$9^{th}$ International Conference on Computational Social Science $IC^2S^2$
July 17-20, 2023, Copenhagen, Denmark

# The Covid-19 wonder-drug: A cross-lingual analysis of Ivermectin misinformation on Twitter

*Keywords: ivermectin, Covid-19, misinformation, networks, social media*

## Extended Abstract

The overwhelming spread of the Covid-19 virus, made worse by vaccine distrust and availability issues, has resulted in social media users around the world advocating for alternative treatments despite no proven effectiveness. One such treatment is the drug Ivermectin, initially conceived as an anti-parasitic agent to treat livestock and eventually finding widespread use in humans as a cure for river-blindness [1]. The initial interest in Ivermectin for Covid-19 stems from the work done by [2], where they find Ivermectin to be an effective inhibitor of the virus in vitro. Since then, no study has been able to convincingly prove that Ivermectin helps treat Covid-19 in randomised controlled trials (RCT). Studies that claim effectiveness have been criticised as being of low quality or fraudulent, with a number of papers having been retracted [3]. "Ivermectin as a treatment for Covid-19" is therefore a highly complicated piece of misinformation, however there are significant public health ramifications. We analyze this complex piece of misinformation in two languages, English and Japanese. In doing so, we contribute to a more detailed understanding of how misinformation is shared in a cross-lingual setting.

A combination of exploratory and network based techniques were used to conduct this analysis. The data-set used was Twitter retweets that contained the keyword 'Ivermectin' in English, and equivalent 'イベルメクチン' in Japanese from February 2020 to March 2022. There were a total of 2,094,388 retweets across 698,484 unique users in English, and 3,056,884 retweets across 259,151 users in Japanese. For each month and language, node degrees calculated using networkx was used to determine and rank the influentiality individual users. The similarity of influential users between each month was then calculated. To analyse how misinformation was shared in the cross-lingual context, we identified URLs shared in both English and Japanese by Ivermectin advocators, or "misinformation spreaders", and analysed the URL language, timing of URL retweet peak diffusion, and the influentiality of users involved.

To calculate the similarity of users between each month, we ranked users based on their influentiality (i.e. users with more node degree connections were at the top) and applied Rank Biased Overlap (RBO). RBO is a rank similarity measure that considers top-weightedness by imposing a stronger penalty for differences towards the top of the list. Hence, our RBO calculation is sensitive to changes in highly influential users. We find that a core group of influential users develops throughout the pandemic, and that there are more core influential users in Japanese than in English (Figure 1).

The online discourse surrounding Ivermectin means that not all users who retweeted about the drug were in support of its use, with a large number disagreeing or refuting claims of its effectiveness. In order to identify the "misinformation spreaders", users were tagged as pro-use or anti-use. First, the top 10 most influential users for each language and month from the RBO calculation were manually reviewed and tagged as pro-use or anti-use depending on the sentiment expressed in their tweets (Tables 1 and 2). The stance of the remaining users was then estimated based on their interactions with the already tagged users. If a given user retweeted a pro-use user more times than an anti-use user, then they were tagged as pro-use

and vice versa. The process was repeated to six node hops in English and five node hops in Japanese, achieving a population coverage of 69.7% in English, with 280,713 tagged as pro-use and 206,428 as anti-use, and 82.6% in Japanese, with 118,474 tagged as pro-use and 95,685 as anti-use. The high proportion of users tagged as anti-use despite the smaller number of users manually tagged at the start, and verifying that the top URLs shared by each group support their respective agenda (Tables 3 and 4) provide a level of confidence in the approach.

To analyse the diffusion of misinformation across the two languages, we observed URLs that were shared in both languages by pro-use users. There were approximately 2,000 unique URLs; the majority of which were English, with 135 URLs being Japanese and 40 in other languages. Most URLs were retweeted a low number of times, however there are a few that appear relatively popular in both languages (Figure 2). Japanese users share a large number of non-Japanese URLs, and are also relatively influential within the Japanese network. On the other hand, English users who share Japanese URLs are not so influential (Figures 5 and 6).

To analyse the timing of diffusion, we compared the timing of when a URL is first posted, when it reaches peak diffusion (maximum daily retweets), when the URL gets posted in the other language, and when it reaches peak diffusion in the other language. Figures 7 and 8 shows that a significant number of URLs get posted in and reach peak diffusion in Japanese before they are even posted by English users for the first time. Such URLs are mostly news related, with a few referencing tweets from prominent English pro-use actors and academic articles. A similar diffusion pattern seems to appear for URLs in Japanese, however manual inspection of these results reveals a number of URLs to YouTube for videos in English. Ignoring YouTube URLs reveals only four Japanese URLs that reach peak diffusion in English before being posted in Japanese, though we do not remove them from the main analysis due to the impracticality of verifying every URL (Figures 9 and 10). Most URLs that reach peak diffusion in their non-native language first are minor, though there are a few that are modestly popular in both English and Japanese compared to the totality of URLs shared (Figure 11).

Our results show that Japanese users are avid spreaders of misinformation in English. Most significantly, we show that Japanese users pick up on misinformation in English often before English users themselves. This challenges notions that Japanese users pick up on popular English misinformation propagated by English users first and spread it within their own circles. Instead, it suggests that they find their own sources in English to support their agenda independently. This has implications for organizations aiming to combat misinformation in Japanese societies, and posits that they must take a cross-lingual view in their efforts. Whilst we find minimal evidence that the same occurs for Japanese misinformation shared in English, further work is needed to understand the extent of this phenomena in other languages.

# References

[1] WC Campbell, MH Fisher, EO Stapley, G.+ Albers-Schönberg, and TA Jacob. Ivermectin: a potent new antiparasitic agent. *Science*, 221(4613):823–828, 1983.

[2] Leon Caly, Julian D Druce, Mike G Catton, David A Jans, and Kylie M Wagstaff. The fda-approved drug ivermectin inhibits the replication of sars-cov-2 in vitro. *Antiviral research*, 178:104787, 2020.

[3] Maria Popp, Miriam Stegemann, Maria-Inti Metzendorf, Susan Gould, Peter Kranke, Patrick Meybohm, Nicole Skoetz, and Stephanie Weibel. Ivermectin for preventing and treating covid-19. *Cochrane Database of Systematic Reviews*, (7), 2021.

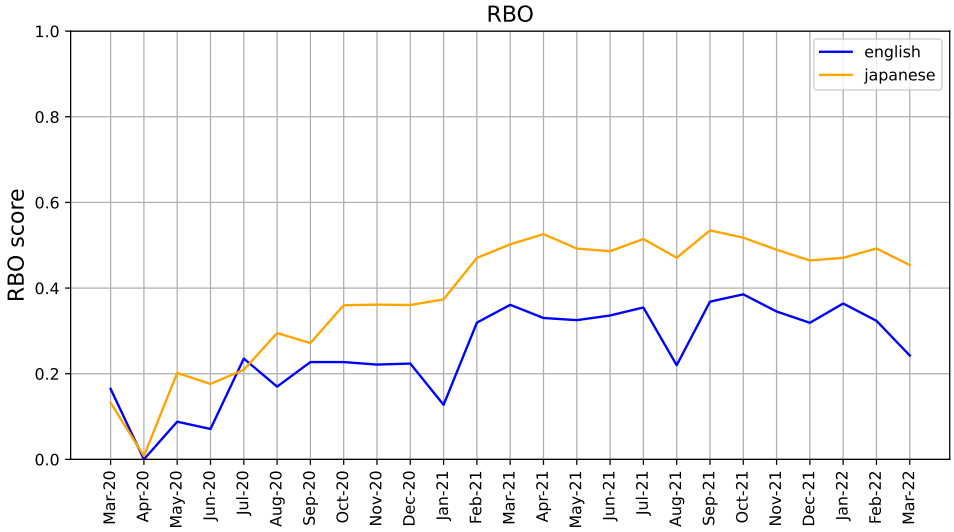


Figure 1: RBO similarity score of users between each month. Users are ranked by influentiality, therefore a higher RBO score on the y-axis indicates fewer changes in top influential users month to month. Increasing RBO over time shows development of core influential user group in each language as pandemic progresses.

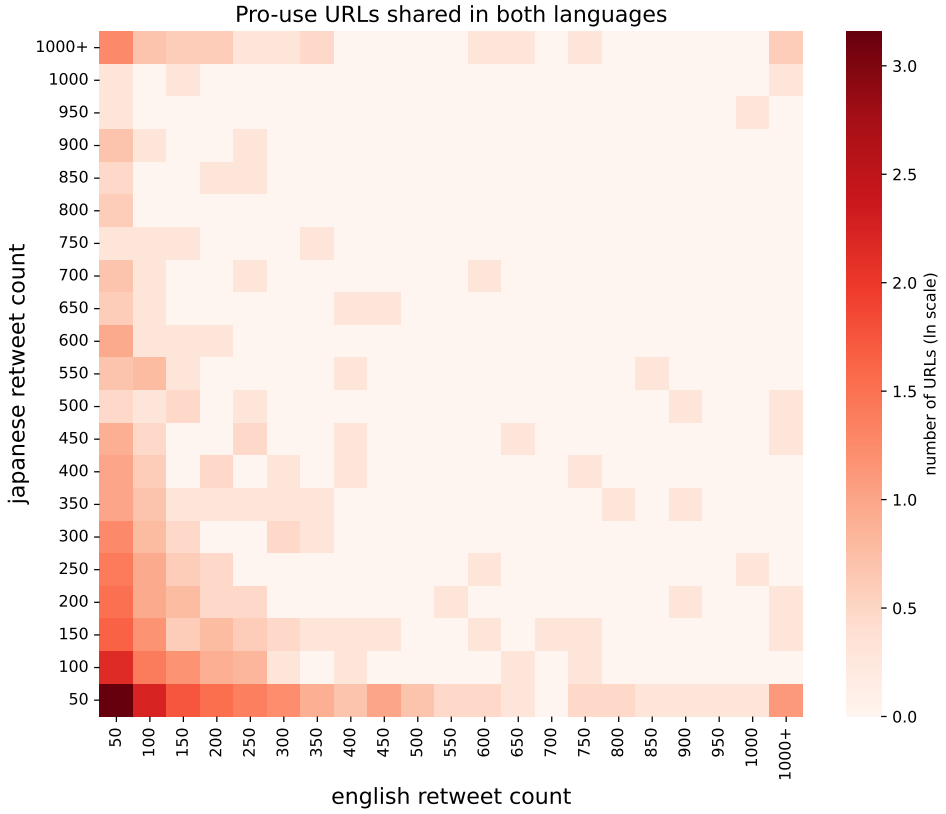


Figure 2: Heatmap showing popularity of all pro-use URLs shared by English and Japanese users, mapped according to retweet count in English and Japanese. Darker coloured areas indicate more URLs, suggesting that the majority of URLs are retweeted a few times, though a number of URLs are popular in both languages.

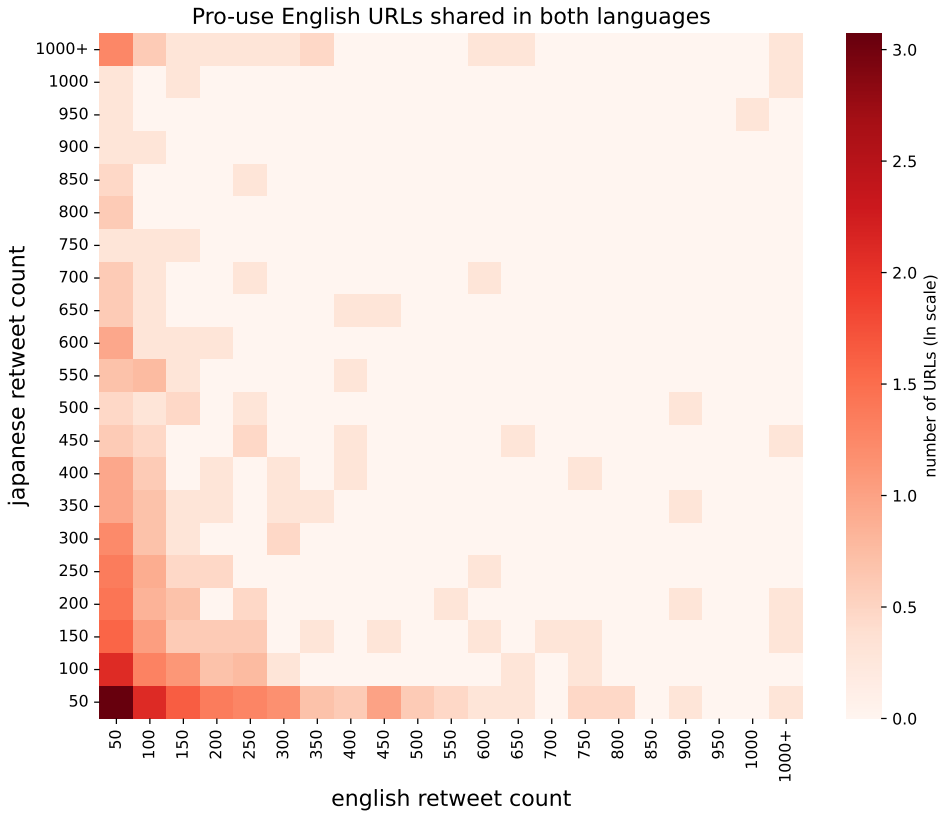


Figure 3: Heatmap showing popularity of English language pro-use URLs shared by English and Japanese users, mapped according to retweet count in English and Japanese. Darker coloured areas indicate more URLs, suggesting that the majority of URLs are retweeted a few times. Darker coloured areas along y-axis suggest popular English URLs amongst Japanese users.

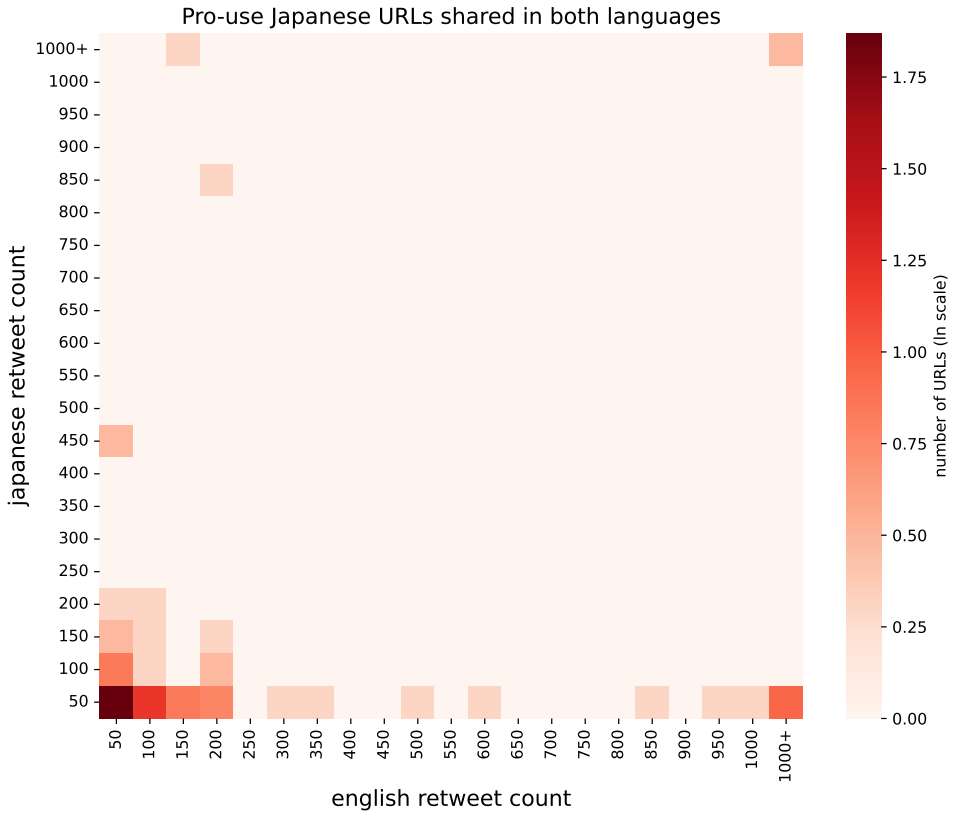


Figure 4: Heatmap showing popularity of Japanese pro-use URLs shared by English and Japanese users, mapped according to retweet count in English and Japanese. Darker coloured areas indicate more URLs, suggesting that the majority of URLs are retweeted a few times. Darker coloured areas along x-axis suggest some popular Japanese URLs amongst English users.

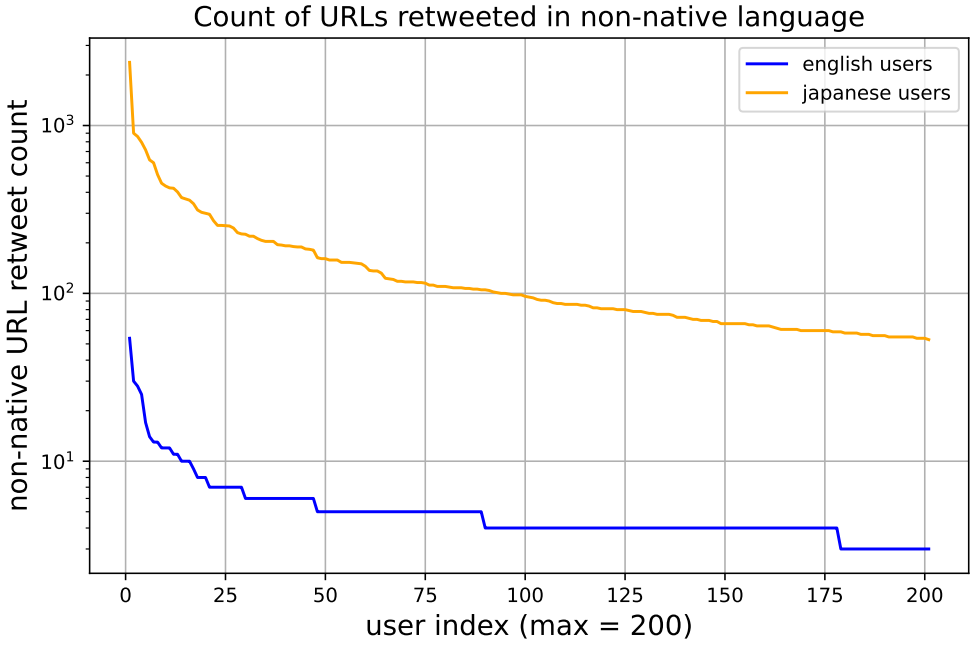


Figure 5: Top 200 users from each language who share the most URLs in their non-native language (i.e. Japanese user sharing English language URLs and vice versa). Indicates that Japanese users share significantly more non-native URLs than English users at the top end.

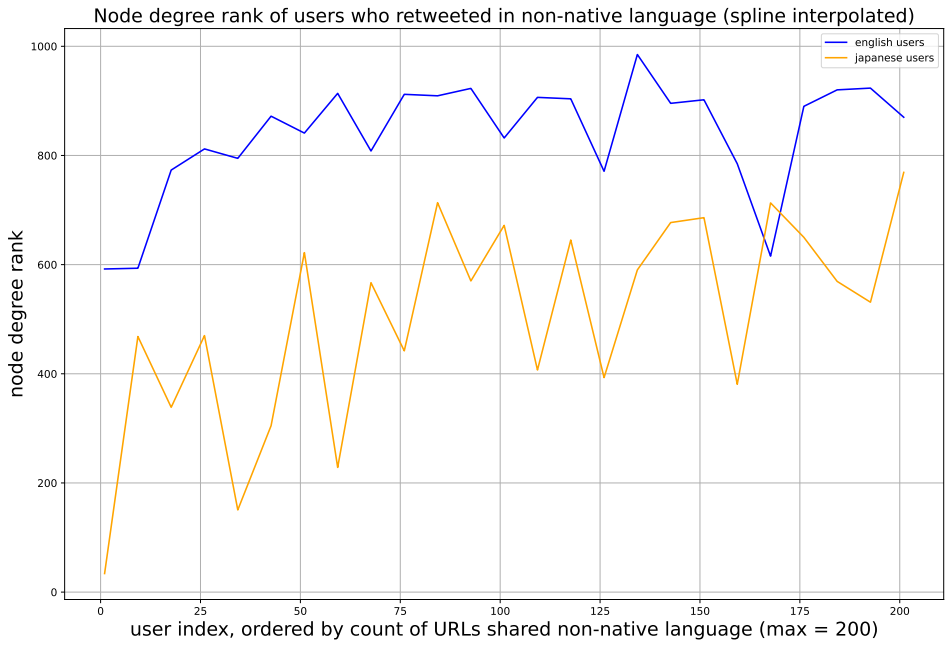


Figure 6: Node degree ranking (influentiality) of top 200 users who shared the most URLs in their non-native language. A lower node node degree rank number indicates higher influentiality, therefore lower points on the graph mean a user is more influential. Indicates that Japanese users who share the most non-native URLs are also more influential within their network than their English counterparts.

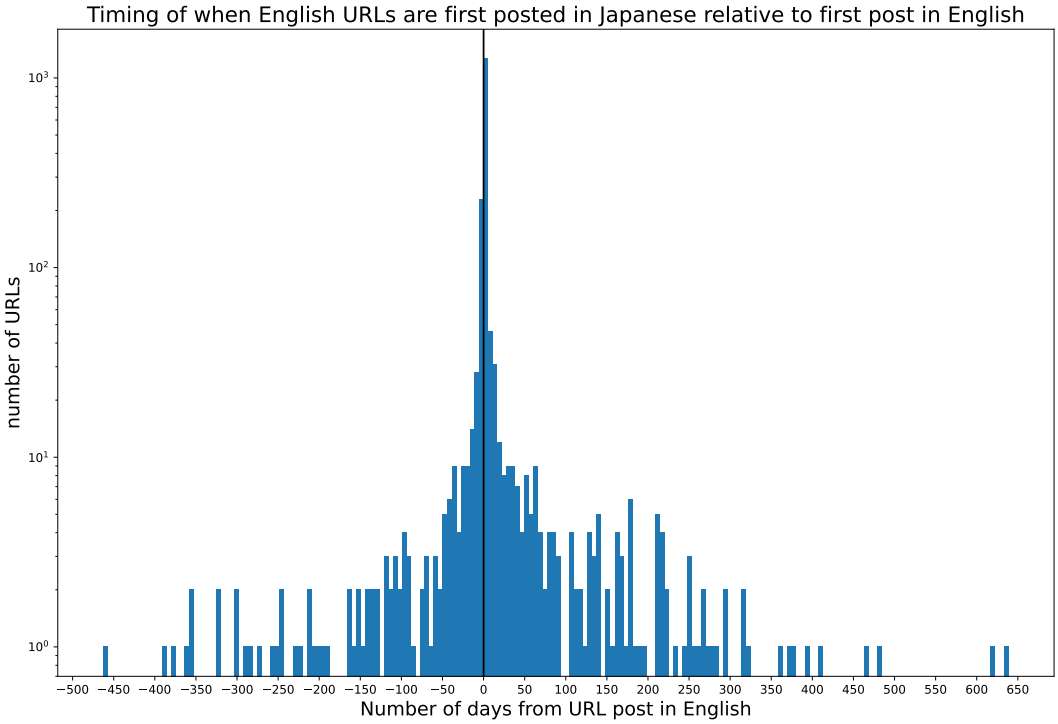


Figure 7: Timing of first post date of an English language URL by Japanese users in relation to first post date by English users. Negative day counts (x-axis) indicate that the URL was posted by Japanese users prior to English users, positive day counts indicate the URL was posted by Japanese users after English users. Shows a significant number of English URLs are posted by Japanese users before English users ($x < 0$).

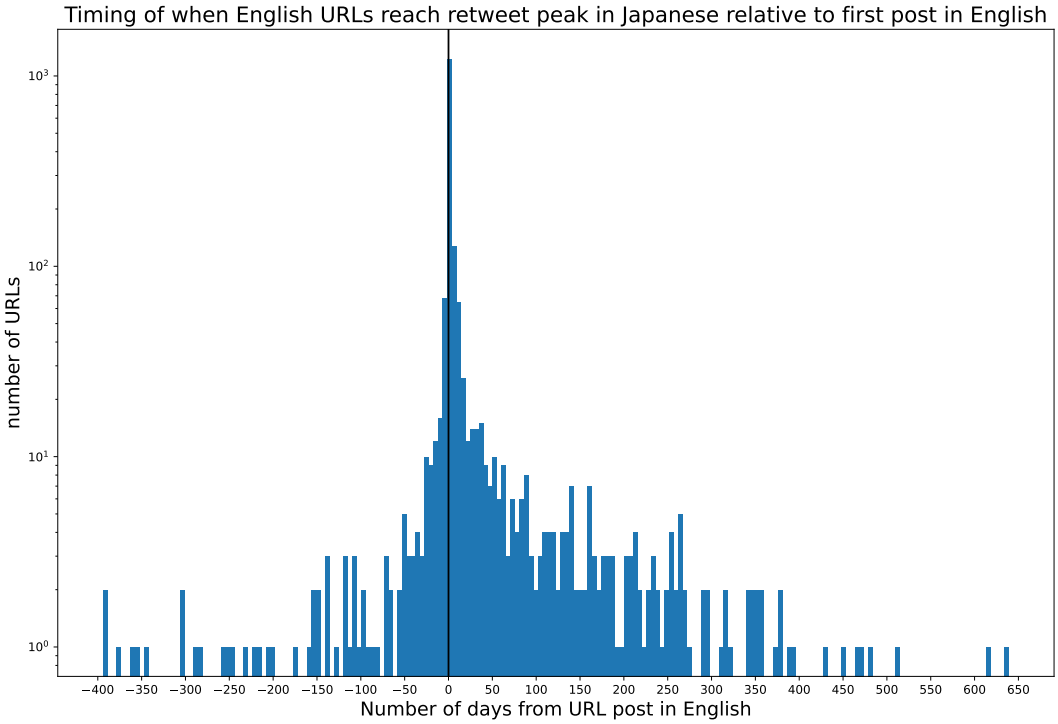


Figure 8: Timing of daily retweet peak date of an English language URL amongst Japanese users in relation to first post date by English users. Negative day counts (x-axis) indicate that the URL daily retweet count peaked amongst Japanese users prior to being posted for the first time by English users. Positive day counts indicate that the URL daily retweet count peaked amongst Japanese users after it was posted by English users. Shows a significant number of English URLs reach retweet peak by Japanese users before being posted by English users ($x < 0$)

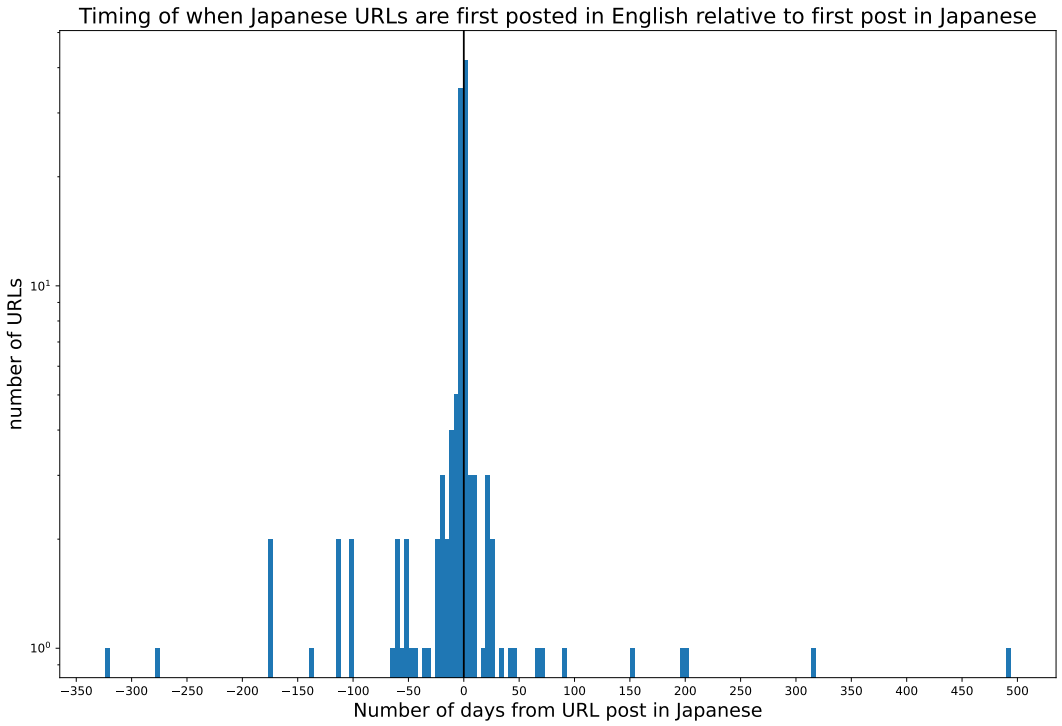


Figure 9: Timing of first post date of a Japanese language URL by English users in relation to first post date by Japanese users. Negative day counts (x-axis) indicate that the URL was posted by English users prior to Japanese users, positive day counts indicate the URL was posted by English users after Japanese users. Shows some Japanese URLs are posted by English users before Japanese users ($x < 0$), though most occur after Japanese users have already posted ($x > 0$)

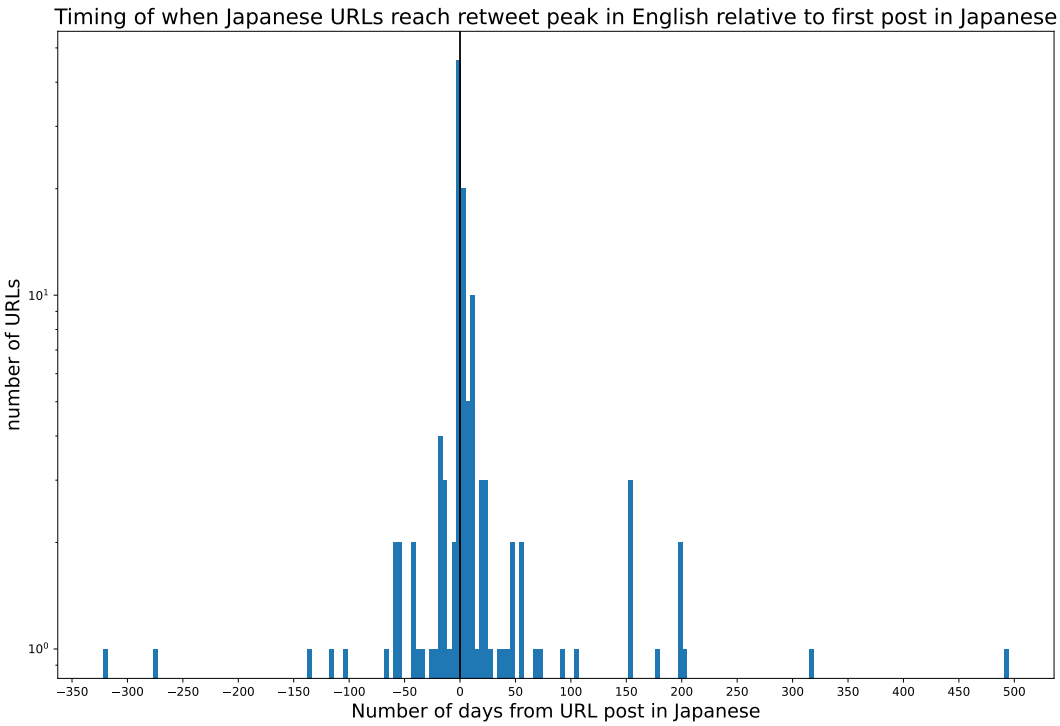


Figure 10: Timing of daily retweet peak date of a Japanese language URL amongst English users in relation to first post date by Japanese users. Negative day counts (x-axis) indicate that the URL daily retweet count peaked amongst English users prior to being posted for the first time by Japanese users. Positive day counts indicate that the URL daily retweet count peaked amongst English users after it was posted by Japanese users. Suggests that very few Japanese URLs reach retweet peak amongst English users before being posted by Japanese users ($x < 0$).

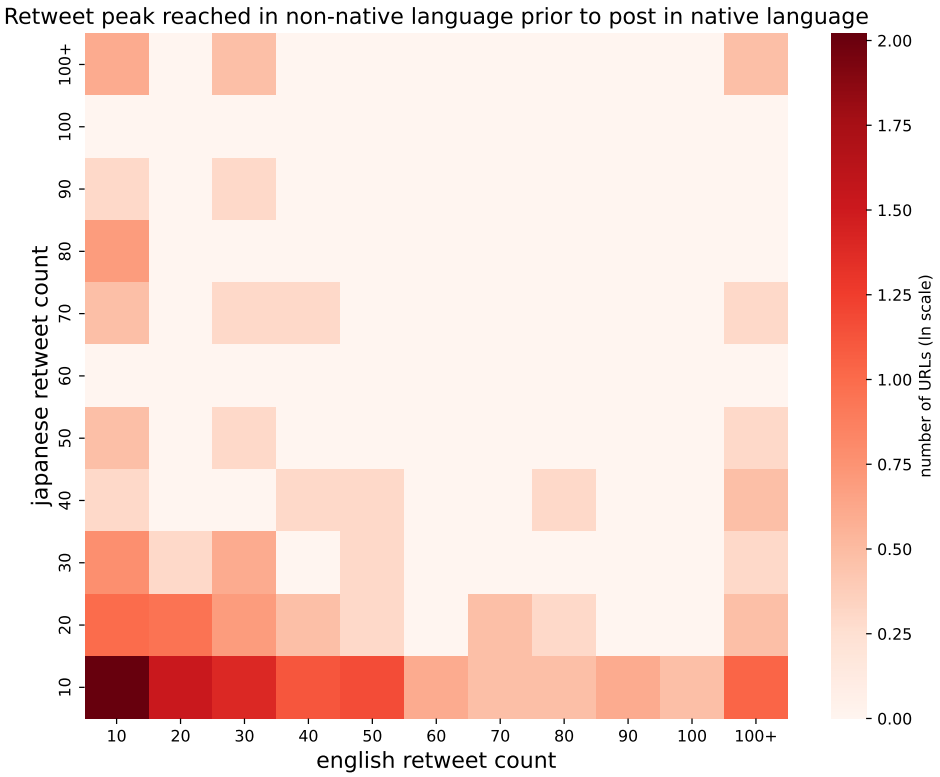


Figure 11: Heatmap showing popularity of URLs that reached daily retweet peak in non-native language prior to first posting in native language, mapped according to retweet count in English and Japanese. Darker coloured areas indicate more URLs, indicating that majority of URLs are retweeted a few times, with some URLs modestly popular in both languages.

| rank | February 2020 | | | March 2020 | | | April 2020 | | | May 2020 | | | June 2020 | | | July 2020 | | | August 2020 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | degrees | stance | user | degrees | stance | user | degrees | stance | user | degrees | stance | user | degrees | stance | user | degrees | stance | user | degrees | stance | user |
| 1 | 6 | undetermined | group | 18 | undetermined | individual | 311 | undetermined | doctor | 91 | pro-use | doctor | 185 | undetermined | doctor | 523 | anti-use | doctor | 1263 | anti-use | |
| 2 | 3 | undetermined | individual | 6 | undetermined | news | 282 | undetermined | individual | 76 | pro-use | individual | 92 | pro-use | individual | 144 | pro-use | individual | 277 | pro-use | |
| 3 | 3 | undetermined | group | 3 | undetermined | news | 274 | pro-use | individual | 65 | pro-use | group | 50 | pro-use | group | 144 | pro-use | individual | 225 | undetermined | |
| 4 | 3 | undetermined | individual | 2 | undetermined | individual | 198 | pro-use | individual | 59 | pro-use | individual | 45 | pro-use | individual | 88 | pro-use | individual | 189 | pro-use | |
| 5 | 2 | undetermined | group | 2 | undetermined | individual | 148 | undetermined | individual | 58 | pro-use | individual | 37 | pro-use | individual | 80 | pro-use | group | 170 | pro-use | |
| 6 | 2 | undetermined | N/A | 1 | undetermined | group | 86 | undetermined | individual | 55 | undetermined | doctor | 29 | pro-use | N/A | 77 | undetermined | individual | 162 | pro-use | |
| 7 | 2 | undetermined | news | 1 | undetermined | individual | 63 | pro-use | individual | 52 | pro-use | individual | 27 | pro-use | individual | 73 | pro-use | group | 129 | pro-use | |
| 8 | 1 | undetermined | N/A | 1 | undetermined | individual | 63 | undetermined | individual | 47 | pro-use | individual | 24 | pro-use | N/A | 61 | undetermined | individual | 113 | pro-use | |
| 9 | 1 | undetermined | group | 1 | undetermined | individual | 61 | undetermined | individual | 45 | pro-use | individual | 23 | undetermined | doctor | 57 | pro-use | individual | 107 | pro-use | |
| 10 | 1 | undetermined | N/A | 1 | undetermined | individual | 59 | undetermined | doctor | 41 | pro-use | individual | 22 | pro-use | N/A | 53 | undetermined | individual | 104 | pro-use | |

| rank | September 2020 | | | October 2020 | | | November 2020 | | | December 2020 | | | January 2021 | | | February 2021 | | | March 2021 | | | April 2021 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | degrees | stance | user | degrees | stance | user | degrees | stance | user | degrees | stance | user | degrees | stance | user | degrees | stance | user | degrees | stance | user | degrees | stance | user |
| 1 | group | 164 | pro-use | group | 212 | pro-use | group | 360 | pro-use | group | 1386 | pro-use | group | 3275 | pro-use | individual | 3671 | pro-use | individual | 3050 | pro-use | individual | 3038 | anti-use |
| 2 | individual | 84 | pro-use | individual | 49 | pro-use | doctor | 224 | anti-use | individual | 516 | pro-use | doctor | 1173 | pro-use | group | 2777 | pro-use | group | 2656 | pro-use | group | 2239 | pro-use |
| 3 | doctor | 78 | anti-use | individual | 48 | pro-use | doctor | 196 | pro-use | group | 422 | pro-use | doctor | 948 | pro-use | individual | 789 | pro-use | individual | 985 | pro-use | group | 1534 | pro-use |
| 4 | news | 73 | pro-use | individual | 29 | pro-use | individual | 57 | pro-use | doctor | 296 | pro-use | individual | 914 | pro-use | group | 692 | pro-use | doctor | 892 | pro-use | doctor | 1250 | pro-use |
| 5 | individual | 57 | pro-use | doctor | 28 | pro-use | individual | 50 | pro-use | doctor | 283 | pro-use | group | 689 | pro-use | individual | 663 | pro-use | journalist | 598 | pro-use | individual | 1177 | pro-use |
| 6 | individual | 51 | pro-use | doctor | 27 | pro-use | individual | 41 | pro-use | individual | 270 | pro-use | individual | 518 | pro-use | individual | 607 | undetermined | doctor | 591 | pro-use | individual | 900 | pro-use |
| 7 | individual | 39 | pro-use | individual | 27 | pro-use | individual | 41 | pro-use | doctor | 249 | pro-use | doctor | 486 | undetermined | individual | 522 | pro-use | individual | 584 | pro-use | doctor | 853 | pro-use |
| 8 | individual | 30 | undetermined | group | 23 | pro-use | group | 28 | pro-use | individual | 175 | pro-use | journalist | 471 | pro-use | doctor | 477 | pro-use | individual | 542 | pro-use | doctor | 778 | pro-use |
| 9 | individual | 27 | pro-use | individual | 16 | pro-use | journalist | 20 | pro-use | group | 156 | pro-use | individual | 354 | pro-use | individual | 450 | pro-use | journalist | 521 | pro-use | individual | 744 | pro-use |
| 10 | individual | 27 | pro-use | individual | 15 | pro-use | group | 20 | pro-use | individual | 154 | pro-use | doctor | 309 | pro-use | individual | 445 | pro-use | group | 508 | pro-use | individual | 659 | anti-use |

| rank | May 2021 | | | June 2021 | | | July 2021 | | | August 2021 | | | September 2021 | | | October 2021 | | | November 2021 | | | December 2021 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | degrees | stance | user | degrees | stance | user | degrees | stance | user | degrees | stance | user | degrees | stance | user | degrees | stance | user | degrees | stance | user | degrees | stance | user |
| 1 | group | 4451 | pro-use | group | 5683 | pro-use | individual | 4501 | pro-use | journalist | 8342 | anti-use | journalist | 13294 | anti-use | doctor | 10614 | pro-use | individual | 6927 | anti-use | individual | 12294 | pro-use |
| 2 | individual | 2984 | pro-use | individual | 5531 | pro-use | doctor | 3883 | pro-use | doctor | 8012 | pro-use | doctor | 8255 | pro-use | doctor | 6549 | pro-use | individual | 4963 | pro-use | individual | 8647 | pro-use |
| 3 | individual | 2117 | pro-use | individual | 2566 | pro-use | individual | 3701 | pro-use | individual | 6106 | anti-use | individual | 7084 | pro-use | individual | 6220 | pro-use | group | 4392 | anti-use | doctor | 4605 | pro-use |
| 4 | doctor | 1834 | anti-use | doctor | 2547 | pro-use | group | 2693 | pro-use | individual | 5092 | anti-use | individual | 6823 | undetermined | individual | 5663 | pro-use | doctor | 3346 | pro-use | individual | 4180 | pro-use |
| 5 | group | 1199 | pro-use | doctor | 2345 | pro-use | individual | 2377 | pro-use | individual | 4697 | pro-use | doctor | 5424 | pro-use | individual | 5569 | pro-use | doctor | 2962 | pro-use | group | 3927 | pro-use |
| 6 | individual | 1171 | pro-use | group | 1710 | pro-use | individual | 2096 | pro-use | group | 4603 | pro-use | doctor | 5345 | pro-use | individual | 4858 | pro-use | individual | 2836 | anti-use | individual | 3919 | undetermined |
| 7 | individual | 1120 | pro-use | group | 1500 | pro-use | group | 1751 | pro-use | individual | 4262 | anti-use | individual | 5291 | anti-use | individual | 3608 | undetermined | journalist | 2779 | pro-use | individual | 3821 | pro-use |
| 8 | individual | 1069 | pro-use | doctor | 1466 | pro-use | individual | 1578 | anti-use | individual | 4096 | pro-use | group | 5055 | anti-use | individual | 3606 | undetermined | individual | 2777 | anti-use | individual | 3172 | pro-use |
| 9 | individual | 897 | pro-use | doctor | 1181 | pro-use | individual | 1387 | pro-use | individual | 4096 | pro-use | doctor | 4863 | anti-use | individual | 3401 | pro-use | individual | 2387 | pro-use | individual | 3021 | pro-use |
| 10 | doctor | 805 | anti-use | individual | 1133 | pro-use | individual | 1371 | undetermined | individual | 3074 | anti-use | doctor | 4509 | pro-use | group | 3204 | anti-use | journalist | 2266 | pro-use | individual | 2886 | anti-use |

| rank | January 2022 | | | February 2022 | | | March 2022 | | |
|---|---|---|---|---|---|---|---|---|---|
| | degrees | stance | user | degrees | stance | user | degrees | stance | |
| 1 | individual | 12096 | pro-use | individual | 10344 | pro-use | journalist | 3287 | anti-use |
| 2 | individual | 10239 | pro-use | individual | 7487 | pro-use | doctor | 3271 | pro-use |
| 3 | individual | 8204 | pro-use | journalist | 7483 | anti-use | individual | 2996 | anti-use |
| 4 | individual | 4606 | pro-use | individual | 5374 | pro-use | individual | 2976 | pro-use |
| 5 | journalist | 3872 | anti-use | individual | 4044 | pro-use | news | 2486 | anti-use |
| 6 | individual | 3758 | pro-use | journalist | 4020 | pro-use | group | 2344 | pro-use |
| 7 | individual | 3481 | pro-use | individual | 3484 | anti-use | individual | 2298 | pro-use |
| 8 | doctor | 3235 | pro-use | individual | 3266 | pro-use | individual | 2048 | pro-use |
| 9 | journalist | 2795 | pro-use | group | 3136 | undetermined | individual | 1904 | anti-use |
| 10 | individual | 2573 | pro-use | individual | 2364 | pro-use | individual | 1560 | anti-use |

Table 1: Top 10 node degree users by month in English

| rank | February 2020 | | | March 2020 | | | April 2020 | | | May 2020 | | | June 2020 | | | July 2020 | | | August 2020 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | degrees | stance | user | degrees | stance | user | degrees | stance | user | degrees | stance | user | degrees | stance | user | degrees | stance | user | degrees | stance | user |
| 1 | 8 | undetermined | individual | 118 | undetermined | individual | 1420 | undetermined | journalist | 1777 | **pro-use** | individual | 1099 | anti-use | individual | 273 | undetermined | individual | 328 | **pro-use** | individual |
| 2 | 6 | undetermined | news | 31 | undetermined | individual | 1380 | undetermined | news | 1381 | **pro-use** | journalist | 568 | anti-use | individual | 261 | **pro-use** | individual | 178 | **pro-use** | individual |
| 3 | 2 | undetermined | individual | 26 | undetermined | journalist | 1166 | undetermined | company | 943 | undetermined | individual | 156 | **pro-use** | individual | 192 | **pro-use** | individual | 125 | **pro-use** | individual |
| 4 | 2 | undetermined | individual | 7 | undetermined | individual | 1155 | undetermined | individual | 865 | undetermined | individual | 140 | **pro-use** | individual | 171 | **pro-use** | individual | 106 | **pro-use** | individual |
| 5 | 2 | undetermined | individual | 5 | undetermined | group | 924 | undetermined | news | 803 | undetermined | individual | 123 | **pro-use** | individual | 168 | **pro-use** | individual | 103 | **pro-use** | individual |
| 6 | 1 | undetermined | individual | 5 | undetermined | individual | 902 | **pro-use** | news | 791 | undetermined | individual | 118 | anti-use | individual | 151 | **pro-use** | individual | 73 | **pro-use** | individual |
| 7 | 1 | undetermined | individual | 3 | undetermined | individual | 856 | undetermined | individual | 348 | undetermined | doctor | 117 | anti-use | individual | 110 | **pro-use** | individual | 65 | undetermined | individual |
| 8 | 1 | undetermined | N/A | 1 | undetermined | doctor | 808 | **pro-use** | individual | 329 | **pro-use** | individual | 71 | undetermined | individual | 107 | undetermined | individual | 64 | **pro-use** | individual |
| 9 | 1 | undetermined | N/A | 1 | undetermined | individual | 801 | undetermined | individual | 319 | **pro-use** | individual | 70 | **pro-use** | individual | 105 | undetermined | individual | 63 | undetermined | individual |
| 10 | 1 | undetermined | N/A | 1 | undetermined | group | 751 | undetermined | individual | 306 | undetermined | individual | 62 | **pro-use** | individual | 100 | **pro-use** | individual | 43 | **pro-use** | |

| rank | September 2020 | | | October 2020 | | | November 2020 | | | December 2020 | | | January 2021 | | | February 2021 | | | March 2021 | | | April 2021 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | degrees | stance | user | degrees | stance | user | degrees | stance | user | degrees | stance | user | degrees | stance | user | degrees | stance | user | degrees | stance | user | degrees | stance | user |
| 1 | 247 | **pro-use** | individual | 182 | undetermined | individual | 211 | **pro-use** | group | 409 | **pro-use** | researcher | 3993 | **pro-use** | researcher | 3510 | **pro-use** | individual | 3318 | **pro-use** | individual | 2891 | undetermined | individual |
| 2 | 226 | **pro-use** | individual | 105 | **pro-use** | individual | 184 | **pro-use** | individual | 314 | **pro-use** | individual | 2186 | **pro-use** | individual | 2364 | **pro-use** | researcher | 3005 | **pro-use** | individual | 2696 | **pro-use** | individual |
| 3 | 195 | **pro-use** | individual | 91 | **pro-use** | individual | 96 | **pro-use** | individual | 260 | **pro-use** | individual | 1599 | **pro-use** | individual | 1411 | **pro-use** | individual | 2725 | **pro-use** | researcher | 1918 | **pro-use** | researcher |
| 4 | 186 | **pro-use** | individual | 83 | **pro-use** | individual | 85 | **pro-use** | individual | 225 | **pro-use** | group | 1434 | **pro-use** | group | 1358 | **pro-use** | doctor | 1511 | anti-use | individual | 1098 | **pro-use** | individual |
| 5 | 174 | undetermined | individual | 76 | **pro-use** | researcher | 69 | **pro-use** | researcher | 210 | **pro-use** | individual | 1095 | **pro-use** | individual | 1319 | **pro-use** | individual | 1472 | **pro-use** | individual | 963 | **pro-use** | individual |
| 6 | 167 | **pro-use** | researcher | 68 | **pro-use** | individual | 60 | **pro-use** | individual | 209 | **pro-use** | individual | 774 | **pro-use** | journalist | 1104 | **pro-use** | individual | 1420 | **pro-use** | individual | 737 | **pro-use** | individual |
| 7 | 127 | **pro-use** | individual | 40 | **pro-use** | individual | 51 | **pro-use** | individual | 190 | **pro-use** | individual | 734 | **pro-use** | individual | 1008 | **pro-use** | doctor | 1331 | anti-use | individual | 651 | **pro-use** | individual |
| 8 | 109 | **pro-use** | individual | 32 | **pro-use** | individual | 33 | **pro-use** | individual | 124 | **pro-use** | individual | 681 | **pro-use** | individual | 871 | **pro-use** | individual | 1312 | undetermined | individual | 626 | **pro-use** | individual |
| 9 | 104 | undetermined | individual | 30 | **pro-use** | N/A | 33 | undetermined | individual | 123 | **pro-use** | individual | 665 | **pro-use** | individual | 842 | **pro-use** | individual | 1185 | **pro-use** | doctor | 604 | anti-use | |
| 10 | 99 | **pro-use** | individual | 29 | **pro-use** | individual | 35 | **pro-use** | individual | 110 | **pro-use** | individual | 637 | **pro-use** | individual | 825 | **pro-use** | individual | 1076 | **pro-use** | individual | 594 | **pro-use** | |

| rank | May 2021 | | | June 2021 | | | July 2021 | | | August 2021 | | | September 2021 | | | October 2021 | | | November 2021 | | | December 2021 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | degrees | stance | user | degrees | stance | user | degrees | stance | user | degrees | stance | user | degrees | stance | user | degrees | stance | user | degrees | stance | user | degrees | stance | user |
| 1 | 3310 | **pro-use** | individual | 4788 | **pro-use** | researcher | 5754 | **pro-use** | doctor | 21306 | anti-use | doctor | 10466 | anti-use | individual | 6386 | anti-use | doctor | 6547 | anti-use | individual | 2342 | anti-use | |
| 2 | 3079 | **pro-use** | individual | 3499 | **pro-use** | individual | 4264 | **pro-use** | researcher | 12660 | **pro-use** | researcher | 9510 | **pro-use** | doctor | 6204 | anti-use | individual | 5218 | anti-use | doctor | 1988 | anti-use | |
| 3 | 1807 | anti-use | researcher | 2778 | **pro-use** | doctor | 3899 | anti-use | individual | 8447 | undetermined | individual | 4370 | undetermined | individual | 3015 | **pro-use** | researcher | 3461 | **pro-use** | individual | 1971 | **pro-use** | |
| 4 | 1670 | **pro-use** | news | 2702 | undetermined | individual | 3608 | anti-use | company | 8061 | anti-use | doctor | 3917 | anti-use | individual | 3012 | **pro-use** | individual | 2748 | anti-use | researcher | 1900 | **pro-use** | |
| 5 | 1544 | undetermined | group | 2630 | **pro-use** | individual | 3359 | **pro-use** | doctor | 7225 | anti-use | news | 3247 | anti-use | individual | 2960 | anti-use | individual | 2294 | anti-use | individual | 1336 | undetermined | |
| 6 | 1526 | undetermined | news | 2244 | **pro-use** | individual | 2877 | undetermined | doctor | 6616 | anti-use | individual | 3065 | anti-use | individual | 2922 | anti-use | individual | 1637 | **pro-use** | individual | 867 | **pro-use** | |
| 7 | 1375 | **pro-use** | individual | 1982 | **pro-use** | doctor | 2301 | anti-use | doctor | 6571 | anti-use | individual | 2909 | undetermined | researcher | 2377 | **pro-use** | doctor | 1551 | anti-use | individual | 786 | **pro-use** | |
| 8 | 1075 | **pro-use** | individual | 1881 | **pro-use** | individual | 1640 | **pro-use** | doctor | 6161 | anti-use | individual | 2854 | **pro-use** | individual | 1754 | anti-use | individual | 1186 | **pro-use** | individual | 682 | **pro-use** | |
| 9 | 1030 | anti-use | journalist | 1618 | **pro-use** | individual | 1631 | **pro-use** | doctor | 5477 | anti-use | individual | 2823 | anti-use | individual | 1687 | **pro-use** | doctor | 1089 | anti-use | individual | 662 | **pro-use** | |
| 10 | 1021 | **pro-use** | company | 1484 | anti-use | individual | 1596 | anti-use | journalist | 5465 | **pro-use** | individual | 2424 | **pro-use** | individual | 1581 | anti-use | individual | 1032 | **pro-use** | individual | 645 | **pro-use** | |

| rank | January 2022 | | | February 2022 | | | March 2022 | | |
|---|---|---|---|---|---|---|---|---|---|
| | degrees | stance | user | degrees | stance | user | degrees | stance | |
| 1 | 2894 | anti-use | doctor | 7477 | anti-use | doctor | 4882 | anti-use | |
| 2 | 2766 | **pro-use** | individual | 2324 | **pro-use** | researcher | 2773 | **pro-use** | |
| 3 | 2278 | anti-use | individual | 2190 | **pro-use** | individual | 2268 | anti-use | |
| 4 | 2137 | **pro-use** | individual | 2146 | **pro-use** | individual | 1916 | anti-use | |
| 5 | 1955 | **pro-use** | individual | 2006 | anti-use | individual | 1563 | **pro-use** | |
| 6 | 1780 | **pro-use** | researcher | 1957 | **pro-use** | group | 1485 | **pro-use** | |
| 7 | 1733 | **pro-use** | doctor | 1708 | anti-use | individual | 1151 | **pro-use** | |
| 8 | 1618 | anti-use | individual | 1373 | anti-use | news | 1032 | undetermined | |
| 9 | 1598 | anti-use | individual | 1280 | undetermined | individual | 837 | undetermined | |
| 10 | 1187 | **pro-use** | individual | 1079 | **pro-use** | individual | 817 | **pro-use** | |

Table 2: Top 10 node degree users by month in Japanese

| rank | URL | description | retweets |
|---|---|---|---|
| 1 | starpolitical.com/bombshell-report-joe-rogan-says-dr-pierre-kory-treated-200-members-of-congress-with-ivermectin-video/ | Bombshell Report: Joe Rogan says Dr Pierre Kory treated 200 members of congress with Ivermectin | 7389 |
| 2 | www.nikkei.com/article/DGXZQOFB25AAL0V20C21A1000000/ | Translated: Tokyo Medical Association recommends administration of ivermectin | 5433 |
| 3 | www.ncbi.nlm.nih.gov/pmc/articles/PMC8383101/ | Ivermectin: a multifaceted drug of Nobel prize-honoured distinction with indicated efficacy against a new global scourge, COVID-19 | 5294 |
| 4 | www.reuters.com/aticle/health-coronavirus-japan-kowa/japans-kowa-says-ivermectin-effective-against-omicron-in-phase-iii-trial-idUSL1N2UB0AV | Japan's Kowa says Ivermectin effective against omicron in phase III trial | 4538 |
| 5 | www.oann.com/india-govt-declares-most-populated-state-officially-covid-free-after-widespread-use-of-ivermectin/ | India govt declares most populated state officially covid free after widespread use of ivermectin | 4445 |
| 6 | www.jpost.com/health-science/israeli-scientist-says-covid-19-could-be-treated-for-under-1day-675612 | Israeli scientist says COVID-19 could be treated for under \$1\day | 4292 |
| 7 | www.emilypostnews.com/p/gofundme-removes-fundraiser-for-dying-b95?r=1im5e&utm_campaign=post&utm_medium=web&utm_source=direct | GoFundMe Removes Fundraiser for Dying Texas Sheriff Deputy After Wife Posts About Ivermectin | 4126 |
| 8 | journals.lww.com/americantherapeutics/fulltext/2021/08000/ivermectin_for_prevention_and_treatment_of.7.aspx | Ivermectin for Prevention and Treatment of COVID-19 Infection: A Systematic Review, Meta-analysis, and Trial Sequential Analysis to Inform Clinical Guidelines | 3930 |
| 9 | www.nobelprize.org/prizes/medicine/2015/press-release/ | Press release | 3891 |
| 10 | journals.lww.com/americantherapeutics/Abstract/9000/Ivermectin_for_Prevention_and_Treatment_of.98040.aspx | Ivermectin for Prevention and Treatment of COVID-19 Infection: A Systematic Review, Meta-analysis, and Trial Sequential Analysis to Inform Clinical Guidelines | 3792 |

Table 3: Top 10 URLs shared by English pro-use users

| rank | URL | description | retweets |
|---|---|---|---|
| 1 | https://www.dailyshincho.jp/article/2021/03141057/ | Translated: Discoverer of Ivermectin, Dr. Satoshi Omura, appeals for 'special approval', Patients taking it in Japan are 'quickly healed' | 16136 |
| 2 | https://dailyshincho.jp/article/2021/03211059/ | Translated: The reason why pharmaceutical companies stubbornly 'hide' the wonder drug ivermectin | 14888 |
| 3 | https://webronza.asahi.com/science/ articles/2021020700003.html | Translated: Ivermectin, discovered by Dr. Ohmura may end the Corona Pandemic | 5675 |
| 4 | https://dailyshincho.jp/article/2021/03201059/ | Translated: The Tokyo Medical Association earnestly appeals for the effective drug Ivermectin, which is 'effective against mutated viruses' | 5656 |
| 5 | https://www.yomiuri.co.jp/choken/kijironko/cknews/20210427-OYT8T50019/ | Translated: Whether Ivermectin is effective or not for corona treatment, Japan should take the lead in resolving the global controversy | 5265 |
| 6 | https://kitasato-infection-control.info/ | Kitasato University Infection Control Research Centre homepage | 5081 |
| 7 | https://www.nikkei.com/article/DGXZQOFB25AAL0V20C21A1000000 | Translated: Tokyo Medical Association recommends administration of ivermectin to prevent worsening symptoms | 5031 |
| 8 | https://anonymous-post.mobi/archives/10115 | Translated: India Ivermectin leads to a sharp decrease in the number of people infected with the corona virus WHO "Don't use ivermectin" Rapid increase in the number of infected people 87% decrease in infected people due to repeated use Indian Bar Association "accuses" WHO = Internet reaction "Even if there is no fuss about vaccines, Does that mean that the strongest vaccine made by the Japanese already existed?" | 4489 |
| 9 | https://t.me/Whiplash347/37729 | Tokyo's Medical Assoc. Chairman holds live press conference recommending ivermectin to all doctors, for all Covid patients. | 4398 |
| 10 | https://dot.asahi.com/dot/2021052600033.html | Translated: Using 'Ivermectin' from Japan, India's corona treatment reduces the number of infected people, but WHO is opposing | 4277 |

Table 4: Top 10 URLs shared by Japanese pro-use users