Assessing Innovation in Mental Health Research: An Analysis of Junior and Senior NIMH Principal Investigators between FY2010 and 2018

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Abstract: Mental illnesses pose a profound burden to individuals and society, affecting nearly one out of every five Americans. Given the need for innovation in treatment development, this paper seeks to elucidate the relationships between federal research funding (through the National Institute of Mental Health), innovation, and seniority of principal investigators receiving grant funding for research. Though literature suggests that innovation is often driven by more junior researchers, we find that between Fiscal Years 2010 and 2018, senior researchers received substantially higher amounts of funding for research, presenting a trade-off that must be considered related to the longer-term impacts of innovation.

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Introduction

Mental illnesses and poor mental health are a significant economic burden to individuals and society, affecting nearly one of five Americans.[1] Many burden of disease studies point to mental illnesses as the leading cause of disability.[3] These statistics are all the more important in the context of a global aging population, among whom prevalence rates of mental illness tend to be higher. Given the public health and economic implications of mental illnesses, the impact of public dollars spent on research for new treatments to decrease this burden is of particular concern.

While the importance of innovation in mental health research is evident, treatment development for mental disorders is behind, particularly as it pertains to drug treatments.[4] In the U.S., the National Institute of Mental Health (NIMH)—the lead federal agency on mental health research—spends millions of dollars annually on research grants.[5] The impact of that investment has been unclear.[6] Former NIMH director Dr. Thomas Insel (serving between 2002 to 2015) has noted, for example, that despite substantial funding "on the neuroscience and genetics of mental disorders… I don't think we moved the needle in reducing suicide, reducing hospitalization, [or] improving recovery for the tens of millions of people who have mental illness."[7]

Given its mandate to transform the understanding and treatment of mental illnesses through basic and clinical research, NIMH should play an important role in funding the development of new innovation for prevention, recovery, and cure of mental illnesses.[8] As such, it is important for NIMH to consider the evidence surrounding who—meaning which researchers—drives innovation and scientific discovery. The connection between those researchers supported by NIMH and their output is relevant for understanding the impact of federal investment in mental health research.

A considerable body of research suggests that age and experience play an important role in innovation and scientific discovery, and that individuals are often most innovative at younger to middle ages.[9] Jones, Reedy, and Weinberg (2014) review the literature of age and great scientific insight, taking a life cycle approach, and find that the frequency of scientific breakthroughs tend to wane in middle age and then continue to decline thereafter.[10] Weinberg and Galenson (2019) identify life cycles of scholarly creativity among Nobel laureate economists and find that conceptual innovators do their most important work earlier in their careers.[11]

Though cutting edge research and scientific discovery may be more likely to occur among less senior researchers, political and other rational considerations could lead to underfunding among this group. Packalen and Bhattacharya (2020) note, for example, in regards to the National Institutes of Health (NIH) more broadly, that a public agency visibly spending taxpayer money may face pressure to show discrete outcomes of funded research, leading to certain topics and researchers being funded more often if believed to reliably produce "results."[12]

In this paper, we contribute to the literature evaluating the impact of federally funded research by examining the connection between NIMH grants and innovation; we consider the dynamics of seniority—meaning establishment in the research field—as an important factor in innovation by asking: *to what extent do NIMH grants, and areas of study and patenting activity (as proxies for innovation) differ between junior and senior researchers between Fiscal Years 2010 and 2018?*

Conceptual Framework (Theory of Change)

Following Lane et al. (2015), our conceptual framework identifies individual researchers as the unit of analysis; our theory of change is that there exists a connection between *what* research is funded and *which* researchers are funded.[13] The intervention of research funding affects the interactions of those who shape larger collaborative networks, which, in turn, through training, knowledge sharing, and other collaboration, influence discovery. By drawing on this framework, we recognize that, per Lane et al., "the social organization and work practices of cutting edge science do not fall cleanly within individual projects bounded by particular goals and clear starting or ending dates."

To the extent that outputs, such as patents or research publications, are connected to activities of specific researchers, the make-up of the researchers funded by NIMH will (at least in part) dictate what has been produced over the past decade for which we study, including the innovation by types of research, by topic, and in the form of patents or otherwise. We hypothesize that this relationship will be reflected in our analysis: given the pressure likely faced by NIMH to fund “safer” research or researchers, and the stagnation in scientific breakthroughs in the mental health space over the past decade plus, the level of seniority of researchers funded by NIMH will be positively correlated with the amount of funding they receive and also correlated with the type of research and outputs they produce.

Data and Methodology

Our approach focuses on a descriptive and exploratory analysis to understand the landscape of mental health research funded by NIMH longitudinally between Fiscal Years (FY) 2010 and 2018. We specifically examine the links between researcher seniority and a set of measures of interest: amount of funding received and, as proxies for innovation, topics of research and patent activity.

We draw from publicly available administrative data for our analysis: the NIH RePORTER (Research Portfolio Online Reporting Tools, Expenditures and Results), an electronic tool that allows users to search a repository of detailed project-level NIH-funded research grants, as well as associated publications and patents that have acknowledged support for this funding.[14] Specifically, we access bulk administrative data through ExPORTER, which is RePORTER data available for download, for FY2010 through 2018.[15] We also download and draw from RePORTER Patent Information, for all patents obtained with funded project references, for all Fiscal Years.

We chose to examine data from FY2010 to 2018 to understand the funding landscape in the most recent decade; additionally, the quantity of data available before these years is significantly less extensive as compared to the years we include; we choose not to include the most recent years of

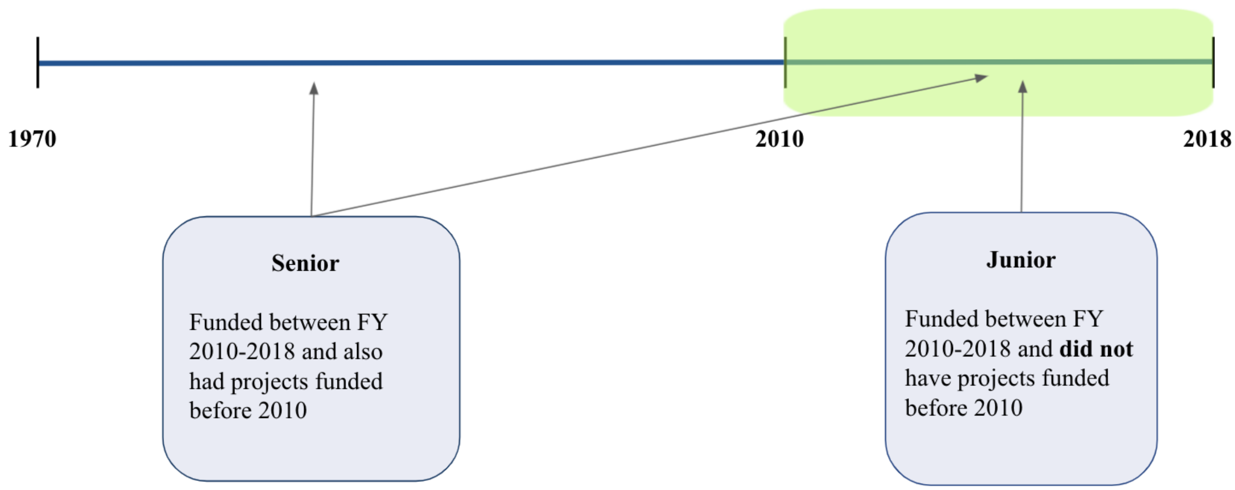
2019 and 2020 so as to best capture data that has had multiple opportunities for review (as revisions are made at least annually).

We use record linkage to connect RePORTER data for FY funding and Patent Information. We directly link funded projects and patents by a unique identifier for projects. NIH crosswalks these datasets for patents and their associated grant-funded projects; using this crosswalk limits the amount of data cleaning necessary to effectively link data.[16] Finally, we restrict our sample to include all grants and patents for NIMH only, as indicated by a data feature for NIH Center (in which NIMH sits).

Our unit of analysis, as mentioned above, is individual researchers, which we define as Principal Investigators, a category provided within RePORTER data. Critical to our analysis is the relationship between seniority and innovation. We therefore use our complete dataset of NIMH grants and associated patents to establish and define two groups of Principal Investigators: Junior Researchers and Senior Researchers. For the purpose of our analysis, Junior Researchers are included in our sample if they receive funding from NIMH and if their first grant is received in FY2010 or later; Senior Researchers are included in our sample if they receive funding from NIMH, from the time they receive their first grant and, if they are still receiving funding in the year 2010 or later (and therefore are covered in our data).

We chose to define our groups of researchers this way because we believe it allows us to capture and separate more established researchers from researchers newer to the field while still drawing on the years for which highest quality data is available. A cut point of funding in FY2010 to determine Junior or Senior Researcher status allows for a decade of time in which Junior Researchers may emerge from the earliest years of the professional life cycle and benefit from effects that might influence productivity, such as training and the transition to full-time active research. This is in line with those factors that precede peak innovation as described in Jones, Reedy, and Weinberg.[10]

Figure 1. We create two groups of researchers, Senior and Junior; Seniors are those who received NIMH research funding prior to FY2010 (and continuously through our covered period) and Juniors are those who received NIMH research funding in FY2010 or later.



To analyze the relationships between seniority and our measures of interest (funding levels, topics of research, and innovation), we examine how many individuals in our groups of Junior and Senior researchers are funded in our covered period (FY2010 to 2018) and the total dollar amount of funding received in this period. Level of funding is obtained through data available in RePORTER for direct and indirect costs awarded in a single fiscal year. For multi-year grants, costs represent the total over the life of the project; for multi-project grants, costs represent all funding for the constituent subprojects.

We consider two separate indicators of proxy innovation: patent activity and topics of research. We measure patent activity for each group as the total amount of patents obtained, including in our sample any patents that report an association with federal funding for which we can connect to a project.

We also examine topics of research among Junior and Senior Researchers using Latent Dirichlet Allocation (LDA), a statistical model for natural language processing that probabilistically estimates the latent topics associated with each word within each document in our sample (document being either a grant or patent abstract). Examining the research topics present among Junior and Senior Researchers provides an additional lens into which groups may be more likely to be producing cutting edge research.

Results

We show descriptive statistics for our two groups of researchers in Table 1. Almost 60 percent of all researchers funded by NIMH between FY2010 and 2018 are Senior Researchers, who by definition have projects which have been funded earlier than a decade ago. Not shown in Table 1, the earliest-funded Senior Researcher had a project with an associated NIMH grant as early as 1972.

Table 1. Between FYs 2010 and 2018, a greater quantity of Senior Researchers were funded by NIMH than Junior Researchers, and [proportionally], Senior Researchers received much higher levels of funding.

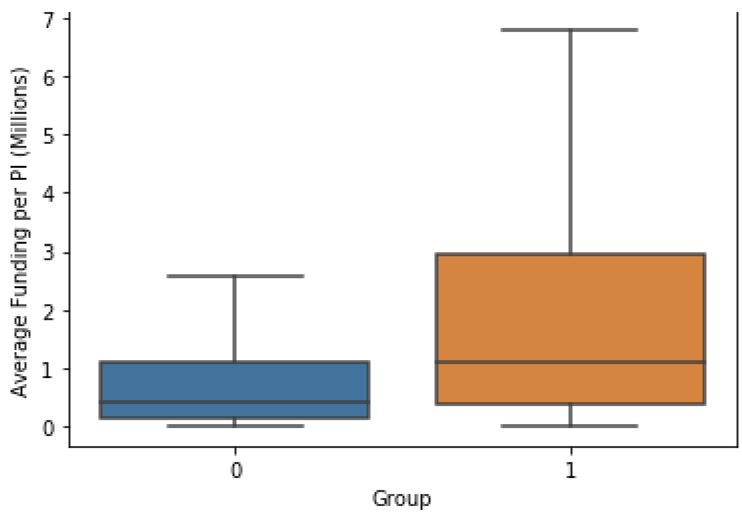
	Junior Researchers	Senior Researchers
Number of researchers	2,782	3,943
Number of unique grants	9,587	23,729
Total funding received	\$4.0 billion	\$11.0 billion
Number of researchers with associated patents	35	172
Total funding tied to patented research	\$0.5 billion	\$2.7 billion

Notes:

Table 1 also shows that research funding within NIMH is highly skewed, with Senior Researchers receiving more than 73 percent of all funding. Our analysis finds that, broadly, 10 percent of all researchers receive 60 percent of the overall NIMH research funding. Our results are in line with previous research finding a highly skewed distribution of all NIH-funded grants, with only 10 percent of NIH researchers receiving more than 40 percent of overall NIH funding.[12]

Figure 2 shows a box plot of the average funding per researcher within Junior and Senior Researcher groups. The lines that extend from each box (whiskers) indicate the variability of individuals' funding within each group outside the upper and lower quartiles. On average, Senior Researchers are more likely to be receiving substantially larger research grants than Junior Researchers.

Figure 2. On average, Junior Researchers (left-hand side) receive less funding per researcher as compared to Senior Researchers (right-hand side).



We also examine patent activity among our groups of researchers. While patents do not reflect all possible innovation within a field, they may serve as a valid proxy for measuring innovation and have been used in the broader literature of NIH-supported research, which also considers patents a valuable metric for identifying strategic investments.[17] Shown in Table 1, though Junior Researchers have fewer patents, it is worth noting that our view of their total research life cycle is truncated, and Senior Researchers have had a longer window within our data to accumulate a higher number of patents in all.

To further understand the connection between seniority and innovation, we examine through text analysis the types of research topics being pursued by both Junior and Senior Researchers. Figure 3 below shows the results of this analysis.

Figure 3. Topic modeling for research (both patented and unpatented) reveal that Junior Researchers may be pursuing more cutting edge research than Senior Researchers.

While some research topics pursued by Senior Researchers indicate the examination of cutting edge research, Junior Researchers appear to be focused to a greater extent on newer technologies that might produce more cutting edge research. For example, we see a topic that indicates DNA sequencing, as evidenced by words like “crispr”, “vector” and “sequence.” That more research funding has been provided to Senior Researchers over the past decade is likely indicative of the types of progress that have been made in relation to mental health technologies and treatments. For example, while new technologies to both the pathophysiology and treatment of mental disorders were established in the early research of our data coverage and prior, very few therapeutics have progressed through late phases of clinical trials or through regulatory approval over the past decade. Our topic modeling for Junior Researchers who obtained patents, however, suggests that may be an area of promise, as we see topics that include “trials,” “compounds,” and related.

These topic models provide additional evidence that while fewer patents have thus far been obtained by Junior Researchers, these newer investigators may provide a more likely channel for the potential of substantial advances in mental health treatment if considering the types of research being pursued.

Limitations

Limitations to our analyses exist. For example, we provide only descriptive analytics and do not make causal inferences. As well, our measures of innovation are not comprehensive, and future research may benefit from examining innovation through research publications and spillover effects of publicly funded research into the private sector. We also recognize that different areas of research (e.g. clinical trials, epidemiological cohort studies) require different levels of funding inherently.[18] Our simple measures, such as overall funding and number of grants, may misrepresent funding comparisons given investments that are naturally expensive. In the same way, focusing on grant numbers may overlook differing intellectual commitment in each grant; currently in production, NIH is working to establish a Research Commitment Index that will weigh the personal commitment for investigators to better understand how to value the return from research funding.

One major limitation of our study is that we do not directly examine the age of researchers. Age, as opposed to seniority, is more directly in line with the existing literature; in this way, the external validity of our analyses is weakened given that we cannot make direct comparisons to many other studies. It is possible that without knowing researchers' age, we also weaken the internal validity of our study in that we cannot explicitly say that we have, with certainty, correctly identified more established researchers. Being "established" does not directly align with age necessarily—to the extent an individual pursues a research career later in life, their newness to a field may still bring a fresh perspective that others at the same age may not necessarily have, and that fresh perspective could contribute to innovation.

As well, it may be the case that the window we chose to split Senior Researchers from Junior Researchers is too narrow. Jones, Reedy, and Weinberg find that while peak innovation still occurs in early to middle ages for medicine, the average age of peak innovation in medicine is slightly older than that of physics and chemistry (at 41 compared to 36 and 39, respectively).[10] Future analyses may benefit from defining groups with a cut point that is further back in time.

Conclusions

In this study, we aim to elucidate the relationships between NIMH research funding and innovation among Junior and Senior Researchers; we find that NIMH research investment from 2010 to 2018 is highly skewed in favor of Senior Researchers. We also find that while Senior Researchers obtain a greater number of patents associated with federally funded research, the research topics pursued by Junior Researchers and the patents they obtain are concentrated in areas of new and promising technology.

This research demonstrates that a trade-off exists between funding more established researchers and funding those newer to the field. Established researchers have the capacity to build on an existing infrastructure of work. As such, it may be the case that Senior Researchers produce outputs that have a more immediate impact. Those researchers newer to the field, however, may bring a fresh perspective and drive fundamental discoveries not made by those who are, as the literature suggests, on an innovation decline.

A strong argument for providing more funding to Junior Researchers is the long-term impact on innovation that it may bring. While effective treatments exist for many mental illnesses, these treatments typically do not reverse the full functional effects of mental disorders.[19] Put simply, a fundamental breakthrough that could substantially decrease the burden of mental illness is more important than ever given the aging population. Within the next decade, one of five Americans will be over age 65.[20] Advancements in modern medicine have meant that deaths from infectious diseases have been reduced but chronic ailments associated with longevity are now a concern. Debilitating mental illnesses, such as dementia, are more common in older adults than their younger counterparts.[21] As the U.S. has tied social services and entitlements (such as Social Security and Medicare) to the most rapidly growing age group, for whom mental illnesses could leave unable to contribute to economic growth sooner than otherwise, a pressing challenge faces younger generations who will be left to support this population.

To our knowledge, we are the first to examine seniority as a factor in research innovation specifically for mental health-related research. Future research could build on this (very) preliminary analysis and examine more precisely the types of innovation that have been generated from NIMH research funding, be it specific patents (e.g. for various types of treatments) or cited research publications. Future research may also examine the specific age of researchers and the impact on scientific discoveries in the field of mental illness.

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