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Two's company: how scale affects research groups

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Section 4:
Behind the data

Two's company: how scale affects research groups

Matthew Richardson

In the 1880s, French agricultural engineer Max Ringelmann carried out a series of experiments exploring how much people put into task in individual and group settings. To do so, Ringelmann had male students pull on a rope and measured the force exerted, first individually and then when they were part of a team. Ringelmann found that while the overall performance increased as students were added to the team, the average performance exerted per worker, or individual performance, decreased linearly with each additional worker[1]. In other words, if each individual had put their effort into their own work, the result would have been greater than when they worked as a team. The effect would come to be studied by social psychologists throughout the twentieth century looking at group performance, but, until 1986, the earliest known source of information about Ringelmann's studies was a 1927 paper by the German industrial psychologist Walther Moede.

In 1974, Alan Ingham and colleagues performed similar rope-pulling experiments in an attempt to verify the existence of the Ringelmann effect[2]. Their findings showed individual performance to decrease significantly with the first few additional co-workers, up to a group of three workers – beyond which additional workers did not significantly decrease individual performance. Ingham et al. described two possible causes for the decrease in individual performance: "It remained unclear whether group members pulled less hard because of incoordination or because of losses in motivation"[2]. Controlling for incoordination in a further experiment in which an individual pulled on the rope – but in some cases believed he was part of a group – the study found a very similar pattern of decreased performance, showing that loss of motivation occurred when co-workers (whether perceived or real) were added to the team.

Ringelmann in research

The Ringelmann effect has real implications for scientific research. Scientific researchers are not simply pulling a rope in unison – but if individual performance decreases as additional researchers come to work on a particular problem, this makes large-scale research projects an unattractive prospect not only for individuals, but also for funding bodies. As Andrea Bonaccorsi and Cinzia Daraio put it, "pressure on public budgets in almost all industrialised countries has led governments to pursue (or at least declare they pursue) efficiency in the allocation and management of resources in the public research sector. The increasing societal demand for accountability and transparency of science also makes it important to demonstrate that public funding follows clear rules"[3].

Ton van Raan has investigated the relationship between a variety of bibliometric indicators of size and research quality, at the level of the research group[4]. Van Raan states that "[t]he research group is the most important working floor entity in science, as clearly shown by the internal structure of universities and research institutes"; however, van Raan goes on to say that obtaining data at the level of a research group is far more difficult than for individual authors, institutes or even for whole countries: this is because research groups are not captured in the bibliographic fields attached to papers, such as author names or institutional addresses.

Sizing up subject fields

When Ralph Kenna and Bertrand Berche started to investigate the relationship between the size of a research group and the performance of those groups, they turned to the UK's Research Assessment Exercise (RAE) as a source of data. The RAE captures data regarding not only the quality of research groups, but their field of research and size. In a rapid chain of papers, Kenna and Berche have compared the sizes of research groups in various fields with the quality assigned to those groups' research[5–9]. Their findings have shown that in every field, there exists a critical mass for increased productivity, with an upper and lower boundary. The lower boundary relates to the classical notion of critical mass, "loosely described as the minimum size a research team must attain for it to be viable in the longer term"; between the lower and upper boundary for critical mass, "the overall strength of research teams tends to rise quadratically with increasing size"; beyond the upper boundary, "research quality levels out".

The basic implication is that "this levelling off refutes arguments which advocate ever increasing concentration of research support into a few large institutions", and their research shows optimal research group sizes in a number of disciplines8. Lately, Kenna and Berche have even used their approach to develop a method of normalizing quality between different research disciplines[9].

While Kenna and Berche have developed a way to analyze the effect research group size on its overall performance, issues remain regarding how research groups can be assessed. Currently, data supplied for national research assessment programs seem to be the best option, where available; however, tools such as SciVal Strata are starting to address the problem, opening up ways of assessing research groups by citation analysis. (For more information on this approach, the reader is referred to the article by Judith Kamalski and Colby Riese in this issue.)

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