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Status Spillovers: The Effect of Status-conferring Prizes on the Allocation of Attention

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Abstract

We investigate the effect of a status-enhancing prize on the attention that a recipient's ''neighbors'' subsequently receive. Do neighbors—individuals who work in economic, intellectual, or artistic domains that are proximate to prize winners—bask in the reflected glory of the ascendant actor and therefore gain as well? Or does competition for attention ensue, attenuating the recognition neighbors would otherwise have garnered? We study the spillover effects of status shocks using life sciences research articles published from 1984 through 2003. Exploiting expert-assigned article keywords, we identify papers that are topically related to publications of future appointees to the prestigious Howard Hughes Medical Institute (HHMI). In difference-in-difference specifications, we find that these scientific neighbor articles experience substantial declines in citation rates after HHMI appointments are announced. That is, neighboring articles attract less attention when authors of papers near them receive a prestigious prize. This pattern reflects more than the trivial transfer of attention from non-winners to winners: once prizes are announced, actors cede scientific territory to prize winners and pursue other opportunities. These negative spillover effects are moderated or even reversed by scientists' social connections and by the novelty and stature of scientific domains.

Keywords: status, networks, prizes, science

Recognition invokes intriguing social dynamics. Selecting who to recognize requires interpersonal judgments, implies categorizing actors subjectively into comparison sets, and depends on establishing criteria to rank contenders. It requires determining whose opinion matters, initiates deference, and incites

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competition among those who aspire to be recognized and those who wish to arbitrate others' opinions. Inevitably, it also generates envy. In short, recognition is a complex social process.

A prize is a status-enhancing accolade that is an important form of recognition—a public judgment about the quality of the recipient's work (Heinich, 2009). Because they often create unanticipated, positive shocks to actors' statuses, prizes present a strategic research site for empirically identifying the effects of status (Azoulay, Stuart, and Wang, 2014). A central theme in the literature on social status has been Merton's (1968) theory of the virtuous cycles of the Matthew effect, in which those who obtain status are the dynamic beneficiaries of accumulating advantages. In the Matthew effect, an actor's identity becomes a lens through which his or her output is evaluated. The status shock from a prize produces a self-augmenting dynamic through time, because high-status actors benefit from perceptions of merit that amplify sometimes negligible actual differences in the quality of their achievements, relative to less-well-regarded but equally skilled peers (Lynn, Podolny, and Tao, 2009).

The extant literature on prizes generally contemplates the effect of a status boost on award winners. By contrast, we motivate a fundamental shift in focus from prize-winning actors to the large group of individuals who work in proximate economic, scientific, or artistic domains: the "neighbors" of prize winners. That is, rather than consider the effect of a status-conferring prize on its recipients, we assess the ecological effect of its bestowal on the neighborhoods in which winners are situated. Status shocks are treatment effects to specific neighborhoods in a broader ecology of effort. When we zoom out from the level of the individual prize recipient and his or her almost-as-accomplished peers, the focus on neighbors raises a broader question for which the literature lacks a compelling answer: what are the implications of an elevation in a few, elite actors' statuses for wider patterns in the allocation of recognition in a social system?

Existing research offers competing predictions of the direction of the potential effect of a prize recipient on that person's neighbors. On one hand, prizes to individuals may consecrate their domains of artistic or scientific endeavor and thus benefit winners and neighbors alike, though not necessarily equivalently. This occurs if greater recognition flows to the entire neighborhood, relative to pre-prize levels. On the other hand, elevations in one actor's prestige may focus the limelight on that actor to such a degree that it crowds out attention to others cast in the winner's shadow. Likewise, a prize may divert attention from the neighborhood altogether, because prizes sometimes resolve the uncertainty of debate. When a matter is settled, people generally attend to it less.

Identifying whether positive or negative spillover effects dominate is important, as the ratio of non-recipients to winners is large. This must be the case because status-enhancing affiliations derive their prestige from their scarcity. For every Nobel Prize awarded, for example, there are myriad non-recipients of the award in pertinent fields of inquiry. This means that the aggregate effect of status shocks may be most extensively felt by actors who have been beyond the purview of most existing status research. More broadly, to truly understand how status processes affect outcomes in social, cultural, and scientific markets, it is necessary to widen the lens from a focus on award nominees and winners to their neighborhoods.

A TWO-HORSE RACE: STATUS SPILLOVERS AS ENDORSEMENT OR COMPETITION

There are at least two broad accounts of how the bestowal of an award may affect a prize recipient's neighborhood. We label one account ''endorsement'' and the second ''competition.'' If endorsement prevails, there will be positive status spillovers: the benefits of recognition will flow from a winner to neighboring members of his or her community. Conversely, competition implies that bestowing an award induces negative spillovers to neighbors, which would occur if the concentration of recognition on one person causes attention to be redirected from others who are proximate. We develop the arguments for each of these mechanisms independently, but we emphasize that the empirical outcomes we observe are likely the blended result of counterbalancing forces. The theoretical rationales for each mechanism are sufficiently compelling that the question is not whether one or the other is exclusively at work; it is which one outweighs the other, on average, and which contextual conditions amplify one process relative to the other.

The Endorsement Effect: Basking in the Reflection of a Neighbor's Glory

Arguments for a positive status spillover effect generally rest on the idea that there is uncertainty in many judgments of merit. This prevalent uncertainty leads to social influence in evaluations of implicit worth (e.g., Asch, 1956; Coleman, Katz, and Menzel, 1957; Salganik, Dodds, and Watts, 2006; Lynn, Podolny, and Tao, 2009). When the quality of an actor or object is not easily determined, evaluators typically assess it based on readily observable signals, including affiliations, awards, gossip, product reviews, and other indirect indicators of merit. Though recent work has challenged some previous estimates of status effects (Simcoe and Waguespack, 2011; Azoulay, Stuart, and Wang, 2014; Kovacs and Sharkey, 2014; Malter, 2014), there is an extensive theoretical literature on the benefits of high status. Podolny's (2005) metaphor of status ''leakage'' characterizes the Bayesian process by which actors are thought to infer others' merits from their affiliations. In Podolny's metaphor, the social value of an award is a process of status leakage: one can think of the status boost that accrues to a prize winner as the lending of prestige from previous to current winners of the accolade. In her recounting of how the Nobel Prize gained distinction, Zuckerman (1977) argued that the prize's stature was socially constructed from its earliest recipients. When the greatest scientific thinkers of the early twentieth century—Planck, Einstein, and Bohr—agreed to accept the Nobel, they created a reverse transfer of their prestige to the prize. Eventually, the Nobel became so highly regarded that its bestowal enhanced the status of subsequent winners, even if they had extremely high levels of pre-prize recognition.

Of course, the spillover of status from one actor to another extends well beyond award winners: in general, the circumscribed flow of status across network ties is what creates the reputational value of affiliations. Graduate students derive status from their affiliations with prestigious departments and universities (Merton, 1968), law firms from the statuses of universities from which they successfully recruit (Phillips and Zuckerman, 2001), new ventures from the prominence of their investors and strategic partners (Stuart, Hoang, and Hybels, 1999), and companies from the industrial categories in which they compete (Sharkey, 2014). In such circumstances, status-based affiliations endorse otherwise less-known individual actors.

Likewise, endorsement-related status leakage may occur when certification from prestigious individuals or organizations raises the tide for whole groups of actors. When actors or objects are nested within categories (Hsu and Hannan, 2005), such as when firms cluster within industries, scientific contributions bundle to fields, and films group to genres, prizes may contribute to the legitimacy of overall categories (Zuckerman, 1999). Prestigious prizes may build a field's collective legitimacy (Lounsbury and Glynn, 2001; Anand and Watson, 2004), especially for an incipient field, in which a status boost to an individual actor can be a seminal catalyst to the coalescence of a collective identity.

Podolny and Stuart (1995) argued that high-status actors have a particular influence in orchestrating paths of change: because of pervasive uncertainty at the early stages of novel scientific and technical trajectories, high-status actors' choices of where to invest resources become "focal points" (Schelling, 1960) that galvanize the attention of the broader community of innovators. As an example, they described the sway of IBM's decision in 1981 to enter the personal computer industry, which spurred the entry of many software producers. In areas in which ex ante technical characteristics are insufficient to adjudicate among competing approaches, the extent of social proof around each competing technical alternative becomes a primary basis for other actors' resource allocation decisions. It is reasonable to expect this dynamic in science, technology, art, and other cultural domains that share the core feature that the true, underlying quality of a product can be very difficult to judge in advance.

Extending this logic to the context of prominent awards, one can think of a major prize as consecrating more than just the person's work: it endorses a field of artistic or scientific pursuit. In this respect, awards may contribute to the categorical legitimacy of an area of work, fueling its adoption (Rossman, 2014). The endorsement effect therefore implies that, all else being equal, near-neighbors will receive more recognition when a member of a community wins a significant prize.

The Competitive Effect: Wilting from the Deflection of Glory

Although status research has emphasized the actor- and category-level benefits of social status, negative effects of status also appear in the literature. Even the Matthew effect is regarded as something of a two-edged sword. Much of the early sociological interest in this phenomenon stemmed from the fact that any accumulative advantage is non-meritocratic: the Matthew effect implies a disjuncture between actual, virtue-based rewards and the socially constructed cycles of recognition that accrue to actors who begin with only a modest quality advantage relative to their peers. Small, early leads—perhaps differences so minor that they exist by chance alone—amplify through the social construction of quality to launch very different outcomes over a lifetime. In other words, the Matthew effect can trump merit.

Some have argued that very high-status actors inevitably confront a range of distractions that may compromise their performance. Bothner, Kim, and Smith (2012) described how elite athletes garner so many opportunities that they can become complacent and distracted from the excellence of work that first brought them prestige. Likewise, in her study of Nobel Prize winners, Zuckerman (1977) observed heavy demands for speech-giving and the like in the post-prize period, which crowds out a singular focus on academic work. Examining the personal ramifications of prizes, Jensen and Kim (2015) found that while winning an Academy Award leads to more professional opportunities, it is also associated with higher divorce rates. Another body of work considers the negative emotion of envy or status deprivation, which often is experienced by near-winners when a structural equivalent receives a meaningful recognition (Burt, 1987; Heinich, 2009). In a different stream of literature, Kovacs and Sharkey (2014) argued that after a product or producer gains recognition, it may receive more negative evaluations as the audience broadens to include individuals with more diverse tastes.

Different streams of the literature therefore describe some of the drawbacks of status for prize recipients, but we are unaware of work that directly addresses the broader ecological dynamics that may ensue with the awarding of prizes or other shifts in status. If a competitive process results in negative spillovers of status shocks, which group of market participants loses when a focal actor wins a prize, and why? Research considering the negative consequences of prizes for non-winners has tended to focus on those coming just shy of victory and has often supplied psychological accounts for their subsequent challenges (cf. Jensen and Kim, 2015). In contrast, our approach both broadens the scope of non-winners to all members of a community of related endeavor, and it centers on audience-side accounts for negative spillovers, rather than the personal travails of passed-over contenders.

Bothner, Godart, and Lee (2010) provided a valuable starting point for explaining negative ecological effects of status shifts. They defined status as "a zero-sum relational asset that is possessed by social actors insofar as they are highly regarded by other highly regarded actors." If status is a zero-sum resource, the elevation of any one actor or set of actors must coincide with decrements to others in the social system. Of course, this is true in any rank ordering: an increase in one actor's rank must occur at the expense of one or more alters who formerly were ranked higher. The ecological consequence of this for a non-recipient of a prize is more than simply being passed over: if a prize winner experiences a sharp elevation in status in a zero-sum system, a number of alters must endure compensatory losses of status to create a place in the rank system for the winner's social climb.

Thinking about status hierarchies as strict rank orderings is stylized in most settings. For instance, what is the true rank ordering among researchers in any subfield of scientific research? Yet an important and general conceptual equivalence can be drawn between strict rank orders and attention-based status systems. The similarity is created by the fact that in many professional, social, and market arenas, participants operate at or near the limit of their budget constraint on attention. The presence of such a binding cap implies a tradeoff that parallels the status dynamics of a strict rank ordering. If one actor experiences a jump in status and therefore garners more recognition from audience members, other actors in the social system necessarily must attract less attention.

For instance, given the large number of scientific articles that are written each month, if one article rises to prominence, scholars' decisions to read this article come at the expense of reading a large number of possible alternatives. The attention allocation problem is precisely what makes prizes in scientific and cultural domains so influential: given audience members' finite capacity, awards are signals that guide the allocation of their scarce attention across a vast array of competing alternatives. This is the curatorial role of the Pulitzer Prize in fiction, the Oscars in film, the Max Weber Award in sociology, and so on.

Because of the central role of the limits of attention, an understanding of the contextual effects of status shocks such as major prizes likely rests in the processes by which audiences allocate attention to non-winners. The simplest possibility is that recognition is monopolized by prize winners when their status crystallizes. Prizes accentuate differences among actors in a domain, and a straightforward diversion of attention occurs, from a relatively more equal distribution across the actors in a market to domination of recognition by one or a few notables. In the absence of prizes, recognition may have been more equally distributed. In all, the prize winner garners more attention, most everyone else experiences a proportionate loss, and the overall distribution of attention exhibits greater skew.

A second, more nuanced possibility is that a prize dampens interest in an area, because a formerly contested terrain transitions into a resolved one. If this occurs, its effect will tend to be more dramatic than a simple reallocation of intra-neighborhood attention: this mechanism results in a net reduction in collective interest in the neighborhood. We think this possibility is particularly intriguing in the context of science: prizes may define canonical works, and the existence of such signature pieces may actually detract from the aggregate attention invested in the broader area of that work. When a particular piece of work rises to great prominence, a probable implication is that it becomes a de facto reference for an idea. Other scholars will attend less to the field that surrounds the idea, because the stature of the canonical work enables their search to begin and end with it alone. When scholars are deciding whose shoulders to stand upon, prizes often render the choice obvious. Scholars unfamiliar with an idea may assume that the field is more narrowly defined than it actually is, leading outsiders to disregard much of the work that is adjacent to that of a prize winner's contribution. Though perhaps counterintuitive, we believe this is a common scenario. By their very nature, canonical works partially function to truncate debate. If this happens, attention may divert from an entire neighborhood: when prizes function to clarify what is most important in a neighborhood, the overall level of attention to it may attenuate.

The set of theories above leads us to the possibility that a competitive effect may swamp any endorsement effect. In each case, in the counterfactual absence of the awarding of the prize, attention dynamics are unchanged from whatever trends were underway just prior to the time the prize was bestowed. If the competitive effect dominates, we anticipate that, all else being equal, near-neighbors will receive less attention when a community member wins a significant prize.[1]

[1] This does not imply any gain or loss in attention to the prize winner; the argument concerns the ecological impact of the prize on the winner's neighborhood. These are all causal theories of the ecological byproduct of a prize.

METHODS

To examine whether a major award generates positive endorsement or negative competitive spillovers in science, we studied how prizes affect the recognition given to neighbors in the intellectual domains surrounding winners. We conducted our analysis at the scientific article level, identifying award-winning scientists' publications, retrieving publications addressing similar content (''neighbor articles''), and examining the change in neighbor articles' citation rates after awards are announced, relative to carefully selected control articles in other scientific areas.

The award we focused on generates a salient jump in the status of mid-career academic life scientists in the United States: appointment to be an investigator of the Howard Hughes Medical Institute (HHMI), a nonprofit medical research organization that is a major participant in biomedical research in the U.S. HHMI's annual budget is larger than the amount the National Science Foundation typically commits to the biological sciences. During periodic, open competitions, the institute solicits applications from scientists at universities and other research institutions across the country. The HHMI selection committee almost exclusively comprises members of the National Academy of Sciences, so the profession's most elite scientists choose winners. Once selected, awardees continue to be based at their home institutions, but they are entitled to append the prestigious ''& HHMI'' to their affiliation in the papers they publish, so that other scientists are reminded of their status. Appointment to HHMI is a major honor—the most prestigious accolade that a U.S. life scientist can receive relatively early in his or her career. Consistent with its stature, HHMI appointment is a harbinger of greater accomplishment: the current group of HHMI investigators includes a remarkable 16 Nobel laureates and 152 members of the National Academy of Sciences.

We studied how HHMI appointments change the allocation of attention to the broader body of research in which awardees' work is situated. Crucial to understanding our empirical approach is recognizing that while we used HHMI prize winners' publications as the conduits of this prize-based status shock to scientific neighbors, prize winners' publications are not in our sample. We did not focus on the fate of winning scientists' work itself—that question has been explored at length in past research (cf. Azoulay, Stuart, and Wang, 2014). Rather, we studied the effect of a winner's prize on the attention paid to neighbor articles—those written by scientific peers in the same field.

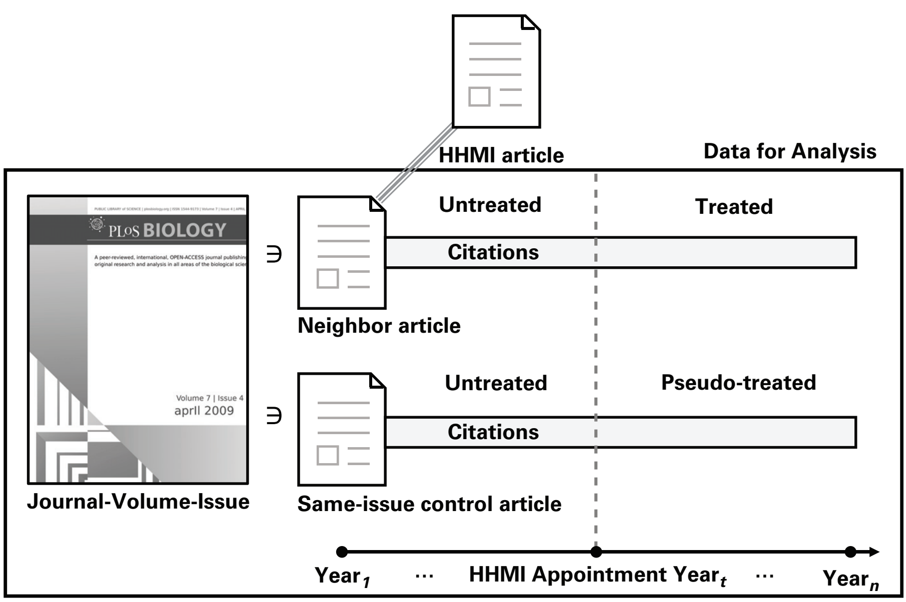
PubMed Data

To implement the research design, we required a high-fidelity method to identify scientific neighbors of the prize winners' papers. We accomplished this with a core feature of the PubMed database maintained by the National Library of Medicine (NLM), which stores a near-census of journal articles in biomedicine. To help researchers identify work on related topics or concepts, the NLM indexes all articles with Medical Subject Headings (MeSH) keywords. MeSH terms constitute a carefully curated, constantly expanding vocabulary maintained by subject matter experts at the NLM. The approximately 25,000 MeSH keywords provide a very fine-grained partition of the intellectual space spanned by the biomedical research literature. Importantly, MeSH keywords are assigned to each article by professional indexers, not by authors.

As researchers browse articles on the NLM website, a list of links to similar articles appears in a sidebar. These lists are also accessible through a public API (application programming interface). Sets of related articles are identified through the PubMed Related Articles algorithm (PMRA), a probabilistic topic-based model that infers relatedness between each published article and every existing article in the PubMed bibliome—the corpus of biology texts. The algorithm yields a continuous relatedness score between any pair of papers, which is derived from proximities in three linguistic spaces: article MeSH keywords, article title words, and article abstract words. Though the actual implementation is complex (see Lin and Wilbur, 2007, for details), in coarse terms one can think of the PMRA algorithm as a measure of structural equivalence between articles in a combined keyword–title–abstract word space. The more two articles share MeSH keywords and title and abstract terms, the nearer they are per the PMRA algorithm. The output of PMRA includes a continuous measure of intellectual proximity between a focal paper and each of its related papers. Therefore one can think of the PMRA set of any article as a compact scientific field centered on its specific content. We used PubMed's public API to identify the PMRA-defined set of neighbor articles for each ''HHMI article''—one published by a scientist who is later appointed to HHMI.

Figure 1 illustrates our empirical strategy. Consider a scientist who is appointed to HHMI in year *t* and published an HHMI article some years before winning the award. A neighbor article is an existing paper that is scientifically close to an HHMI article, as determined by membership in its PMRA set. We retained neighbor articles that were published prior to both the HHMI article and the time of the award.

Figure 1. Illustration of empirical strategy.



As we explain in more detail below, neighbor articles were treated after year *t*, and because citations to neighbor articles occurred both before and after HHMI appointments, we could assess within-article changes in citation rates, comparing the before- and after-award periods. To estimate the causal effect of the HHMI award on citation rates to these neighbor articles, however, we needed to know how treated papers would have performed over time if an HHMI appointment had not been awarded to a scientific peer. That is, we needed a control group of papers that were unaffected by HHMI awards but followed a citation trend parallel to what we would have expected of the treated papers had none of their scientific peers received an HHMI appointment.

To create this data structure, we matched each neighbor article to a control article that was scientifically unrelated to the HHMI award winner's work. This is the comparison in our experiment: HHMI neighbor articles versus scientifically orthogonal control papers. Contrast this to a traditional research design, which might consider HHMI articles to be the treated units and neighbor articles to be the controls. Our experiment runs at a one-step remove: neighbor articles in a prize winner's PMRA are the treated units, and controls are similar-quality articles with identical exposure times but in different areas of science.

For each neighbor article, we returned to its journal and issue of publication and selected a random article from the same issue as a control. Thus each control article was published at the same time and in the same journal volume and issue as its corresponding neighbor article.[2] We accepted a control paper only if it was scientifically unrelated to the HHMI article, per PMRA. Thus, although control papers were at risk of citation for exactly the same period of time and by a similar audience as the treated papers, the control papers were never in the same scientific fields as their corresponding treated papers. Following convention, we assigned control papers the treatment year of the corresponding neighbor article as the "pseudo-treatment" year.

As illustrated in figure 1, HHMI articles define the treatment condition, but these papers are not in the data for analysis. The question animating our work is how the bestowing of a prize affects the trajectories of existing articles in the scientific field of the award winner; we do not study how HHMI awards affect future outcomes for prize winners. By benchmarking neighbor articles against carefully chosen controls (and not the HHMI articles themselves), we go beyond comparative studies that contrast award winners with runners-up and assess the absolute effect of status shocks on neighbors. Because of the rich data in this setting, we were able to construct a control group of articles truly unaffected by the status shock, allowing us to determine how the scientific neighbors of HHMI articles depart from the (counterfactual) citation rates they would have experienced had they never been adjacent to a prize winner.

A critical feature of the research design is that we studied only neighbor articles and control articles published before an HHMI award was granted, though we analyzed the full time path of citations to these articles, including the period after the prize. Focusing only on articles published before the prize offers several methodological advantages. First, as noted, citations to these articles occurred both before and after treatment, which allowed us to construct

[2] We describe alternate control selection strategies in the Online Appendix, http://journals.sagepub.com/doi/suppl/10.1177/0001839217731997.

Table 1. Descriptive Statistics for HHMI Investigators (N = 393) in Year of Appointment*

Variable	Mean	S.D.	Median	Min.	Max.
Year of appointment	1992.331	5.181	1993	1984	2003
Year of highest degree	1980.662	7.571	1981	1956	1998
Career age at appointment	11.669	6.228	10	0	36
Female	0.191	0.394	0	0	1
Number of source articles	4.583	3.467	4	1	19
Career publications	46.793	42.967	33	1	285
Career citations	5849.966	6975.52	3862	111	90245
Number of publications in top 1% of citations	8.276	8.499	6	0	74

*Career performance is accumulated up through the year HHMI appointment is announced.

within-article, difference-in-difference comparisons. Second, because pre-prize articles were published before a given HHMI appointment was awarded, we can assume that their quality and scientific content are strictly exogenous to the bestowing of the prize. These articles were written well before a focal HHMI was selected, which all but ensures that the existence and content of all neighbor articles is exogenous to the bestowal of the award.

Thus our empirical design was to analyze the change in rates of citation to neighbor articles following the announcement of the HHMI appointment that treats them, relative to the change in rates of citations experienced by closely matched control articles: a differences-in-differences estimation strategy. Expressed in terms of the paper-time segments denoted in figure 1, we examined how citation rates during the ''treated'' interval compare with the ''untreated'' window for the treated cases, as compared with the same difference between the ''pseudo-treated'' and ''untreated'' windows for the control articles.

Table 1 reports career attributes of the 393 scientists appointed to HHMI from 1984 through 2003, who ''treat'' their scientific fields when they receive their appointments. The table illustrates the scientific eminence of this set of scholars; the modal HHMI award winner is male and about 12 years into his independent research career at the time he is appointed. He has written about five research papers in which he served as the lead author or principal investigator in the two years prior to his award and 46 articles in all years prior to his award, and his past work has been very highly cited.

HHMI articles. We collected all publications for which eventual HHMI investigators were first or last authors, and we constrained this set of papers to include only article-type, original research publications—we dropped reviews, letters, and so forth. Also, we restricted HHMI articles to those published one or two years before the HHMI author's appointment. This step ensured that the ''treating'' papers are proximate to the time of appointment, even though treated papers typically have existed for longer, as we explain below.

Table 2 reports descriptive statistics for the 1,801 HHMI articles used in our study. These publications appear in journals with high impact factors. Consistent with the eventual stature of their authors, these papers receive high citation counts: the median paper in our set achieves a cumulative citation

Table 2. Descriptive Statistics for HHMI Articles (N = 1,801)

Variable	Mean	S.D.	Median	Min.	Max.
Publication year	1990.911	5.076	1991	1982	2002
Number of authors	4.018	2.132	4	1	15
Publication age in year of appointment	1.481	0.5	1	1	2
Total forward citations through 2007	159.012	320.325	83	0	8145
Total forward citations (cohort percentile)	86.346	18.678	93.7	0	100
Journal impact factor	8.976	7.144	6.495	0	30
Total number of neighbor articles	26.805	32.058	19	1	741

count that places it at the 94th percentile of the cumulative citations received by all biomedical papers published in its year of publication.[3]

Neighbor articles. As table 2 shows, each HHMI article is related through PMRA to an average of 27 neighbor publications preserved after using filtering steps similar to those we used for HHMI articles. We removed all non-research articles from the neighbor article data and restricted neighbor articles to those published at least two years before the corresponding HHMI article. The time restriction helps us avoid the potential confound of scientists sorting into intellectual spaces with known or pending HHMI attention, and it makes the results more conservative. We also constrained neighbor articles to have been published no more than 10 years before the time the HHMI scientist received his appointment. Neighbor articles are considered treated in all years after the year that the relevant HHMI appointment is announced. In addition, we restricted the neighbor articles to those that were treated only once—that is, they were related to only one HHMI article during our analysis window.[4]

Control articles. As described above, we constructed a control group by selecting papers that appeared in the same issue of the same journal of publication as the treated neighbor articles. In robustness checks, we further matched on article and PMRA field characteristics to eliminate nearly all sources of heterogeneity (Furman and Stern, 2011).

Model

The principal models estimate the rate of citations to each neighbor article, relative to its control article, in each year *t*. The estimating equation can be written:

[3] Percentiles of total forward citations were calculated within publication-year cohorts.

[4] It is common in these data for neighbor article*s* to be multiply treated. This occurred when a focal neighbor article fell in the PMRA set of multiple HHMI articles authored by more than one prize winner. Typically, these separate episodes of treatment also occurred at different time periods. For instance, a neighbor article might be written in 1993 and then fall within the PMRA set of articles written by 1997 and 1999 HHMI investigators. This neighbor article then posed an estimation challenge because there was no clear definition of pre-treatment for the 1999 award. To address this problem, we limited the dataset to neighbor articles that were treated by a single prize winner. In robustness checks, we included multiple-treated papers, which resulted in a significant increase in the size of the dataset but recovered similar, but even stronger, results.

$$E[y_{it}|X_{ijt}] = \exp[\beta_0 + \beta_1 NEIGHBOR_i \times AFTER_{jt} + f(AGE_{it}) + \delta_t + \gamma_i]$$

where *i* indexes articles (neighbor or control); *j* indexes the scientist who wrote the relevant HHMI article; *NEIGHBOR* indicates that a focal article *i* is a neighbor article to the HHMI article written by *j* (assigned a 1 for neighbor articles and 0 for control articles); *AFTER* is an indicator set to 1 for each year after the HHMI appointment has been announced; $f(AGE_{it})$ denotes a series of indicators of article vintage; δ_t represents calendar-year effects; and γ_i corresponds to article fixed effects. Because the regressions include article fixed effects, and the state of being a neighbor article (or control) is time-stationary, we could not include a *NEIGHBOR* article dummy independent of the interaction effect with *AFTER*. In results below, we denote the coefficient corresponding to the *NEIGHBOR* × *AFTER* interaction effect simply as "treated."[5]

The dependent variable is the annual citation count to article *i*. To ensure that changes in citation rates do not reflect the follow-on citation activity of authors (and the HHMI authors themselves), we removed self-citations and citations from the focal HHMI article.[6] The dependent variable has a lower bound of zero. Following convention, we estimated conditional quasi-maximum likelihood Poisson models (Hausman, Hall, and Griliches, 1984). Because observations are potentially correlated within neighbor article sets, we clustered standard errors around HHMI investigators.

RESULTS

Table 3 reports descriptive statistics for neighbor articles and control articles. Several variables in the table are perfectly matched by construction. Exact matches include the age of articles at the time the treatment-inducing HHMI appointment is announced, the publication year of the article, and the journal impact factor, which are identical because control articles are matched to treated articles based on their appearance in the same journal issues in which treated articles are published.[7] Treated and control articles also have a similar number of authors.

On average, neighbor articles have garnered six more citations than their corresponding control articles (26.2 versus 20.2) at the time they are treated with the relevant HHMI appointment. This is unsurprising because HHMI

[5] In estimating this equation, we faced the challenge of simultaneously accounting for time-based trends, age, and cohort effects. In particular, it is impossible to observe an article with the same age and same observation year but a different birth cohort (Hall, Mairesse, and Turner, 2007). The standard solution to this problem is to constrain two or more coefficients to be equal, which will then permit identification (Mason et al., 1973). Corresponding age–cohort–year estimates then can be sensitive to arbitrarily chosen values (Rodgers, 1982a, 1982b). But because our goal is to estimate a clean treatment effect that is purged of confounding variation, and not to estimate the year–age–cohort effects per se, this does not pose a problem in our case. To identify the estimating equation, we collapsed upper values of the article age variable into a single category. Our results are robust to many alternate binning strategies.

[6] Our results are robust to alternate constructions of the dependent variable in which self-citations and those from the focal article are retained.

[7] The data set has a case-control structure. We drew one control article per treated article. It is conventional to assign a "treatment" date to the untreated cases (the controls) that mirrors that of the treated case. When we say that the age of treated and control papers is identical at the time of treatment, it is because we calculated the age of the control paper at the time its paired observation is treated (i.e., the year when an HHMI is awarded to a scientific cousin of the treated article).

Table 3. Descriptive Statistics for Neighbor Controls and Articles*

	Neighbors (N = 23,334)			Controls (N = 23,334)			Overall	
Variable	Mean	S.D.	Median	Mean	S.D.	Median	Min.	Max.
Publication year	1987.492	5.941	1988	1987.492	5.941	1988	1974	2000
Number of authors	3.830	2.127	3	3.785	2.108	3	1	65
Journal impact factor	5.364	5.180	4	5.364	5.180	4	0	30
Article age in year of appointment	5.704	2.115	5	5.704	2.115	5	3	10
Stock of citations at appointment	26.152	57.342	11	20.193	47.165	8	0	2654
Total forward citations by 2007	63.645	174.026	26	50.896	110.695	21	1	16193
Total forward citations (cohort percentile)	73.823	23.429	81	70.799	23.79	77	13	100
Has any author of focal HHMI article	0.068	0.251	0	0.001	0.036	0	0	1
Has collaborator of focal HHMI author	0.138	0.344	0	0.015	0.122	0	0	1
Cited by focal source article	0.121	0.326	0	0.001	0.024	0	0	1
PubMed relatedness score	0.581	0.144	1	.	.	.	0	1

*Since only neighbor articles are related to HHMI-authored articles, the PubMed relatedness score is missing for control articles.

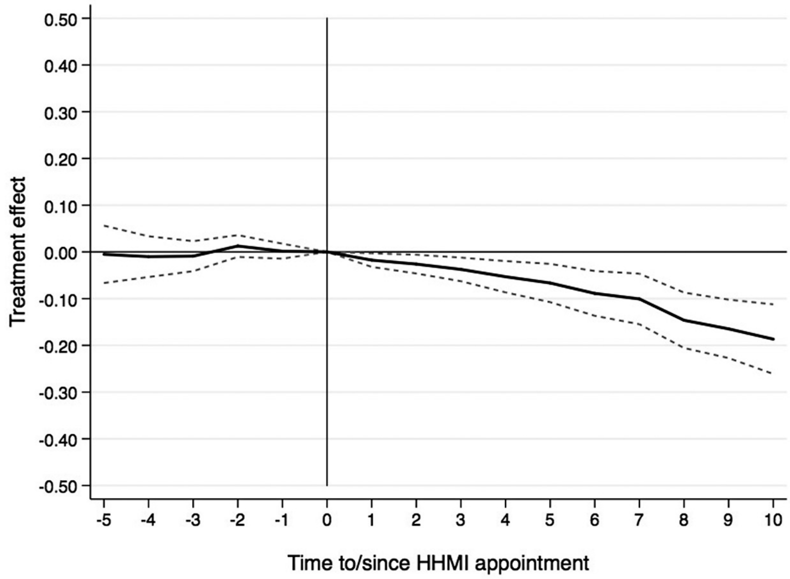
winners typically hail from quite active areas of science. The validity of the differences-in-differences design does not require control articles to have the same citation counts as treated articles in the period before treatment; rather, the difference-in-difference estimator assumes only that treated and control articles follow similar citation trends during the pre-treatment interval. We verify this assumption in analyses below and report supplemental analyses that rely on matching estimators to eliminate all observable pre-treatment differences between treated and control articles.

Table 3 also reports a number of article characteristics that may affect the magnitude of the treatment effect. One such factor is a (continuous) measure of scientific similarity between the neighbor article and the HHMI paper that treated it, which enables us to assess whether the magnitude of treatment subsides with scientific distance. We constructed the *PubMed relatedness score* between an HHMI article and neighbor article as the PMRA value for the paper pair, normalized by the score of the paper that is most related to the HHMI article. Because we constrained all control articles to be scientifically unrelated to HHMI articles, the PMRA score is defined for neighbor articles only. By construction, all control articles are effectively infinite (or undefined) distances from HHMI articles; they are selected from unrelated areas of science to insure that their citation trajectories are unaffected by HHMI awards.

Table 3 also summarizes whether the neighbor article shares any author with the corresponding HHMI article, has any past or future collaborator of the HHMI-winning scientist, and is cited by the focal HHMI article. These events occur occasionally among the neighbor articles and almost never among the control articles, bolstering confidence in our control selection design (i.e., that control papers inhabit different scientific fields than HHMI articles). Below, we examine how the treatment effect varies with the presence of authorship, collaboration, and citation ties.

The core regression results are presented in table 4 later in the Results section. In model 1, we find a strong, robust, negative spillover effect of HHMI appointment (–.069, $p < .01$). This means that when a scientist wins an HHMI

Figure 2. Dynamics of the treatment effect.*



* Estimates of the dynamics of the treatment effect are plotted as a solid line; 95% confidence intervals corresponding to cluster-robust standard errors (clustered at the level of HHMI investigators) appear as dashed lines. Annual citation counts are regressed onto interaction terms between treatment status and the number of years before/elapsed since the HHMI appointment. The indicator variable for treatment status interacted with the year of appointment ("year zero") is omitted.

award, the neighbor articles that already existed in close scientific proximity to the award winner's previously published articles experience a sharp decline in subsequent citation rates, relative to controls. On average, neighbor articles undergo a 6.67-percent (1–*exp*(–.069)) annual decrease in the rate of citations following the appointment, relative to control articles. This finding and subsequent extensions lead to our core empirical claim that the average effect of a prize is to divert attention away from areas of science near prize winners' past work. We find that in the post-prize period, attention dwindles to neighbor articles, and this competitive loss of recognition swamps any positive endorsement benefit of prizes except in a few ranges of the data, which we describe below.

Figure 2 plots the dynamics of the effect of the HHMI appointment on neighbor articles, relative to controls. This plot was prepared by substituting the main treatment indicator with separate interaction effects between an indicator for neighbor article and dummies for time to and from HHMI appointment. A flat graph with confidence intervals absorbing the x-axis indicates no statistical difference in citation trends between HHMI-related neighbor papers and control papers. If the control selection strategy is valid, we should observe a relatively flat line in the pre-treatment/pre-prize interval and a shift in the slope at the time of the prize if its bestowal causes a change in the baseline citation rates to neighbor articles.

Figure 2 portrays a nearly flat graph in the years leading up to HHMI appointment, followed by a sharp, steady decrease in the treatment effect in years thereafter. Neighbor articles and controls were on almost identical citation trends prior to the award, neighbor articles experience a precipitous decline in citations after the award is announced, and this decline is coincident to the timing of the award. The pre-prize pattern and the disjuncture at appointment lend support to our choice of control articles—it is clear that the prize effect is not a continuation of a downward pre-trend. Rather, the prize announcement causes a decline in citations to neighbor articles, relative to controls that were performing on a similar trend in the pre-prize period. Because we included article age fixed effects, the observed decline is beyond what would be expected from a natural decay in citations over time from the article's starting point, relative to controls: the treatment effect accelerates the rate of decay that would have occurred as a natural byproduct of the aging of the article and the advancement of science.

The prize's effect also appears to be permanent. On average, neighbor articles do not recover from the negative treatment effect, as evidenced by the steady decline in the citation rate over time, relative to the trend established by control articles. An alternative pattern still consistent with the negative main effect reported earlier would be a sharp decline followed by an eventual (partial) recovery. To explain the treatment effect's persistence, we return to the accumulative advantage process that Merton (1968) labeled the Matthew effect: initial differences in status imbue with a positive tint the lenses through which quality is assessed. But before any such evaluative process can occur, audience members must know of a product's existence. Put differently, in all markets for all things, exposure precedes adoption.

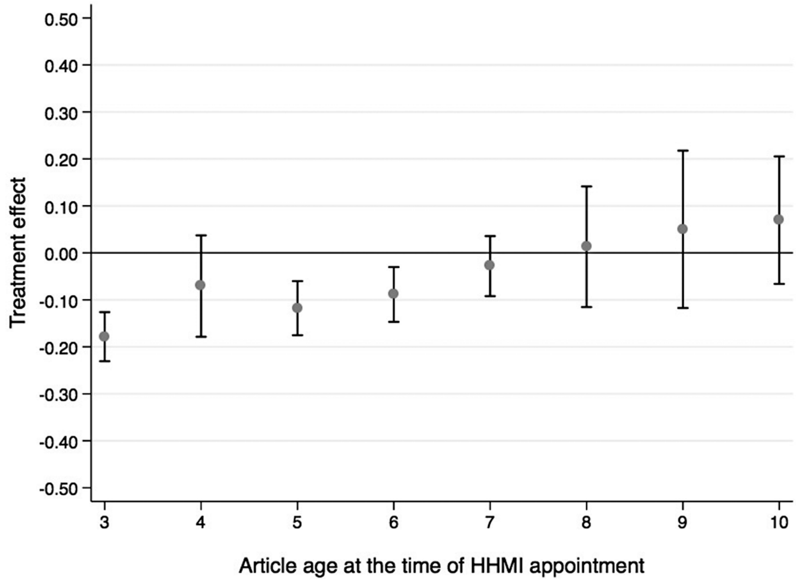
This inherent virality in the accrual of attention in cultural markets contributes to positive feedback dynamics. Exposure follows from the adoption of others, which means that the more people who read a book, watch a film, or cite a scientific article, the more other people become aware of the focal product's existence. This feedback cycle is likely in science because citations in articles serve as small billboards for existing work: though there are other search and information channels that lead to the discovery of existing work, the scientific community in part learns about research through citations. The more an article is cited, the more it comes to the attention of scholars who read the citing work, and a loss in citations contributes to permanent unraveling in citation trajectories, because fewer would-be adopters are exposed to the article in the next period. Thus a diversion of attention during the diffusion process would have persistent consequences, consistent with our findings.

Boundaries of the Competitive Effect

Because we included a census of the PMRA-related neighbor articles for each HHMI article, our findings at the article level have a ready interpretation at the neighborhood level: scientific spaces centered around the work of (eventual) prize winners generally experience a loss of attention after awards are announced.[8] With this core result in place, we delineated the bounds in which

[8] Because our methodology excludes citations received by prize winners' articles themselves, the results miss any countervailing uptick in citations to HHMI articles after the award, which would offset some of the loss in citations to the other papers in the winner's neighborhood. But because there is an average of 27 neighbor articles for each HHMI article in the data, the post-award increase in citations to HHMI articles that would be necessary to offset the loss of citations across all 27 papers per neighborhood would be quite large. Still, in robustness checks, we conducted additional analyses that included HHMI articles and same-issue controls. These analyses almost exactly replicated the pattern reported above.

Figure 3. Treatment interaction with article age at time of HHMI appointment.*



* Estimates of the treatment effect for articles of various ages at the time of the relevant HHMI appointment are plotted as gray dots; 95% confidence intervals corresponding to cluster-robust standard errors (clustered at the level of HHMI investigators) appear as black bars.

the competitive effect of treatment is present by examining within-neighborhood and between-neighborhood variation in the treatment effect. We began by examining the temporal boundary of the negative treatment effect: we interacted treatment with indicators of neighbor article age at the time its peer article's author is appointed to HHMI. This result is reported in figure 3. Note that though article age at a peer's appointment is a non-time-varying characteristic of each paper, the interaction effects are identified because treatment varies within units. Intuitively, if the treatment effect of the prize is causal, we would expect its strength to depend on the time lag between the publication date of neighbor articles and the time of the prize. The treatment effect should be weaker for older articles that already are well-established at the time a peer wins an HHMI appointment. This is exactly what we found: the treatment effect is most negative for the most recent neighbor articles and falls to zero for articles at least seven years old at the time the prize is bestowed.

We next considered whether the competitive effect of the award depends on scientific proximity. If the negative effect we observed is the result of a social process, it should naturally attenuate as neighbors become more scientifically distant from the epicenter of a status shock. Model 2 of table 4 includes an interaction between treatment status and an indicator that turns on when the normalized PMRA score is in the top 50 percent of the sample distribution. As expected, the competitive effect is generally reserved to the top 50 percent of the PMRA relatedness score.

The subsequent columns in table 4 introduce article-attribute moderators of the treatment effect. We began by investigating whether the competitive effect is offset when there is a direct, collaborative relationship between the authors of neighboring papers and the prize winner whose award treats their articles. In this case, we would expect the reflection of glory from the prize to be strongest, as direct collaborators of prize winners may even receive partial credit for the award. Model 3 of table 4 shows that the presence of an authorship tie between the HHMI and neighbor author sharply diminishes or even reverses the negative treatment effect: if the author of the scientific neighbor article has an HHMI coauthor, the paper suffers no loss of citations at the time the prize is granted. Likewise, model 4 provides marginally significant evidence that if an author of the neighbor article is a pre-prize collaborator of the focal HHMI prize winner, the negative treatment effect is offset (.173; $p < .10$). Of interest as a falsification test, model 5 includes an interaction effect for whether the author of the neighbor article collaborates with an HHMI-prize winner in the future. In this case, the scientific community is unaware of the collaboration at the time of the award because it has yet to occur. As expected, a future collaboration with the HHMI author does not confer current relief from the negative treatment effect.

By design, all neighbor articles in our dataset were published before the HHMI appointment was awarded and therefore they pre-date treatment. This enabled us to distinguish neighbor articles by whether or not they were directly cited by the focal HHMI article that resulted in treatment. Technically speaking, all neighbor articles were in the risk set of possibly citable papers when the treating HHMI article was published. Conditional on accounting for scientific proximity, we reasoned that direct recognition from the HHMI winner may shield neighbor articles from some of the negative effect of the prize. Just as pre-prize collaboration with an award winner may signal quality, third parties may infer that because a cited neighbor article informed or served as an input into a prize winner's work, it too is of high merit. Model 6 in table 4 shows that this type of implicit endorsement does significantly attenuate the negative treatment effect.

We next considered the effect of broader, ecological conditions on the nature of status spillover effects. Sociological arguments about endorsements focus on uncertainty as a crucial moderator of the potential benefits of high-status affiliations (Stuart, Hoang, and Hybels, 1999). Under conditions of certainty, judgments of quality are unaffected by social cues. To generate proxies for the level of ambiguity in judgments of scientific articles' quality, we investigated whether the treatment effect varies with the degree to which the HHMI article's intellectual space is developed prior to the prize's announcement. We measured the stature of HHMI-article-centric fields in two ways: the average number of citations accrued to neighbor articles of a given HHMI article by the year of appointment, and the average journal impact factor of the HHMI article's PMRA-related articles.

Models 7 and 8 of table 4 show that the negative treatment effect is especially pronounced for fields in the upper distribution of mean citations and journal status. Figure 4 illustrates these effects across the full range of the data. For HHMI article fields in the lowest 20 to 30 percent of baseline citations or journal impact factor, the treatment effect is actually positive. This suggests that for emerging scientific spaces in less prominent publication outlets, a prize to any member of the field boosts attention to all articles in the field, and an endorsement process overwhelms the competitive effect we observe elsewhere in the

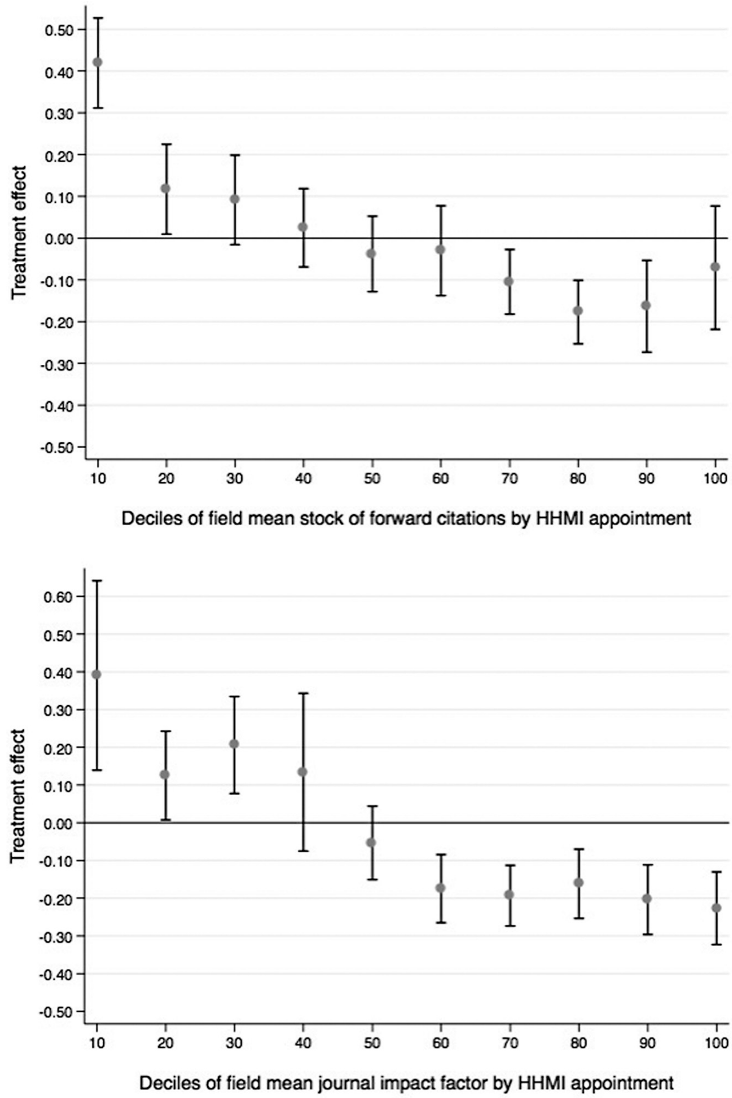
Table 4. Effects of Appointment on Citations to Neighbor Articles*

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Treated	–.069••	–.022	–.093••	–.091••	–.069••	–.118••	–.110••	–.189••	–0.009
	(.020)	(.034)	(.018)	(.017)	(.022)	(.020)	(.027)	(.024)	(0.036)
Treated × Top 50% PMRA score		–.083•							
		(.040)							
Treated × Shares an author with focal HHMI article			.195•						
			(.095)						
Treated × Has pre-appt. collaborator of focal HHMI				.173					
				(.102)					
Treated × Has post-appt. collaborator of focal HHMI					.002				
					(.039)				
Treated × Cited by focal HHMI article						.159••			
						(.047)			
Treated × HHMI article field in lower 50% of citations per article at baseline							.159••		
							(.041)		
Treated × HHMI article field in lower 50% of mean JIF at baseline								.305••	
								(.050)	
Treated × HHMI article in top 50% of citations in first year after HHMI appointment									–.132••
									(.048)
Number of HHMI investigators	393	393	393	393	393	393	393	393	393
Number of HHMI articles	1,801	1,801	1,801	1,801	1,801	1,801	1,801	1,801	1,801
Number of neighbor/control articles	46,668	46,668	46,668	46,668	46,668	46,668	46,668	46,668	46,672
Number of article-year observations	957,080	957,080	957,080	957,080	957,080	957,080	957,080	957,080	957,176
Log likelihood	–1,316,020	–1,315,729	–1,315,300	–1,315,436	–1,316,020	–1,315,098	–1,315,194	–1,312,286	–1,315,609

•$p < .05$; ••$p < .01$.

*Estimates stem from conditional quasi-maximum likelihood Poisson specifications. The dependent variable is the total number of forward citations (excluding self-citations and citations by the focal HHMI) received by each neighbor article or same-issue control article in a particular year. All models incorporate a full suite of article, calendar-year, and article-age fixed effects. Robust standard errors clustered at the level of HHMI investigators are reported in parentheses.

Figure 4. Treatment interaction with field size and field status.*



* Estimates of the treatment effect for deciles of field size (mean stock of citations received by the year before the relevant HHMI appointment; Panel A), or for deciles of field status (mean journal impact factor; Panel B) are plotted as gray dots; 95% confidence intervals corresponding to cluster-robust standard errors (clustered at the level of HHMI investigators) appear as black bars.

data. As a field matures and the value of its scientific endeavor is more assured, the implicit endorsement of a prize to one of the field's principal protagonists is no longer so significant to the legitimation of the overall field.

Sources of the Competitive Effect

We also considered mechanisms that might be behind the robust competitive effect we found. First, we investigated whether the negative effect for neighbor articles corresponds to positive gains for HHMI articles by incorporating in a treatment interaction the number of citations received by HHMI articles in the year immediately following appointment. We continued to compare neighbor articles with same-issue controls.[9] Model 9 of table 4 includes interactions between treatment status and an indicator that the article's relevant HHMI article is in the top 50 percent of citations received the first year after the appointment announcement. Similar to the results found for the PMRA score interaction (model 2 of table 4), the competitive effect is reserved for articles neighboring HHMI articles in the top 50 percent of citations in the year after appointment: articles neighboring HHMI articles experiencing an especially large gain in attention post-appointment are themselves especially susceptible to a decline in attention. Figure 5 plots the interaction of treatment and deciles of HHMI article citation changes.

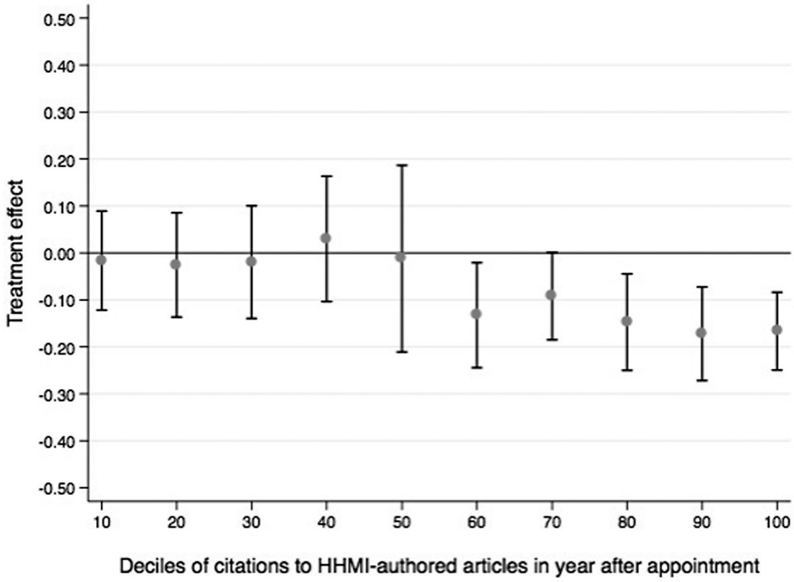
This result suggests the competitive effect may arise from the direct transfer of attention from neighbors to award winners, though we have reason to believe that other processes are also at play. In their study of the Matthew effect in our context, Azoulay, Stuart, and Wang (2014) found evidence of only a modest benefit in citation rates to HHMI appointees because of their award. Though we necessarily employed a different research design than those authors, we suspect that the loss of citations to neighbor articles is not simply recaptured by the prize winner alone—the results are driven by more than just a transfer of attention from neighbors to prize winners.

One ironic possibility is that the negative treatment effect of a prize on scientific neighbors may arise from acts of deference to award winners. If the scientific community perceives an award as associating ownership of a particular corner of the scientific landscape to the lab of the winner and his or her close associates, there may be a decline in subsequent entries of scientists working in the areas of prize winners. Authors who do enter award-winning fields after the bestowal of a prize may do so at a greater scientific distance from the winner (and the winner's nearest neighbors) in deference to the winner's implicit ownership of scientific turf. The upshot is that those who would otherwise attend to the activities of prize winners and their neighbors cede prize-adjacent science to others, resulting in a decline in citation rates to near neighbors. We find suggestive evidence that this is occurring in the data. To examine deference, we decomposed the dependent variable into two complementary counts. We used the PMRA algorithm to distinguish citations that come from two different sources: papers within a focal article's PMRA (i.e., very near neighbors) and articles outside of the focal article's PMRA. This allowed us to estimate the treatment effect on both sources of attention and compare the estimated magnitudes.

In models 1 and 2 of table 5, the dependent variable is the number of citations to a given neighbor article or control article from papers within its sphere of PMRA-related articles. In models 3 and 4, the dependent variable is citations from papers outside this sphere. We estimated the models using only neighbor articles and control articles with variation in both dependent variables, so that

[9] We retained same-issue controls to identify whether neighbor articles do absolutely better or worse following appointment. Directly comparing neighbor articles with HHMI articles risks confounding: a disparity between these articles could occur due to the HHMI articles receiving more attention post-appointment irrespective of any change to neighbor articles.

Figure 5. Treatment interaction with citations to HHMI-authored articles one year after appointment.*



* Estimates of the treatment effect for deciles of citations to HHMI-authored articles in one year after appointment are plotted as gray dots; 95% confidence intervals corresponding to cluster-robust standard errors (clustered at the level of HHMI investigators) appear as black bars.

the subsamples for these regressions are identical.[10] The treatment effect remains negative in both models 1 and 3, but a one-sided Wald test suggests a strongly statistically significant difference in magnitudes of the main effect: the loss of citations from within-field alters is more than 2.5 times the magnitude of the loss from out-of-field papers. In short, relative to patterns in control fields, the treatment effect is driven primarily by a loss of within-PMRA citations. After an HHMI award is announced, articles that are later produced in a scientific neighbor's PMRA set are less likely to cite the focal neighbor article, relative to the base rates established in control fields.

This decomposition of citations also illuminates the source of the gains to award winners and their immediate affiliates. Model 3 of table 4 showed that neighbor articles that share an author of the HHMI article—either the HHMI appointee or his or her coauthor—receive a comparative increase in citations after the award is announced. In models 2 and 4 of table 5, we again introduce the treatment and author overlap interaction. We see that papers with direct authorship ties with the focal HHMI article are largely buffered from the loss of citations from within the field, but they experience a marginally significant gain (.244; $p < .10$) in citations from outside the field. This suggests that the added attention to prize winners and their clique of close associates results primarily from a broadening of the domain's audience that

[10] One consequence of this constraint is that a few HHMI scientists and their HHMI papers are no longer represented in the sample. In an unreported analysis, we estimated the average treatment effect on non-decomposed citations, and our effect is robust to this loss of observations.

Table 5. Effects of Appointment on Citations to Neighbor Articles*

	(1) Citations (within field)	(2) Citations (within field)	(3) Citations (out of field)	(4) Citations (out of field)	(5) Percent MeSH overlap with citing papers
Treated	–.219••	–.241••	–.062•	–.095••	–.003••
	(.027)	(.028)	(.025)	(.024)	(.001)
Treated × Shares an author with focal HHMI source		.218••		.244	
		(.053)		(.136)	
Number of HHMI investigators	382	382	382	382	393
Number of HHMI articles	1,563	1,563	1,563	1,563	1,801
Number of neighbor/ control articles	24,110	24,110	24,110	24,110	24,110
Number of article-year obs.	507,910	507,910	507,910	507,910	507,910
Log likelihood	–289,107	–289,052	–735,147	–734,481	691,790

• $p < .05$; ••$p < .01$.

*Estimates are from conditional quasi-maximum likelihood Poisson (models 1-4) or linear fixed effects regression (model 5) specifications. The dependent variable for models 1–4 is the total number of forward citations (excluding self-citations and citations by the focal HHMI) received by each neighbor article or same-issue control article in a particular year, with restrictions on whether the citations were from within the field (models 1–2) or from outside the field (models 3–4). The dependent variable for model (5) is the average percent of Medline Subject Heading (MeSH) keyword overlap between a treated or control paper and its citing papers. All models incorporate article, calendar-year, and article-age fixed effects. Robust standard errors clustered at the level of HHMI investigators are reported in parentheses.

bestows a highly selective benefit to prize winners and their associates rather than to the overall field.

Together, the findings in table 5 tell us that a subtle shift is at play. Right or wrong, awards clarify the attribution of scientific credit (Merton, 1968), so when scholars produce new articles in the vicinity of prize winners, they may keep a slightly greater distance to stand a better chance of staking a claim. Model 5 of table 5 provides further evidence that this is occurring. In this model, the dependent variable is a measure of keyword overlap between the focal neighbor article and the citing articles that arrive in a given year. This was constructed by retrieving the sets of MeSH keywords for each neighbor article and citing article pair, dividing the intersection of their keyword sets by the union, and averaging within citation years. Ordinary least squares regression with article fixed effects estimates a negative treatment effect: compared with controls, neighbor articles experience a decrease in average MeSH overlap after the prize. Considering this model and previous results, we see that neighbor articles receive fewer citations post-prize than would be expected and that the citations they do receive are generally from papers further away in scientific space. Thus the results of table 5 hint at an additional explanation of why neighbor article citation rates continue to decline relative to control articles. Whereas HHMI award winners may amass more attention and (in time) more scrutiny, neighbor articles' pool of followers may shrink: there are simply fewer people prospecting in the neighborhood.

Robustness Checks

Because we included article fixed effects and found almost no difference between treated and control citation trends in the pre-HHMI appointment period, we are confident that the competitive effect of status on neighbors is not attributable to stable article-level differences or dynamic shocks (other than treatment). Still, we conducted many additional analyses to test the validity of the findings, and these results are presented in the Online Appendix (http://journals.sagepub.com/doi/suppl/10.1177/0001839217731997).

First, as an additional check on article-level heterogeneity, we employed coarsened exact matching to improve on randomly selected same-issue controls (Iacus, King, and Porro, 2012), selecting control and neighbor articles that have nearly identical pre-HHMI citations. Using treated and control panels matched on pre-appointment citation stocks, we again estimated a nearly identical, negative average treatment effect.

Second, we examined the potential role of field heterogeneity in explaining our results to ascertain whether the decline in citations observed in the treated articles coincides with a cresting in the activity level in a field just before HHMI appointment. Under this alternative explanation of the findings, the negative effect associated with HHMI appointment would not be due to a causal effect of status spillovers but rather to a selection bias imposed during the assignment to treatment. We undertook several analyses to understand the influence of field heterogeneity. To examine relative field size, we retrieved the PMRA sets for each treated article and random, same-journal-issue control paper and tabulated field sizes at treatment. Before further filters, the treated neighbor articles are related to 125.8 articles on average, while the control articles are PMRA-related to 102.6 papers (see table A1 in the Online Appendix). Therefore treated articles exist in fields that are almost 25 percent larger than control fields. To eliminate this source of field-level heterogeneity from the results, we identified same-journal-issue control articles that match on PMRA field size counts using coarsened exact matching. When we estimated the treatment effect while matching on field size, the average treatment effect remained negative and statistically significant.

We also created two measures of field maturity to compare the scientific fields of treated and control articles: the time elapsed since the earliest PMRA-related paper was published in the field and the average age of the MeSH keywords assigned to the papers in each field. Results are substantively similar (see the Online Appendix). If anything, our original control fields are very slightly more mature than treated fields. The results are robust in coarsened exact matching regressions that select control articles to match on the field maturity measures.

Finally, we reassembled the data panels in a very different manner. We identified a group of scientists who completed their terminal degree at the same time as the HHMI appointees and had accumulated similar counts of career citations by the time of the HHMI appointment. Next, we retrieved the publications of this group of "pseudo-HHMIs" that appeared during the same period as our HHMI-authored source articles and retrieved the papers related to these pseudo-HHMI source articles. Then, for each HHMI neighbor article, we selected a same-journal-issue control article that was a member of this superset of pseudo-HHMI related papers. Results shown in the Online Appendix indicate that if anything, the pseudo-neighbor papers are from fields with more activity than HHMI-neighbor papers. Again, we find that the average treatment effect estimated with these panels is consistent with a competition effect. In all, across multiple reconstructions of the control group, we find robust evidence of negative status spillover effects.

DISCUSSION

The results of this study provide a deeper understanding of how one actor's recognition shifts the fates of the many peers engaged in similar undertakings. Existing theories imply conflicting expectations of the consequences of status shifts for social neighbors. Under an endorsement account, status gains to the few result in positive reevaluations of the social standing of the many, as positive social recognition is reflected onto neighbors. Under a competition account, status elevations induce even greater stratification in a community because attention that otherwise would have targeted neighbors is either crowded out or diverted to another location.

The allocation of attention generally is driven by two questions: "Which domain?" and "Which actor or product in a given domain?" These questions correspond to Zuckerman's (1999) two-stage "categorical imperative" model: audiences first consider whether objects conform to a given cognitive category and then assess the differences among objects deemed members of the consideration set. The categorical imperative may be generalized to conditions in which the categorical options are not known in advance: in many areas of creative endeavor, producers and consumers often find themselves considering what domain(s) to enter next, including areas that they have attended to previously. In the context we study, prizes in the biomedical sciences, the allocation of effort is the outcome of a search across a set of interconnected fields and then a choice about a specific point of entry within a field. This process constantly unfolds as researchers initiate new projects and change the direction of existing ones.

Our findings suggest that positive status shocks invoke categorization processes that can adversely affect those in the neighborhoods of winners' areas of endeavor. The bestowal of a prestigious prize generally decreases attention to the winner's area of activity compared with what we would expect if a prize had not been awarded. One explanation is that prizes render neighborhoods synonymous with the activities of prize winners. Though this may solidify categorical boundaries, a potential consequence for attention-allocating audiences is a narrowing of perceived entry criteria, thus limiting follow-on activity in the domain. A variation of this explanation that is especially intriguing in scientific contexts is that a prize may transform a previously contested terrain into a more clearly undisputed one and, in the process, define canonical works that become de facto references for an idea. With decreased entry into the neighborhood and decreased variation in what outside audiences attend to, aggregate attention to the area actually atrophies relative to what would occur if a prize were not awarded.

In technical, scientific, and cultural markets, a core function of prizes is to contour the allocation of producers' efforts and audience members' attention. The literature shows that prizes and other markers of prestige adjust participants' focal points in these markets. But a narrow view of prizes misses their full ecological consequences, in which recipients' bumps in status diffuse throughout the neighborhoods of their endeavors. We generally find that in this diffusion, competition swamps endorsement. We present striking and consistent evidence that scientific output in the intellectual vicinity of work by accolade-winning scientists experiences a sizeable and persistent decline in the rate of attention after prizes are announced.

In assessing these results, it is vital to bear in mind that the experiment we ran is unlike prior research on the subject. The treatment effect in our paper is not the effect of the prize on the winner's work; it is the effect of the prize on the fates of the preexisting output of the winner's neighbors. Likewise, the yardstick against which the fates of these treated articles are computed is not based on prize winners themselves but on comparable science that was not subject to any recent change in status. Had the neighbor articles in our data not been indirectly exposed to prize winners via scientific adjacencies, they would have enjoyed more prolonged attention from the scientific community.

There is a growing interest in the potential negative consequences of status mobility. Jensen and Kim (2015) investigated the personal-life effects of Academy Award nominations. That work shared our interest in the externalities of prizes, though their work focused on nominees' private lives and ours concerns the proximate cultural domain in which elevated actors are embedded. An interesting marriage of their work and ours would be a domain-focused project in the context of film that might examine the ramifications of, say, Best Picture awards on the films reflecting a similar genre or subject. More generally, much of the current literature on negative effects of status shocks focuses on status deprivation or other social-psychological accounts of winners' or non-winners' subsequent travails. Conversely, our results, along with Kovacs and Sharkey's (2014), provide support for audience-side mechanisms for negative spillover effects.

Though we find that status shocks generally induce an aggregate negative spillover to a prize winner's neighbors, we believe that this effect arises because the competitive effect dwarfs endorsements in magnitude—not because there is an absence of positive status spillovers. In some of our data, there is clear evidence of endorsements. For instance, in new subfields of science and those with low cumulative grant funding, neighboring articles from the pre-prize period benefitted from the announcement of awards in their scientific proximity. It is useful to return to Podolny's (2001) distinction between two forms of uncertainty: the uncertainty of the best way to convert inputs into outputs in a manner that other parties will value (egocentric uncertainty) and the quality of focal actors (altercentric uncertainty). Both types may be pertinent concerns in undeveloped scientific fields, which is precisely the kind of context in which we expect legitimation from categorical affiliations to matter most. Here, not only is the quality of a given scientist uncertain, but the value of the scientific enterprise in that area is as-yet undetermined. In such conditions, one actor's elevation in status indicates that his or her neighbors have also made the right bet and positions them as the foundation for subsequent entry in the space. Subsequent endeavors will be more attentive to establishing the identity of the space, rather than differentiating among actor quality (Kennedy, 2005).

A distinct aspect of our empirical context is that the actors producing content and those bestowing recognition in the form of citations are one and the same: scientists are both the producers and consumers of research. It is worth considering whether the finding of the dominance of competition over endorsement would hold in settings without an ''audience of experts.'' Theory suggests that if anything, the results should be dampened in contexts in which experts sit on both sides of the market, as they do in academia. Relative to general audiences, scientists as expert consumers should be adept at judging the underlying quality of research and thus should be less susceptible to social distortions in their judgments of merit. In other words, comparable tests of the degree and magnitude of status spillover effects should be larger in markets in which consumers of a good have less expertise than producers. Consistent with this view, Heinich (2009) offered a theoretical comparison of the impact of artistic and scientific prizes. She considered prizes to be critical in both domains, but because of the enormous uncertainty around value in artistic fields, prizes in literature and the arts are potentially much more significant in their effect than awards of equivalent prestige in science.

This brings us to one of the important boundary conditions of the paper that, fittingly, is itself about boundaries. Millions of scientific articles are published each year, and vast quantities of works are created in art, architecture, and cinematography. If these titanic bodies of work are like large seas, the effect of a scarce, status-creating prize is like dropping a rock in the sea. The accolade influences the career of its recipient for sure, but the prize also creates a splash in one area—a scientific field in our project—and its effect then ripples across adjacent areas of work. To truly understand the ecological effects of the status dynamics of prizes, it may be necessary to observe the entire sea. Thus the questions we examine in this project require researchers to confront the classic social scientific challenge of a micro-to-macro linkage to truly understand the full ecology of a status effect in markets. The broader questions of how status shocks affect social, scientific, economic, and cultural communities remain open.

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