

Large Teams Develop and Small Teams Disrupt

Discussion on the Implications for
Science Funders

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Large teams develop and small teams disrupt science and technology

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Increased team size: complexity of modern problems that require interdisciplinary solutions and improvements in communication

Assessment:

How does the character of S&T produced by large teams differ from the produced by small teams? Where does the biggest innovation (disruption) come from?

Analysis:

- 42 million papers from Web of Science, 1954-2014 / 611 million citations
 - 5 million patents from US PTO, 1976-2014 / 65 million citations
- 16 million software projects from GitHub, 2011-2014 / 9 million forks.



Background and Claims

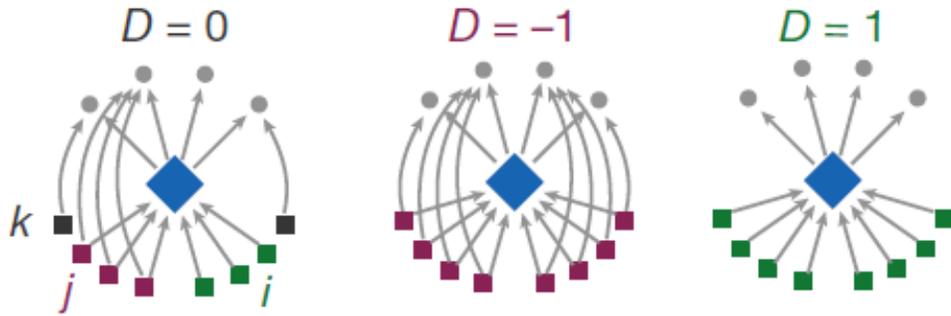
Small Teams	Large Teams
Publish more disruptive work	Develop existing work
Undertake new, untested opportunities with potential for high growth or failure	Focus on sure bets in large markets
Search literature more deeply	Build on recent/popular developments
Succeed further into the future – more disruption / innovation	Garner attention immediately – more citations
Generate more ideas	Neutralize each other's viewpoints
Recall more learned information	Reject external perspectives more often

Publications become less disruptive over time
Teams with federal funding are less disruptive



Definitions

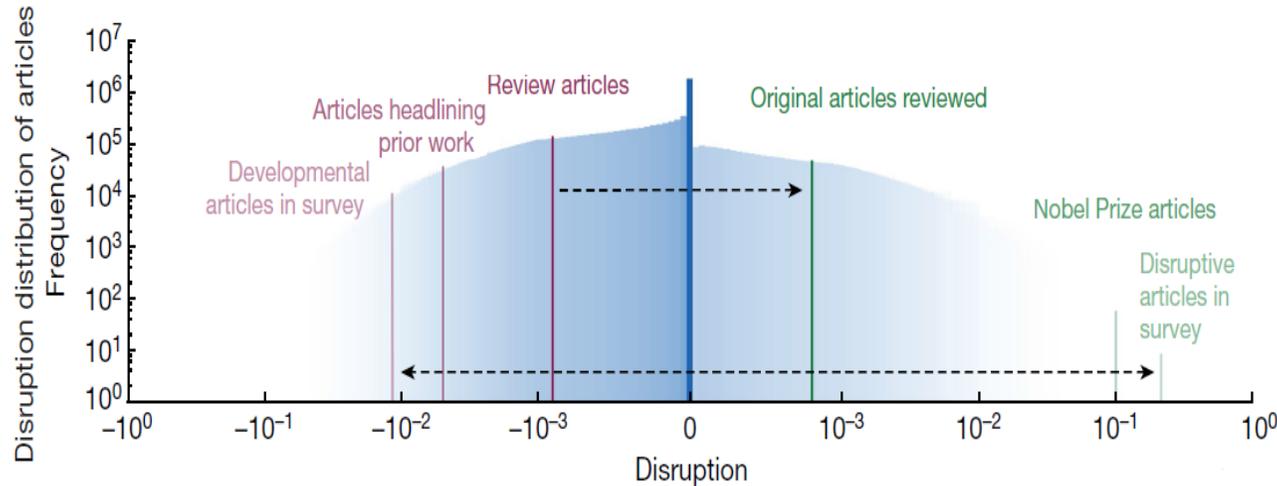
Developmental Disruptive



Disruptive research breaks the path of acknowledgement to former work on which it builds.

- Referenced paper
- ◆ 'Focal' paper
- ■ Subsequent citing works

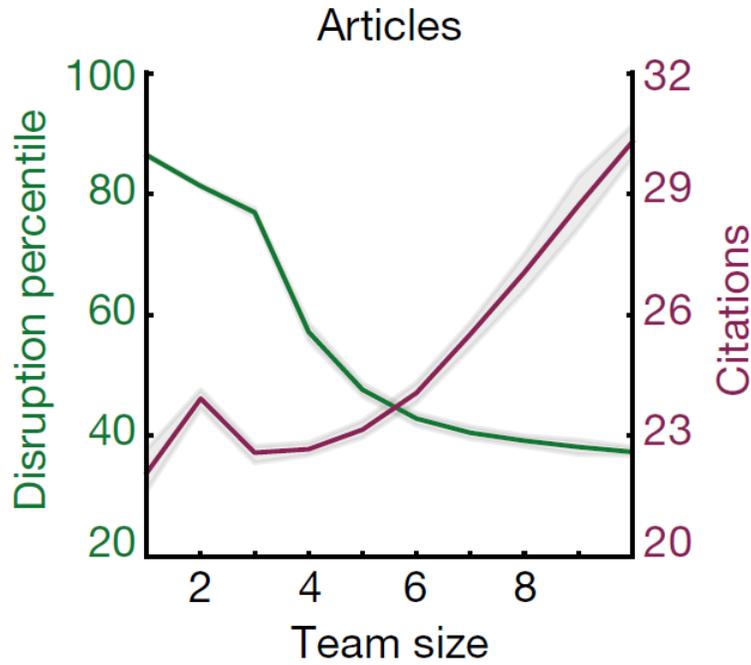
$$\text{Disruption: } D = p_i - p_j = \frac{n_i - n_j}{n_i + n_j + n_k}$$



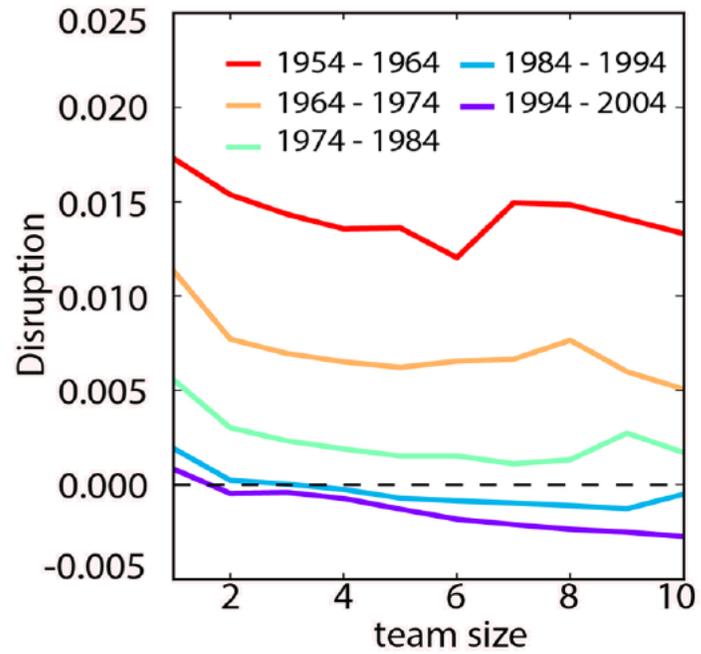
The majority of publications are “developmental” in nature



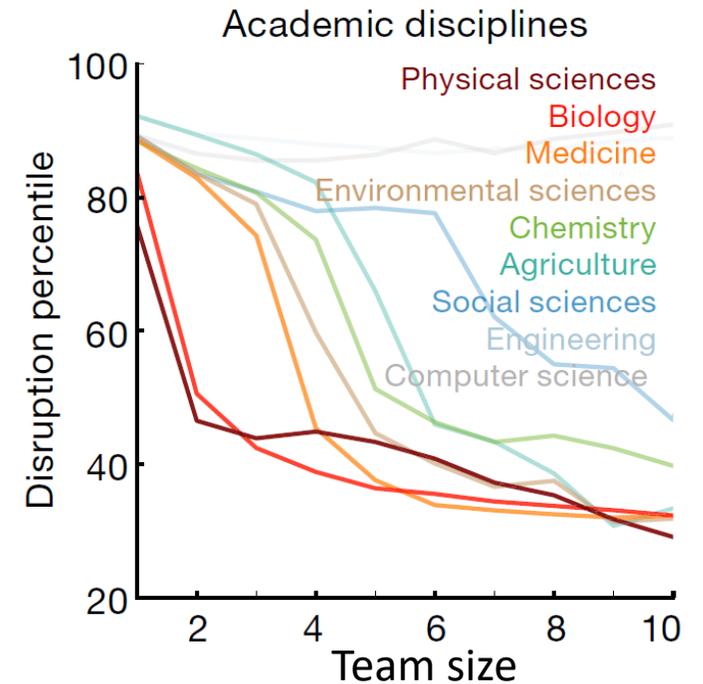
Disruption Across Time and Discipline



Across all fields and times, the average publication from a small team is more disruptive. The average publication from a large team is more widely cited.



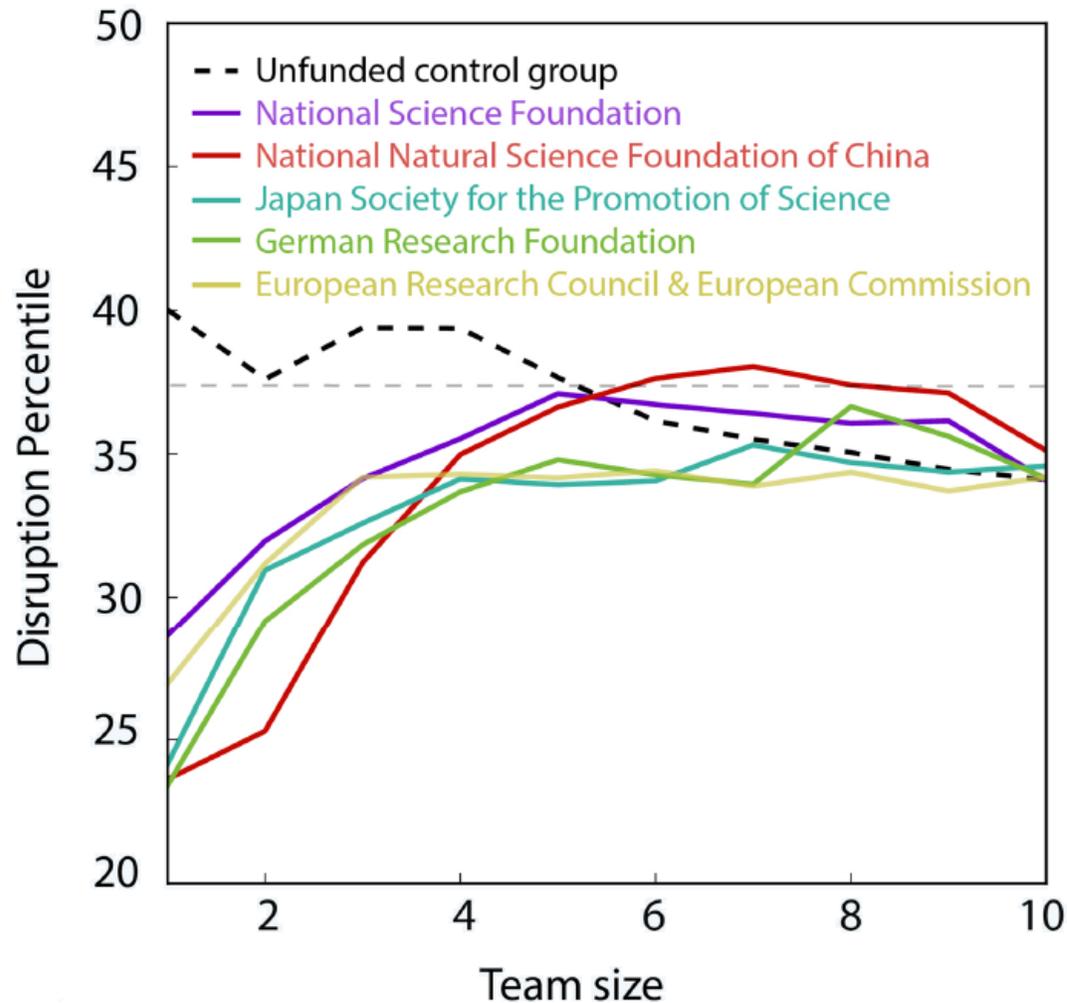
Older publications are more disruptive; newer publications are more developmental



The relationship between disruption and team size varies widely by discipline. Physical Sciences are quite sensitive to team size while Eng. and Comp. Sci. has little relationship.



Funding and Disruption



- Considers only acknowledged funding – if no funding source is acknowledged publication is considered “unfunded.”
- Funded small teams are less disruptive than unfunded teams. Funded large teams are as disruptive as unfunded large teams.

Questions for Discussion

- Given your knowledge of the field, are the conclusions of this paper correct? If not, why not?
- Assuming the conclusions are correct:
 - What should MPS consider in balancing small teams and large teams in each division? Within initiatives?
 - How can NSF encourage more disruptive ideas in larger teams?
 - How do we encourage less conservative awards?

