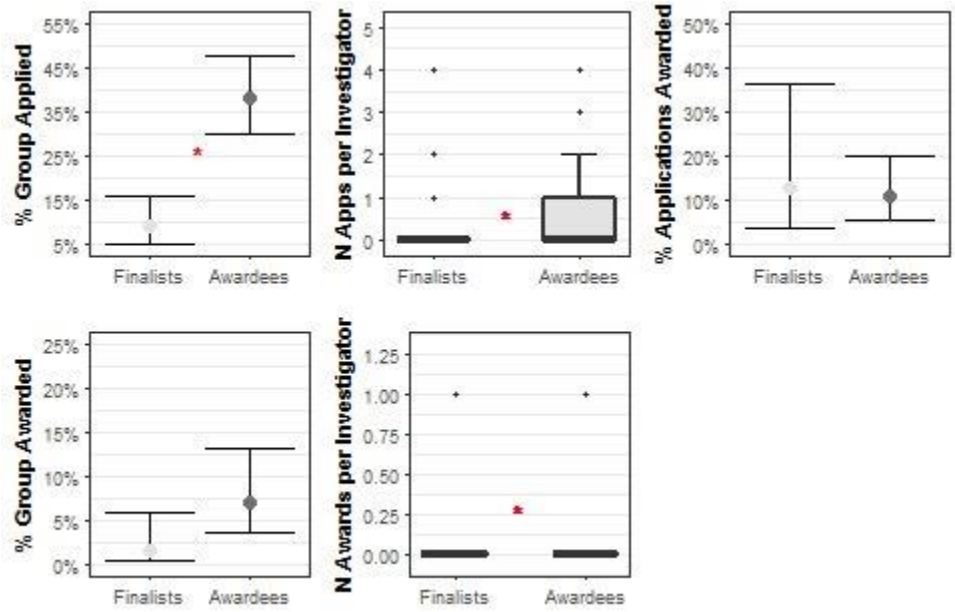


Figure 17. DP1 Grants Applied for and Received by Finalists and Awardees

b. Received Funding

DP1 applications were awarded at a similar rate for each awardee group. NI awardees received significantly more awards than did finalists due to their higher rate of application submissions, though there was no significant difference in the proportion of finalists and awardees who received DP1 funding.

Table 7. DP1 Applications and Awards

DP1	NI Finalists		NI Awardees		Test Statistic	p Value	Effect Size
	Statistic	**95% CI**	**Statistic**	**95% CI**			
Applications							
Mean (SD)	0.13 (0.50)	[0.03, 0.21]†	0.64 (1.00)	[0.45, 0.82]†			
Median	0.00	[0.00, 0.00]†	0.00	[0.00, 0.00]†	W = **4854.00**	**<.001**	r = **0.35**
Proportion of Group Applied	9.17% (11/120)	[5.20%, 15.67%]‡	38.26% (44/115)	[29.89%, 47.39%]‡	$\chi^2_{(df = 1)}$ = **26.13**	**<.001**	*Phi* = **0.34**
Awards							
Mean (SD)	0.02 (0.13)	[–0.01, 0.03]†	0.07 (0.26)	[0.02, 0.11]†			
Median	0.00	[0.00, 0.00]†	0.00	[0.00, 0.00]†	W = **6535.00**	**.045**	r = **0.13**
Percent of Applications Awarded	12.50% (2/16)	[3.50%, 36.02%]‡	10.81% (8/74)	[5.58%, 19.91%]‡	$\chi^2_{(df = 1)}$ = 0.00	>.999	*Phi* = 0.02
Percent of Group Awarded	1.67% (2/120)	[0.46%, 5.87%]‡	6.96% (8/115)	[3.57%, 13.13%]‡	$\chi^2_{(df = 1)}$ = 2.84	.092	*Phi* = 0.13

Note: Bolded results are significant.

† Bootstrapped Basic confidence intervals.

‡ Wilson score-test-based binomial confidence intervals.

3. R01 Grants

STPI team members analyzed differences in several combinations of R01 Type 1 and Type 2 applications and awards in order to understand the finalist and awardee post-award application and award landscape. All comparisons are illustrated in Figures 18a and 18b, and descriptive statistics and results for each comparison are shown in Tables 8a, 8b, and 8c.

a. Applied for Funding

There was no statistically significant difference in the proportion of the finalist and awardee groups who applied for R01 Type 1 grants, nor in the number of R01 Type 1 applications submitted by each investigator.

The finalist group applied for R01 Type 2 grants at a significantly higher rate and submitted significantly more R01 Type 2 applications than did awardees. However, considering R01 Type 1 and Type 2 applications together, a significantly larger proportion of the awardee group applied for both types of R01 grants than did the finalist group, though there was no significant different in the number of R01 Type 1 and Type 2 applications submitted.

b. Received Funding

R01 applications were awarded at a similar rate for both groups regardless of type, suggesting that finalists and awardees were likely to be successful in receiving R01 funding. There were no statistically significant differences in the number of awards received by investigators in each group. Finally, there was no statistically significant difference in the proportion of each group that received an award.

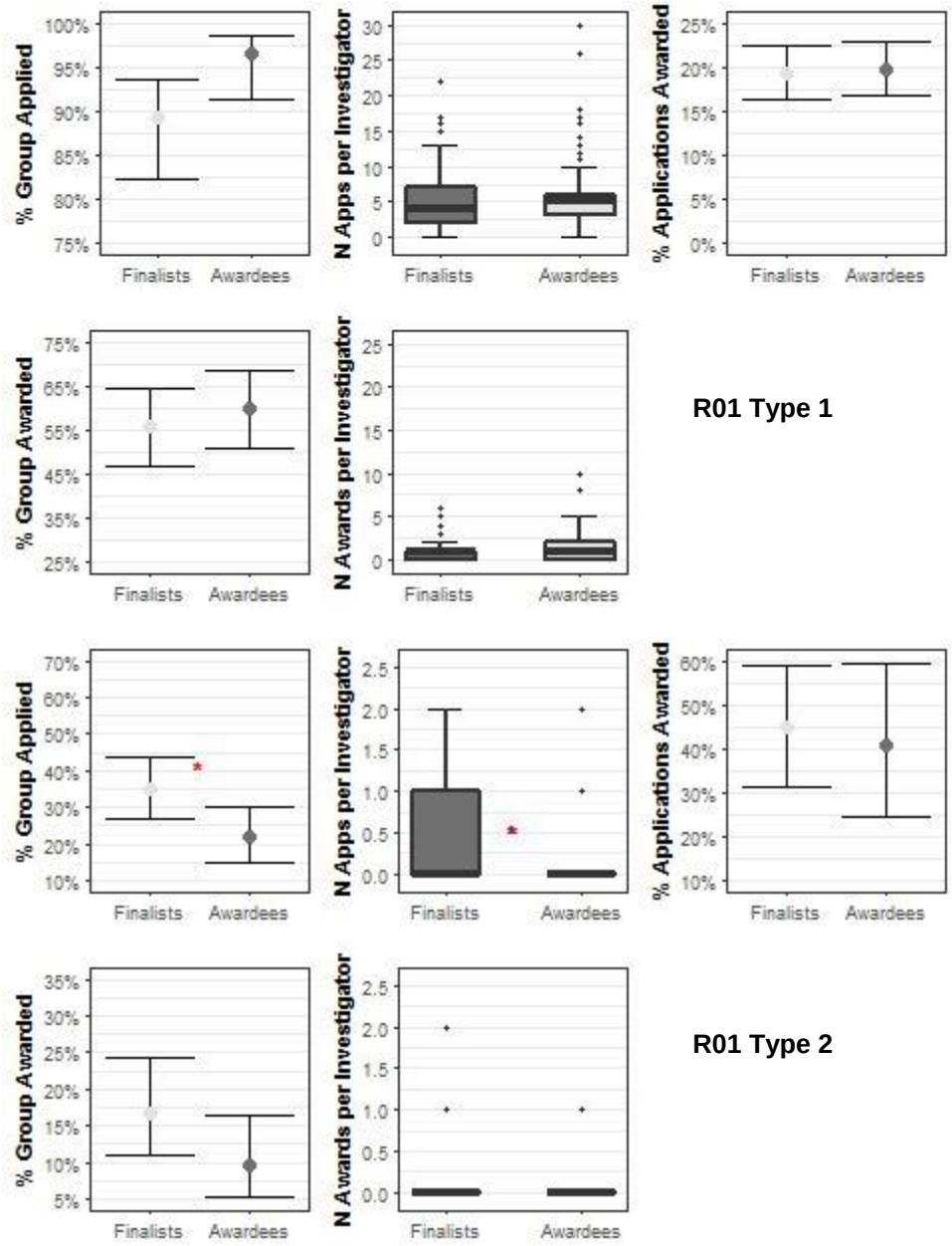


Figure 18a. R01 Type 1 (top panel) and Type 2 (bottom panel) Grants Applied for and Received by Finalists and Awardees

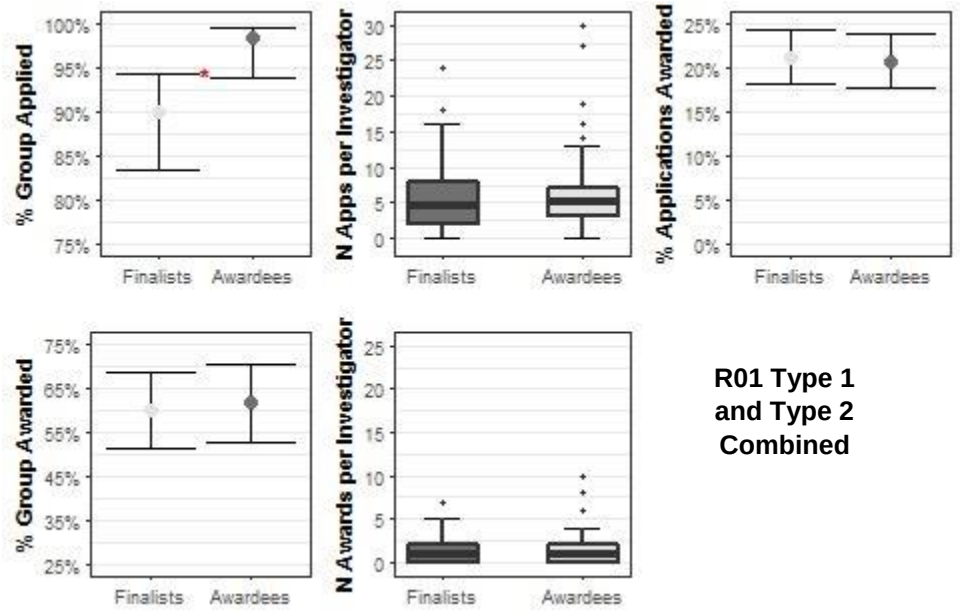


Figure 18b. R01 Types 1 and 2 Grants Applied for and Received by Finalists and Awardees

Table 8a. R01 Type 1 Applications and Awards

	NI Finalists		NI Awardees				
R01 Type 1	**Statistic**	**95% CI**	**Statistic**	**95% CI**	**Test Statistic**	**p Value**	**Effect Size**
Applications							
Mean (SD)	5.01 (4.10)	[4.26, 5.72]†	5.61 (4.70)	[4.70, 6.42]†			
Median	4.00	[3.00, 5.00]†	5.00	[5.00, 6.00]†	$W = 6365.50$	.303	$r = 0.07$
Proportion of Group Applied	89.17% (107/120)	[82.34%, 93.56%]‡	96.52% (111/115)	[91.40%, 98.64%]‡	$\chi^2_{(df = 1)} = 3.70$	.054	*Phi* = 0.14
Awards							
Mean (SD)	0.96 (1.16)	[0.74, 1.16]†	1.10 (1.48)	[0.82, 1.36]†			
Median	1.00	[1.00, 2.00]†	1.00	[1.00, 1.00]†	$W = 6583.00$	.519	$r = 0.04$
Percent of Applications Awarded	19.13% (115/601)	[16.19%, 22.47%]‡	19.69% (127/645)	[16.80%, 22.93%]‡	$\chi^2_{(df = 1)} = 0.03$	.860	*Phi* = 0.01
Percent of Group Awarded	55.83% (67/120)	[46.90%, 64.40%]‡	60.00% (69/115)	[50.86%, 68.49%]‡	$\chi^2_{(df = 1)} = 0.26$	.607	*Phi* = 0.04

† Bootstrapped Basic confidence intervals,
‡ Wilson score-test-based binomial confidence intervals,

Table 8b. R01 Type 2 Applications and Awards

	NI Finalists		NI Awardees				
R01 Type 2	**Statistic**	**95% CI**	**Statistic**	**95% CI**	**Test Statistic**	**p Value**	**Effect Size**
Applications							
Mean (SD)	0.39 (0.57)	[0.29, 0.49]†	0.23 (0.47)	[0.15, 0.31]†			
Median	0.00	[0.00, 0.00]†	0.00	[0.00, 0.00]†	W = **7835.50**	**.022**	r = **–0.15**
Proportion of Group Applied	35.00% (42/120)	[27.05%, 43.88%]‡	21.74% (25/115)	[15.18%, 30.12%]‡	$\chi^2_{(df = 1)}$ = **4.44**	**.035**	*Phi* = **0.15**
Awards							
Mean (SD)	0.18 (0.40)	[0.10, 0.24]†	0.10 (0.30)	[0.03, 0.15]†			
Median	0.00	[0.00, 0.00]†	0.00	[0.00, 0.00]†	W = 7395.5	.105	r = 0.11
Percent of Applications Awarded	44.68% (21/47)	[31.41%, 58.75%]‡	40.74% (11/27)	[24.51%, 59.27%]‡	$\chi^2_{(df = 1)}$ = 0.01	.932	*Phi* = 0.04
Percent of Group Awarded	16.67% (20/120)	[11.06%, 24.35%]‡	9.57% (11/115)	[5.43%, 16.32%]‡	$\chi^2_{(df = 1)}$ = 2.00	.157	*Phi* = 0.10

Note. Bolded results are significant; *OR* = Odds Ratio.
† Bootstrapped Basic confidence intervals,
‡ Wilson score-test-based binomial confidence intervals,

Table 8c. R01 Types 1 and 2 Applications and Awards

R01 Type 1 and Type 2 Combined	NI Finalists		NI Awardees				
	Statistic	**95% CI**	**Statistic**	**95% CI**	**Test Statistic**	**p Value**	**Effect Size**
Applications							
Mean (SD)	5.40 (4.34)	[4.60, 6.15]†	5.84 (4.78)	[4.92, 6.67]†			
Median	4.50	[3.00, 5.00]†	5.00	[5.00, 6.00]†	W = 6541.50	.490	r = 0.05
Proportion of Group Applied	90.00% (108/120)	[83.33%, 94.19%]‡	98.26% (113/115)	[93.88%, 99.52%]‡	$\chi^2_{(df = 1)}$ = **5.75**	**.016**	*Phi* = **0.17**
Awards							
Mean (SD)	1.13 (1.33)	[0.89, 1.37]†	1.20 (1.56)	[0.90, 1.46]†			
Median	1.00	[1.00, 1.00]†	1.00	[1.00, 1.00]†	W =6.799.50	.840	r = 0.01
Percent of Applications Awarded	20.99% (136/648)	[18.03%, 24.29%]‡	20.54% (138/672)	[17.65%, 23.75%]‡	$\chi^2_{(df = 1)}$ = 0.02	.893	*Phi* = 0.01
Percent of Group Awarded	60.00% (72/120)	[51.06%, 68.32%]‡	61.74% (71/115)	[52.61%, 70.11%]‡	$\chi^2_{(df = 1)}$ = 0.02	.889	*Phi* = 0.02

Note: Bolded results are significant; *OR* = Odds Ratio.
† Bootstrapped Basic confidence intervals.
‡ Wilson score-test-based binomial confidence intervals.

C. Summary of Grant Funding Findings

Overall, the finalist and awardee groups were similarly likely to apply for post-decision + 1 funding. Awardees were more likely to submit DP1 and R01 Type 1 applications, whereas finalists were more likely to submit R01 Type 2 applications. With the exception of R01 Type 2 grants, awardees also consistently submitted more applications. Generally, applications were awarded at the same rate, but awardees tended to receive more awards and were generally more likely to be funded. Finalists were better positioned to submit R01 Type 2 applications because the NI award does not allow for competitive renewal; however, awardees seemed to compensate with more R01 Type 1 applications.

5. Summary Findings

This chapter contains integrated data from the surveys, bibliometric analyses, and grant analyses and organizes the data into characteristics of professional advancement, funding, and career publications for finalists and awardees before and after application submission or award receipt.

A. Professional Advancement

The STPI team analyzed finalist and awardee indicators of laboratory and research expansion, professional recognition, employment status, and tenure as measures of professional advancement.

With one exception, there were no statistically significant differences in finalist and awardee perceptions of their professional status as measured by the research and laboratory indicators employed in STPI's surveys, including the receipt of tenure (Tables 9 and 10). Awardees reported more recognition through a journal cover more than finalists, a finding that achieved statistical significance. There were no statistically significant differences in employment status at the time the surveys were conducted (Table 11).

Conclusion: Overall, finalists and awardees were similar in their career status.

Table 9. Survey Results: Research and Laboratory Indicators

Survey Item	Survey
Expanded Research Laboratory	No statistically significant difference
Formed New Collaborations	No statistically significant difference
Expanded Focus of Laboratory to New Disciplines	No statistically significant difference

Table 10. Survey Results: Honors, Awards, and Recognition

Survey Item	Survey
Received Honor/Award	No statistically significant difference
Popular Press Media Coverage	No statistically significant difference
Journal Cover Feature	Awardees > finalists
Asked to Serve as Regular Reviewer	No statistically significant difference
Changed Institutions	No statistically significant difference
Tenure	No statistically significant difference

Table 11. Survey Results: Current Employment

Survey Item	Survey
Academic Institution	No statistically significant difference
Medical Institution (university affiliation)	No statistically significant difference
Other*	No statistically significant difference

*National Laboratories, medical affiliations not associated with a university, and industry.

B. Ability to Obtain New Funding

To evaluate the ability of finalists and awardees to obtain NIH funding following application submission or award receipt, the STPI team examined their R01 Type 1 and Type 2 grant histories as reported in the IMPAC II database from their dates of application submission or award receipt, plus 8 years (Table 12).

Table 12. Summary of the Finalist and Awardee Grant Analysis

	All NIH Type 1	DP1 Type 1	R01 Type 1	R01 Type 2	Finalist R01 Type 1 & 2 and Awardee R01 Type 1
Proportion of group applying	No statistically significant difference	Awardees > finalists	Awardees > finalists	Finalists > awardees	Awardees > finalists
Average number of applications submitted	No statistically significant difference	Awardees > finalists	No statistically significant difference	Finalists > awardees	No statistically significant difference
Proportion of group funded	No statistically significant difference	No statistically significant difference	No statistically significant difference	No statistically significant difference	No statistically significant difference
Percent of applications awarded	No statistically significant difference	No statistically significant difference	No statistically significant difference	No statistically significant difference	No statistically significant difference
Average number of awards received	No statistically significant difference	No statistically significant difference	No statistically significant difference	No statistically significant difference	No statistically significant difference

The STPI team found no statistical difference in the overall proportion of finalists and awardees submitting all NIH applications. When specific award mechanisms are considered, a larger proportion of finalists than awardees applied for R01 Type 2 awards, whereas a lower percentage applied for all other grant mechanisms and combinations assessed. Although finalists submitted a higher average number of R01 Type 2 and a lower average number of DP1 applications, there was no statistical difference in the proportion of the group funded or the average number of awards received.

Conclusion: Finalists and awardees differ in the pattern of their grant application submissions but were similar in the proportion of the group funded, percent of applications awarded, or average number of awards received. Finalists received DP1 grants at the same rate as awardees.

C. Career Publication Record

The STPI team used bibliometric approaches to compare several characteristics of finalist and awardee career publications, that is, all *pre-decision* + 1 publications and all *post-decision* + 1 publications. The team assessed impact and productivity of career publications, as well as interdisciplinarity, and, as a measure of collaboration, co-author networks.

1. Research Impact

The STPI team assessed the papers published by finalists and awardees in peer-reviewed journals to estimate the potential scientific impact of their research. Impact is frequently analyzed by average citations per publication and a variety of journal impact factors such as the H-index, which is based on the number of papers and citations, or IPP, which is based on the number of citations per paper published in a journal.

The team found that finalists had fewer pre-application/award *average citations per publication* than did awardees; however, there was no post-application/award difference in finalist and awardee citation rates. For three of the four journal-based measures of research impact, Finalists had lower impact scores than did awardees, both pre- and post-application/award (Table 13).

Table 13. Bibliometric Analysis: Citation Rates and Journal Impact Factors

	Pre-decision + 1	Post-decision + 1
Average Citations per Publication	Awardees > finalists	No statistically significant difference
IPP	Awardees > finalists	Awardees > finalists
SNIP	Awardees > finalists	Awardees > finalists
SJR	Awardees > finalists	Awardees > finalists

	Pre-decision + 1	Post-decision + 1
H-Index	No statistically significant difference	Finalists > awardees

Productivity is closely linked to impact as a measure of the general output of research. It can be assessed by the number of publications in a given time period and the average number of publications per year. The STPI team identified no statistical difference in the number of pre- and post-decision publications for finalists and awardees, nor in average number of annual publications (Table 14).

Conclusion: Overall, finalists had lower journal impact scores for career publications than did awardees; however, their productivity was similar to awardees.

Table 14. Bibliometric Analysis: Number and Timing of Publications

	Pre-decision + 1	Post-decision + 1
Number of publications	No statistically significant difference	No statistically significant difference
Average annual publications	No statistically significant difference	No statistically significant difference

2. Co-author networks.

Co-author networks provide insight into the breadth and type of collaborations developed by a researcher. Networks can be assessed through the number of individuals, institutions, and countries with whom the awardee is collaborating and publishing.

Awardees have a larger number of unique co-authors prior to their NI award; however, *post-decision* + 1 and for all other co-author measures, there were no statistical differences (Table 15).

Conclusion: Finalists and awardees have similar collaborative networks.

Table 15. Bibliometric Analysis: Co-author Network

	Pre-decision + 1	Post-decision + 1
Average number of authors per publication	No statistically significant difference	No statistically significant difference
Unique coauthors	Awardees > finalists	No statistically significant difference
Average number of coauthor institutions	No statistically significant difference	No statistically significant difference

	Pre-decision + 1	Post-decision + 1
Unique coauthor countries	No statistically significant difference	No statistically significant difference

3. Interdisciplinarity

Interdisciplinarity is considered a characteristic of innovation and a mode of research that solves complex problems whose solutions are beyond the scope of a single field of research practice.[29] As a proxy for the interdisciplinarity of finalist's and awardees' research, the STPI team analyzed the unique subject codes assigned by Scopus to journals in which finalists and awardees published their career papers.

The team determined that the number of unique subject codes assigned to journals containing pre- and post-decision career publications was not statistically different for finalists and awardees (Table 16).

Conclusion: Finalists and awardees display similar degrees of interdisciplinarity in their career publications.

Table 16. Bibliometric Analysis: Interdisciplinarity

	Pre-decision + 1	Post-decision + 1
Total unique subject codes	No statistically significant difference	No statistically significant difference

4. Summary of Career Analyses

Integrated findings for finalists' and awardees' career status demonstrate that Finalists were not statistically different from awardees on most measures of professional advancement, funding, and career publications. Finalists were statistically less likely to report that their research was highlighted on a journal cover than were awardees and had lower journal impact factors prior to and after their NI application. Finalists were similar to awardees in their productivity and in grant awards received. Finalists' and awardees' collaborative networks are similar in size, and their career publications display similar degrees of interdisciplinarity.

[29] A.F. Blackwell, *Radical Innovation: Crossing Knowledge Boundaries with Interdisciplinary Teams.* University of Cambridge Technical Report No. 760.

D. Summary Conclusions

New Innovator award finalists and awardees are early stage investigators who identified the NI Award as an opportunity to propose innovative, high risk research for their first major NIH grant. While both groups scored well enough to be reviewed by a panel of specially-convened reviewers, the awardees scored better than the finalists in this review and received funding. Finalists did not receive NI award funding.

The most significant difference between finalists and awardees is noted for journal impact factors, a measure of the potential impact of research results. Awardees scored higher on the journal impact factors for their career publications than did finalists, suggesting that awardee research overall has the hallmarks of research that is more likely to advance biomedical and bio-behavioral science.

Appendix A. New Innovator Award Finalist Survey

NIA Finalists Survey

Page One

NIH New Innovator Evaluation

Welcome and thank you for taking part in this survey provided to you by the IDA Science and Technology Policy Institute (STPI) on behalf of the National Institutes of Health (NIH). STPI is a federally funded research and development center that has been contracted by the NIH to assess the NIH's New Innovator Award (NIA) program. Your feedback is an invaluable component of this process.

Purpose of the Survey
You have been contacted because you were a finalist for the New Innovator Award. We would like to know about your perspectives on the research proposed in your NIA application, other NIH funding you may have received, and significant career events following your NIA application.

Confidentiality Statement
STPI is independent of the NIH and has been contracted to collect these data. All responses will be kept confidential and protected to the extent possible by law.

Only aggregate data will be presented to the NIH. Your decision to participate is voluntary and will have no effect on your current or future relationship with the NIH.

Instructions for the Survey
The survey is divided into four sections:

Section 1 - Funding: You will be asked to provide information on NIH funding you received for research that was substantially the same as your NIA proposed research.
Section 2 - Career Progression: You will be asked to provide information about your career progression since applying for the NIA.
Section 3 - Expert Selection: You will be asked to provide the names of experts in your field who could assist STPI in its review of research proposed in your NIA application.
Section 4 - Additional Comments (Optional): You will have the option to provide any other comments on the NIA program.

This survey is estimated to require 20 minutes to complete.

If you would like to review the NIA Funding Opportunity Announcement, please see the

following link: http://commonfund.nih.gov/newinnovator

Follow-Up Interview
After submission, STPI staff may call you for a short (~30 minute) phone interview to discuss your responses.

Inquiries and Concerns
If you have questions or concerns about completing this survey, please contact us at NIAoutcomes@ida.org.

Thank you for your valuable contribution to this process.

*

- ○ Yes, I wish to participate
- ○ No, I do not want to participate

(untitled)

1. Did your research have preliminary data when you submitted your NIA application? *

- ○ Yes, I had preliminary data.
- ○ No, I did not have preliminary data.

(untitled)

2. In this section you will be asked to report any NIH grant awards you received for research that was substantially the same as the research proposed in your NIA application. "Substantially the same" means that your funded research had similar hypotheses and/or methods to your NIA proposal.

Since your submitted your NIA application, have you been awarded other NIH grants awards that are substantially the same as the research proposed in your NIA application. *

- ○ Yes, I have received other NIH grants.
- ○ No, I have not received other NIH grants.

3. Please provide the following information for each NIH Grant award received. If you have multiple awards to report, select "Add additional award" for each award and enter the requested information *

Grant Award Number

Did this new research proposal have more preliminary data than your NIA application?

- ○ Yes, I had more preliminary data.
- ○ No, I did not have more preliminary data.

If your grant was eligible for competitive renewal, was the funding competitively renewed?

- ○ Yes, the funding was renewed.
- ○ No, the funding was not renewed.
- ○ The grant was not eligible for competitive renewal.

Add additional award

4. Have you received any awards greater than $50,000 that are **not** substantially similar to your NIA proposed research?

- ○ Yes, I have received additional awards.
- ○ No, I have not received additional awards.

5. Please provide the following information for each award received. If you have multiple awards to report, select "Add additional award" for each award and enter the requested information *

Funding Agency

Agency Type

Public agency ○

Private agency ○

Grant Number

Estimated Award Amount

$

Award Date

Add additional award

(untitled)

6. Which of the following best describes your current employment?

- I am employed by an **academic institution**.
- I am employed by a **medical institution** affiliated with a University.
- I am employed by a **medical institution** that is **not** affiliated with a University.
- I am employed by a **private foundation** or **non-governmental organization**.
- I am employed in **industry** or work for a **corporation**.
- Other-Please Specify

*

7. What is your current job title? Please include academic rank, if applicable. *

Title:

8. Are you in the same scientific discipline reported on your NIA application? *

- Yes, I am in the same discipline.
- No, I am not in the same discipline.

9. What is your new discipline and what caused this transition? *

(untitled)

10. Below is a list of changes that may have occurred since your NIA application; please indicate whether or not the change took place for you. *

	Yes, this occurred	No, this did not occur
I received an award/honor.	○	○
I was promoted.	○	○
I received tenure.	○	○
I am applying for tenure.	○	○
I expanded my research lab.	○	○
I formed new partnerships/collaborations.	○	○
I expanded my research focus to new disciplines.	○	○
I changed institutions.	○	○
My research has been featured in the popular press/media.	○	○
My research has been featured on the cover of an academic journal.	○	○
I have been invited to serve as a regular reviewer for a journal.	○	○
I have been invited to serve as a journal or book editor.	○	○

11.

Other Career Development (Optional)

Add Another

12. Please list the awards/honors you received. If you have multiple awards/honors to report, select "Add another award" to enter each award.

Award

Add another award

(untitled)

13. An important component of the NIA evaluation is the expert review panel and STPI will identify reviewers who can contribute a knowledgeable and complete review of your NIA research. These individuals will represent a mix of perspectives on your field of research.

If you would like to provide the names and contact information for possible reviewers, please do so in the space provided below.

	First Name	Last Name	Email
Expert One			
Expert Two			
Expert Three			
Expert Four			
Expert Five			

(untitled)

14. In the space provided, please provide any additional perspectives on the NIA program. This section is optional.

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Abbreviations

API	application programming interface
DP1	NIH Director's Pioneer Award (Activity Code)
FY	fiscal year
ID	identification
IDA	Institute for Defense Analyses
IPP	Impact per Publication
NDPA	NIH Director's Pioneer Award
NI	New Innovator
NIH	National Institutes of Health
R01	Research Project Grant (Activity Code)
SJR	SCImago Journal Ranking
SNIP	Source-Normalized Impact per Publication
STPI	Science and Technology Policy Institute
XML	Extensible Markup Language