Title: Big team science as a response to urgent societal developments

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ßßSupplemental Materials: The work focuses on a near-population of articles linked to keywords “terrorism”, “COVID-19”, and “ChatGPT”. These records were accessed in September 2024 (October 2024 for COVID-19 records) via OpenAlex: an open-source bibliographic catalogue of scientific papers.

Records were removed if they (a) had duplicative DOI’s, (b) did not contain any authorship meta-data, or (c) were published before an event signaled the societal development. For the latter, terrorism papers had to be published after the date of the attacks (September 11, 2001); COVID-19 records had to be published after the first cases emerged in November 2019; ChatGPT records had to published after the public release of the tool (November 30, 2022). This left us with *N* = 289,986 terrorism papers, *N* = 1,824,565 COVID-19 paper, and *N* = 35,940 ChatGPT papers.

Team size was extracted using OpenAlex authorship meta-data. Because there is no precise definition of “big team science” (Baumgartner et al., 2023), the present work describes multiple granular operationalizations: publications with (a) 10 - 19 authors, (b) 20 - 29 authors, (c) 30 - 39 authors, (d) 40 - 49 authors, (e) 50 - 59 authors, (f) 60 - 69 authors, (g) 70 - 79 authors, (h) 80 - 89 authors, (i) 90 - 99 authors, and (j) 100+ authors. These big team efforts are compared to publications with relatively smaller teams of 1 - 4 and 5 - 9 authors.

For publication speed, we used OpenAlex publication dates to determine how many days had passed since an event signaled an urgent societal development. For terrorism papers, we used September 11, 2001. For COVID-19 papers, we used the date the World Health Organization declared a pandemic (March 11, 2020). For ChatGPT data, we used the date the tool was made publicly available (November 30, 2022).

Descriptive statistics

Tables S1 (terrorism research), S2 (COVID-19 research) and S3 (ChatGPT research) contain descriptive statistics for research speed and mentions in scholarly articles, news outputs, and policy documents.

Examination of big teams in research on terrorism

As mentioned in the main text, research on terrorism has been overwhelmingly published by relatively small teams. However, a sizeable number of papers (*N* = 2,693) had 10 or more co-authors. An examination of their impact reveals diminishing returns.

First, consider the *N* = 2,131 articles that had between 10 and 39 articles. Compared to papers co-authored by small teams of 1 – 4 co-authors, these larger collaborations tended to be published later in time. However, these larger collaborations also tended to receive more mentions in scholarly articles, news outputs, and policy documents (Fig. S1). However, impact diminished in the rare instances (N = 208) where researchers published papers with 40 or more co-authors. Based on the limited evidence available, we offer the tentative conclusion described in the main text: ultra-large collaborations on terrorism yielded diminishing returns in terms of impact (Fig. S2).

Examination of ultra-large (and ultra-rare) collaborations in research on ChatGPT

The main text focuses on articles with up to 39 co-authors (Fig. S3) because there isn’t enough data to speak confidently about larger collaborations. For example, there are only *N* = 19 articles with 40 – 49 co-authors, *N* = 6 articles with 60 – 69 co-authors, and *N* = 1 article with 80 – 89 co-authors (Table S1).

Based on the limited evidence available for these ultra-large collaborations, we offer this tentative conclusion: increases in team size were reliably associated with increases in mentions in scholarly articles; for mentions in policy documents and the general population, however, the biggest teams exhibited diminishing returns (Fig. S4).

**Fig. S1. Impact and response time of research conducted on terrorism.** Average value (y-axis) of scholarly article mentions, news output mentions, policy document mentions, and response time (panels) for teams of various sizes (x-axis). Dots represent means and error bars represent one standard error.

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**Fig. S2. Impact and response time of research conducted on terrorism (ultra-large collaborations included).** Average value (y-axis) of scholarly article mentions, news output mentions, policy document mentions, and response time (panels) for teams of various sizes (x-axis). Dots represent means and error bars represent one standard error.

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**Fig. S3. Impact and response time of research conducted on ChatGPT.** Average value (y-axis) of scholarly article mentions, news output mentions, policy document mentions, and response time (panels) for teams of various sizes (x-axis). Dots represent means and error bars represent one standard error.

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**Fig. S4. Impact and response time of research conducted on ChatGPT (ultra-large collaborations included).** Average value (y-axis) of scholarly article mentions, news output mentions, policy document mentions, and response time (panels) for teams of various sizes (x-axis). Dots represent means and error bars represent one standard error. Error bars are not plotted in instances with insufficient data (e.g., access to only one observation).

**A group of graphs showing the results of a report

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**Table S1. Terrorism research speed and mentions in scholarly articles, news outputs, and policy documents.** For each team size range, mentions are described in terms of both raw and percentile-transformed values. Also described is the number of articles indexed in OpenAlex (*n*) and the proportion of those articles that received mentions. NA’s refer to instances where there was no available data. Also described is response time, in terms of number of days since a notable event signaled an urgent development.

|  |  |  | **raw** | | **percentile** | |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **mentions** | **team size** | ***n*** | ***M*** | ***SD*** | ***M*** | ***SD*** | **proportion of articles mentioned** |
| scholarly articles | 1 - 4 | 271588 | 14.91 | 72.04 | 41.43 | 35.41 | 0.63 |
| scholarly articles | 5 - 9 | 15705 | 27.05 | 93.71 | 55.89 | 34.81 | 0.77 |
| scholarly articles | 10 - 19 | 2108 | 34.14 | 164.22 | 53.4 | 37.02 | 0.72 |
| scholarly articles | 20 - 29 | 292 | 32.98 | 89.51 | 49.24 | 38.81 | 0.67 |
| scholarly articles | 30 - 39 | 85 | 43.91 | 207.33 | 45.91 | 38.39 | 0.65 |
| scholarly articles | 40 - 49 | 26 | 73.38 | 255.82 | 33.57 | 39.59 | 0.46 |
| scholarly articles | 50 - 59 | 31 | 59.61 | 217.71 | 35.51 | 40.17 | 0.48 |
| scholarly articles | 60 - 69 | 73 | 2.16 | 12.82 | 10.94 | 23.28 | 0.21 |
| scholarly articles | 70 - 79 | 21 | 37.38 | 74.87 | 29.3 | 41.71 | 0.38 |
| scholarly articles | 80 - 89 | 4 | 35.5 | 36.99 | 75.81 | 23.34 | 1 |
| scholarly articles | 90 - 99 | 2 | 0 | 0 | 0 | 0 | 0 |
| scholarly articles | 100 + | 51 | 754.18 | 2220.76 | 42.38 | 45.78 | 0.49 |
| news outputs | 1 - 4 | 271588 | 0.68 | 6.74 | 13.58 | 32.32 | 0.15 |
| news outputs | 5 - 9 | 15705 | 1.39 | 8.51 | 16.04 | 34.83 | 0.18 |
| news outputs | 10 - 19 | 2108 | 2.97 | 21.53 | 19.85 | 37.96 | 0.22 |
| news outputs | 20 - 29 | 292 | 5.12 | 29.66 | 27.43 | 42.6 | 0.3 |
| news outputs | 30 - 39 | 85 | 7.87 | 39.89 | 26.88 | 43.36 | 0.28 |
| news outputs | 40 - 49 | 26 | 8.25 | 20.39 | 30.73 | 45.62 | 0.33 |
| news outputs | 50 - 59 | 31 | 6.61 | 18.31 | 26.48 | 44.05 | 0.28 |
| news outputs | 60 - 69 | 73 | 0.05 | 0.28 | 2.85 | 15.75 | 0.03 |
| news outputs | 70 - 79 | 21 | 9.67 | 31.31 | 31.03 | 45.96 | 0.33 |
| news outputs | 80 - 89 | 4 | 0.67 | 0.58 | 56.44 | 48.88 | 0.67 |
| news outputs | 90 - 99 | 2 | NA | NA | NA | NA | NA |
| news outputs | 100 + | 51 | 156.39 | 506.2 | 64.59 | 48.24 | 0.65 |
| policy documents | 1 - 4 | 271588 | 0.18 | 1.15 | 8.62 | 26.96 | 0.09 |
| policy documents | 5 - 9 | 15705 | 0.3 | 1.59 | 12.36 | 31.7 | 0.13 |
| policy documents | 10 - 19 | 2108 | 0.41 | 1.87 | 13.53 | 33.13 | 0.14 |
| policy documents | 20 - 29 | 292 | 0.89 | 2.67 | 19.07 | 38.42 | 0.2 |
| policy documents | 30 - 39 | 85 | 0.89 | 2.66 | 16.67 | 36.78 | 0.17 |
| policy documents | 40 - 49 | 26 | 0.42 | 1.16 | 15.78 | 36.9 | 0.17 |
| policy documents | 50 - 59 | 31 | 0.28 | 0.96 | 10.52 | 30.65 | 0.11 |
| policy documents | 60 - 69 | 73 | 0.02 | 0.13 | 1.46 | 11.48 | 0.02 |
| policy documents | 70 - 79 | 21 | 0.58 | 1.73 | 15.82 | 37.01 | 0.17 |
| policy documents | 80 - 89 | 4 | 0 | 0 | 0 | 0 | 0 |
| policy documents | 90 - 99 | 2 | NA | NA | NA | NA | NA |
| policy documents | 100 + | 51 | 11.09 | 27.18 | 55.16 | 49.53 | 0.57 |
| response time | 1 - 4 | 271588 | 4641.4 | 2270.6 | 50.35 | 28.8 |  |
| response time | 5 - 9 | 15705 | 5195.4 | 2209.63 | 43.17 | 28.78 |  |
| response time | 10 - 19 | 2108 | 5078.55 | 2254.54 | 44.6 | 29.24 |  |
| response time | 20 - 29 | 292 | 5715.01 | 2080.42 | 36.2 | 27.46 |  |
| response time | 30 - 39 | 85 | 5559.58 | 2340.22 | 37.53 | 29.98 |  |
| response time | 40 - 49 | 26 | 5636.62 | 2735.63 | 35.94 | 35.38 |  |
| response time | 50 - 59 | 31 | 5577.13 | 2151.62 | 37.61 | 27.6 |  |
| response time | 60 - 69 | 73 | 5587.62 | 1279.2 | 39.66 | 15.45 |  |
| response time | 70 - 79 | 21 | 5150.48 | 2038.11 | 44.18 | 28.09 |  |
| response time | 80 - 89 | 4 | 6189 | 2600.98 | 28.68 | 34.9 |  |
| response time | 90 - 99 | 2 | 1754 | 0 | 85.91 | 0 |  |
| response time | 100 + | 51 | 5571.39 | 1965.24 | 38.61 | 27.1 |  |

**Table S2. COVID-19 research speed and mentions in scholarly articles, news outputs, and policy documents.** For each team size range, mentions are described in terms of both raw and percentile-transformed values. Also described is the number of articles indexed in OpenAlex (*n*) and the proportion of those articles that received mentions. Also described is response time, in terms of number of days since a notable event signaled an urgent development.

|  |  |  | **raw** | | **percentile** | |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **mentions** | **team size** | ***n*** | ***M*** | ***SD*** | ***M*** | ***SD*** | **proportion of articles mentioned** |
| scholarly articles | 1 - 4 | 1208365 | 5.33 | 34.9 | 31.95 | 35.99 | 0.47 |
| scholarly articles | 5 - 9 | 438876 | 10.31 | 51.95 | 44.79 | 38.25 | 0.61 |
| scholarly articles | 10 - 19 | 141051 | 17.12 | 90.79 | 52.73 | 38.24 | 0.69 |
| scholarly articles | 20 - 29 | 22333 | 33.7 | 200.75 | 59.51 | 37.9 | 0.74 |
| scholarly articles | 30 - 39 | 6358 | 49.26 | 218.86 | 63.74 | 37.37 | 0.77 |
| scholarly articles | 40 - 49 | 2788 | 62.72 | 264.83 | 62.64 | 38.99 | 0.75 |
| scholarly articles | 50 - 59 | 1286 | 64.7 | 227.43 | 65.79 | 36.92 | 0.79 |
| scholarly articles | 60 - 69 | 817 | 55.9 | 257.43 | 63.35 | 37.93 | 0.76 |
| scholarly articles | 70 - 79 | 422 | 81.45 | 222.02 | 68.53 | 37.69 | 0.79 |
| scholarly articles | 80 - 89 | 378 | 70.22 | 229.25 | 66.29 | 37.45 | 0.79 |
| scholarly articles | 90 - 99 | 260 | 77.53 | 215.22 | 64.46 | 38.88 | 0.76 |
| scholarly articles | 100 + | 1631 | 94.2 | 381.81 | 69.03 | 37.15 | 0.8 |
| news outputs | 1 - 4 | 1208365 | 1.52 | 15.33 | 15.66 | 33.37 | 0.18 |
| news outputs | 5 - 9 | 438876 | 2.32 | 21.76 | 18.93 | 35.92 | 0.22 |
| news outputs | 10 - 19 | 141051 | 4.07 | 36.95 | 24 | 39.19 | 0.28 |
| news outputs | 20 - 29 | 22333 | 8.53 | 53.41 | 34.54 | 43.65 | 0.39 |
| news outputs | 30 - 39 | 6358 | 15.75 | 77.22 | 39.83 | 45.12 | 0.44 |
| news outputs | 40 - 49 | 2788 | 18.93 | 95.06 | 44.79 | 45.68 | 0.49 |
| news outputs | 50 - 59 | 1286 | 20.82 | 79.18 | 45.34 | 45.82 | 0.5 |
| news outputs | 60 - 69 | 817 | 16.94 | 65.56 | 46.13 | 45.81 | 0.51 |
| news outputs | 70 - 79 | 422 | 23.19 | 71.57 | 51.14 | 45.8 | 0.56 |
| news outputs | 80 - 89 | 378 | 22.48 | 85.8 | 46.36 | 46.31 | 0.5 |
| news outputs | 90 - 99 | 260 | 30.78 | 107.59 | 44.34 | 46.09 | 0.49 |
| news outputs | 100 + | 1631 | 33.71 | 139.38 | 56.53 | 44.96 | 0.62 |
| policy documents | 1 - 4 | 1208365 | 0.1 | 0.76 | 4.88 | 21.06 | 0.05 |
| policy documents | 5 - 9 | 438876 | 0.12 | 0.91 | 5.24 | 21.81 | 0.05 |
| policy documents | 10 - 19 | 141051 | 0.18 | 1.29 | 6.38 | 23.95 | 0.07 |
| policy documents | 20 - 29 | 22333 | 0.36 | 2.27 | 9.8 | 29.16 | 0.1 |
| policy documents | 30 - 39 | 6358 | 0.62 | 3.8 | 12.05 | 31.99 | 0.12 |
| policy documents | 40 - 49 | 2788 | 0.71 | 3.49 | 15.03 | 35.13 | 0.15 |
| policy documents | 50 - 59 | 1286 | 0.89 | 3.85 | 15.3 | 35.46 | 0.16 |
| policy documents | 60 - 69 | 817 | 0.69 | 3.39 | 12.71 | 32.73 | 0.13 |
| policy documents | 70 - 79 | 422 | 1.2 | 5.62 | 20.24 | 39.55 | 0.21 |
| policy documents | 80 - 89 | 378 | 1.19 | 6 | 15.77 | 35.83 | 0.16 |
| policy documents | 90 - 99 | 260 | 1.19 | 5.84 | 15.53 | 35.62 | 0.16 |
| policy documents | 100 + | 1631 | 0.99 | 4.97 | 16.92 | 36.88 | 0.17 |
| response time | 1 - 4 | 1208365 | 802.48 | 408.51 | 49.91 | 28.54 |  |
| response time | 5 - 9 | 438876 | 819.23 | 417.84 | 48.8 | 29.08 |  |
| response time | 10 - 19 | 141051 | 798.59 | 427.24 | 50.32 | 29.68 |  |
| response time | 20 - 29 | 22333 | 750.92 | 428.76 | 53.63 | 29.75 |  |
| response time | 30 - 39 | 6358 | 738.58 | 431.34 | 54.58 | 29.93 |  |
| response time | 40 - 49 | 2788 | 733.63 | 413.54 | 54.86 | 28.74 |  |
| response time | 50 - 59 | 1286 | 742.67 | 426.01 | 54.24 | 29.57 |  |
| response time | 60 - 69 | 817 | 788.56 | 429.14 | 50.95 | 29.93 |  |
| response time | 70 - 79 | 422 | 742.71 | 413.95 | 54.09 | 28.89 |  |
| response time | 80 - 89 | 378 | 792.41 | 429.02 | 50.76 | 30.02 |  |
| response time | 90 - 99 | 260 | 795.78 | 401.22 | 50.36 | 28.32 |  |
| response time | 100 + | 1631 | 836.97 | 408 | 47.7 | 28.56 |  |

**Table S3. ChatGPT research speed and mentions in scholarly articles, news outputs, and policy documents.** For each team size range, mentions are described in terms of both raw and percentile-transformed values. Also described is the number of articles indexed in OpenAlex (*n*) and the proportion of those articles that received mentions. Also described is response time, in terms of number of days since a notable event signaled an urgent development. NA’s refer to instances where the value could not be computed (e.g., because of zero variance).

|  |  |  | **raw** | | **percentile** | |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **mentions** | **team size** | ***n*** | ***M*** | ***SD*** | ***M*** | ***SD*** | **proportion of articles mentioned** |
| scholarly articles | 1 - 4 | 26324 | 4.66 | 27.05 | 30.78 | 37.35 | 0.42 |
| scholarly articles | 5 - 9 | 8017 | 7.18 | 30.48 | 41.94 | 39.54 | 0.55 |
| scholarly articles | 10 - 19 | 1392 | 12.58 | 69.79 | 46.99 | 39.83 | 0.61 |
| scholarly articles | 20 - 29 | 106 | 37.27 | 169.64 | 47.47 | 42.16 | 0.58 |
| scholarly articles | 30 - 39 | 41 | 27.83 | 56.35 | 65.82 | 35.81 | 0.8 |
| scholarly articles | 40 - 49 | 19 | 4.42 | 10.99 | 30.48 | 41.48 | 0.37 |
| scholarly articles | 50 - 59 | 11 | 13.91 | 24.15 | 42.94 | 49.38 | 0.45 |
| scholarly articles | 60 - 69 | 6 | 5.33 | 6.5 | 55.1 | 43.52 | 0.67 |
| scholarly articles | 70 - 79 | 2 | 799.5 | 1130.66 | 50 | 70.71 | 0.5 |
| scholarly articles | 80 - 89 | 1 | 4 | NA | 79.06 | NA | 1 |
| scholarly articles | 90 - 99 | 2 | 1 | 1.41 | 33.89 | 47.93 | 0.5 |
| scholarly articles | 100 + | 19 | 34 | 61.09 | 48.26 | 44.59 | 0.58 |
| news outputs | 1 - 4 | 26324 | 1.48 | 17.96 | 15.83 | 34 | 0.18 |
| news outputs | 5 - 9 | 8017 | 1.59 | 13.04 | 15.6 | 33.89 | 0.18 |
| news outputs | 10 - 19 | 1392 | 3.27 | 28.53 | 19.58 | 37.09 | 0.22 |
| news outputs | 20 - 29 | 106 | 1.96 | 5.51 | 27.45 | 41.76 | 0.31 |
| news outputs | 30 - 39 | 41 | 10.04 | 34.24 | 42.21 | 46.72 | 0.46 |
| news outputs | 40 - 49 | 19 | 1 | 2.21 | 26.85 | 43.36 | 0.3 |
| news outputs | 50 - 59 | 11 | 0.83 | 0.41 | 68.1 | 33.36 | 0.83 |
| news outputs | 60 - 69 | 6 | 0 | NA | 0 | NA | 0 |
| news outputs | 70 - 79 | 2 | 24 | NA | 98.68 | NA | 1 |
| news outputs | 80 - 89 | 1 | 2 | NA | 90.5 | NA | 1 |
| news outputs | 90 - 99 | 2 | 0 | NA | 0 | NA | 0 |
| news outputs | 100 + | 19 | 8.17 | 19.52 | 30.18 | 47.08 | 0.33 |
| policy documents | 1 - 4 | 26324 | 0.03 | 0.43 | 1.82 | 13.27 | 0.02 |
| policy documents | 5 - 9 | 8017 | 0.03 | 0.29 | 2.01 | 13.92 | 0.02 |
| policy documents | 10 - 19 | 1392 | 0.03 | 0.3 | 1.77 | 13.08 | 0.02 |
| policy documents | 20 - 29 | 106 | 0.13 | 0.6 | 5.72 | 23.36 | 0.06 |
| policy documents | 30 - 39 | 41 | 0.12 | 0.43 | 7.6 | 26.85 | 0.08 |
| policy documents | 40 - 49 | 19 | 0 | 0 | 0 | 0 | 0 |
| policy documents | 50 - 59 | 11 | 0.17 | 0.41 | 16.34 | 40.03 | 0.17 |
| policy documents | 60 - 69 | 6 | 0 | NA | 0 | NA | 0 |
| policy documents | 70 - 79 | 2 | 1 | NA | 98.06 | NA | 1 |
| policy documents | 80 - 89 | 1 | 0 | NA | 0 | NA | 0 |
| policy documents | 90 - 99 | 2 | 0 | NA | 0 | NA | 0 |
| policy documents | 100 + | 19 | 0 | 0 | 0 | 0 | 0 |
| response time | 1 - 4 | 26324 | 337.26 | 188.69 | 49 | 26.99 |  |
| response time | 5 - 9 | 8017 | 342.98 | 199.79 | 47.41 | 27.98 |  |
| response time | 10 - 19 | 1392 | 356.45 | 198.3 | 45.71 | 28.08 |  |
| response time | 20 - 29 | 106 | 347.66 | 184.73 | 47.82 | 26.93 |  |
| response time | 30 - 39 | 41 | 318.12 | 148.05 | 53.6 | 22.33 |  |
| response time | 40 - 49 | 19 | 317.89 | 189.65 | 50.83 | 27.03 |  |
| response time | 50 - 59 | 11 | 248.55 | 165.99 | 62.15 | 21.66 |  |
| response time | 60 - 69 | 6 | 307.83 | 215.63 | 48.58 | 28.24 |  |
| response time | 70 - 79 | 2 | 66.5 | 48.79 | 83.54 | 1.36 |  |
| response time | 80 - 89 | 1 | 494 | NA | 22.02 | NA |  |
| response time | 90 - 99 | 2 | 237 | 289.91 | 58.08 | 37.36 |  |
| response time | 100 + | 19 | 260.89 | 183.16 | 58.44 | 24.07 |  |