

How New Ideas Diffuse in Science

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Extended Abstract

Why do some new ideas have long and varied careers, diffusing extensively, while others find limited use and are quickly forgotten? While many new publications, inventions, and products offer novel intellectual contributions, only some stick, spread, and get meaningfully integrated into our collective understanding and knowledge base. Understanding how and why this happens is the focus of this article. This question is pressing to consider in our contemporary knowledge-based, internet-driven society, where people of all backgrounds are inundated with a dizzying and ever-expanding array of new ideas competing for their attention. Moreover, new ideas are foundational to sustained scientific and technological advance as well as to effective policymaking, and economic progress.

Extensive literatures in the history of science, sociology of knowledge and science, and management sciences explore the conditions that promote the development and widespread adoption of new ideas. The bulk of this literature emphasizes social factors to explain ideational diffusion. Based on these “externalist” accounts, a new idea spreads due to its social context: the individual actors who create, champion, frame, and manage it (Rogers 2010); the interconnections these actors share with other actors in the wider community and network (Uzzi and Gillespie 2002); and even material matters such as funding, institutional resources, and differential status and prestige (Bourdieu 1988). Rightfully, in explaining an idea’s diffusion, these accounts look to the identities, relationships, resources, and aims of the people who carry it widely and who continue to work on it at length. Yet, there is a complementary perspective to those that emphasize social factors of ideational diffusion. These accounts look to the cultural and ideational context of an idea (Toulmin 1972). According to these “internalist” accounts, the diffusion of a new idea is predicated on its comprehensibility and coherence (McDonald and Mair 2010), its relationship to established paradigms and thought styles (Kuhn 1970), and its pragmatic usefulness to solve problems and resonate with the intellectual and cultural moment (Hallett, Stapleton, and Sauder 2019).

The reality is that both external and internal conditions matter jointly and dynamically, depending on the new idea’s own idiosyncratic career. Drawing on these extensive literatures, we build and test a theory of diffusion that combines both external and internal factors (i.e., social and ideational factors). In particular, we argue that a new idea—in this study’s case, a new scientific idea introduced in published journal articles—diffuses when its authors have social prominence, span diverse, distal research collectives, and have consistent champions. We additionally argue that an idea is likely to diffuse when it is linked to prominent scientific facts, when it is deeply integrated into extant research traditions, and when it achieves coherence through consistent conceptual linkages to the established body of knowledge. Yet, we move beyond a simple additive theoretical model that combines social and ideational factors. We argue ideas have careers: that these ideational and social conditions change over time and that these changes, in turn, correspond with a new idea’s propensity to diffuse at different stages of its lifetime. Our findings suggest a developmental story where an idea’s continued appeal depends on a changing cast of characters and associated uses. An idea’s meaning and position within ideational and social contexts is a diachronic process, and historically contingent shifts in its meaning have consequences for its diffusion over time.

To test this theory of diffusion, we assemble a comprehensive dataset (~7 billion token words from 38,578,016 articles of the Web of Science (WoS), 1900-2016), using advanced natural language processing (NLP) techniques, socio-semantic network analysis, and over-dispersed Poisson regression adapted to a multilevel context. Specifically, we extract scientific ideas from articles, identify which are new, and then trace their diffusion process across published articles over time. By identifying the authors and neighbor terms associated with these new ideas within and across articles, we capture each new idea's networks of collaborating authors and networks of interrelated concepts. We then aggregate these networks over distinct periods to reflect a new idea's changing social and ideational context. In so doing, we develop a longitudinal ecological depiction of how new scientific ideas vary in their diffusion and how such variation corresponds with their adapted use. Finally, we use interaction models to identify when these conditions are associated with a new idea's propensity to diffuse.

This article's depiction of the diffusion of new ideas changes our understanding of scientific development in several ways. First, it offers a comprehensive view of how new scientific ideas diffuse by analyzing a large, longitudinal corpus of scholarship that spans heterogeneous fields of knowledge for over twenty years. Second, it measures ideas in a more refined way by observing them as discrete new terms (not as whole articles) and it traces diffusion as the incorporation of these ideas within later articles (not as mere citation). Third, it integrates externalist and internalist accounts, identifying conditions under which new ideas find both social and intellectual resonance (or lack thereof), and shows how this relates to their future adoption. In particular, new ideas find intellectual resonance when they are consistently and intelligibly used, address valued intellectual problems (e.g., core to science and embedded in research traditions), and they find social resonance when they achieve social reach. Last, the article depicts adaption as an important feature of ideational diffusion. Scholarly ideas are slow to take hold, and it is only after they get some traction that conditions of intellectual and social resonance have greatest influence.

This study contributes to our understanding of how new ideas diffuse. It is not simply the case that ideas diffuse when they have champions or star entrepreneurs. It is also not simply a question of the status and resources of an idea's authors. These matter, certainly, but we find that they matter in conjunction with an idea's *cultural resonance* (Hallett et al. 2019): its relations to the established body of knowledge, its coherence and consistency, and its association with prominent other ideas. Internal and external ecologies matter for both minor and major ideas. And they set off different trajectories helping us understand how some new ideas continue to diffuse in science while others peter out and disappear.

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