

# On the differences between tweeting and retweeting scientific articles: Implications for altmetrics

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## Abstract

Despite differences in extent of engagement of users, original tweets and retweets to scientific publications are considered as equal events. Current research investigates quantifiable differences between tweets and retweets from an altmetric point of view. Twitter users, text, and media content of 371 randomly selected tweets and retweets linking to scientific articles published on PLoS ONE were manually categorized. Results for power of proportion differences indicated that while academic and personal accounts produced majority of original tweets (35% and 27%, respectively), they posted significantly larger proportion of retweets (43% and 41.5%). Bots and Business accounts, however, had both posted significantly more original tweets (20% and 6.5%) than retweets (2% and 3%). Natural communication sentences prevailed in retweets (79% vs. 42%) and images were found three times more in retweets (55.5%) than original tweets (18%). Overall, the findings suggest that the attention scientific articles receive on Twitter may have more to do with the inclusion of visual content in the tweets and human interaction, rather than the significance of or genuine interest towards the research results.

## Introduction

The act of tweeting, i.e. writing and sending a short message on Twitter, can be considered as somewhat different from the act of retweeting, i.e. forwarding an original tweet that someone else has tweeted earlier. Writing an original tweet takes some effort and engagement with the topic, while retweeting can be done with a simple click on a button, clearly requiring less engagement with the topic and the original source. Yet, oftentimes both tweeting and retweeting are treated as similar events and in altmetric purposes they are not separated. In some cases, one could argue, the number of retweets might be more important than original tweeting. Celebrities and social media influencers depend on the engagement of their followers to disseminate their message even further. On the other hand, disseminating new knowledge about scientific discoveries might be argued to benefit more from higher numbers of original tweeting and true engagement, as retweeting doesn't require any engagement or even knowledge about the original discovery or source. But users might also have different motivation for retweeting scientific publications. Mohammadi et al. (2018) investigated motivations to engage with scientific tweets, finding that 85% of participants in his survey retweet to disseminate research; 42% do that because they want to let the author know that they have found the research interesting; 20% do it to save it for later access; and 15% to let the author know that they have read the article. This research investigates differences between the acts of tweeting and retweeting of scientific articles and discusses what implications the findings have on the reliability and applicability of Twitter in research evaluation.

Due to a variety of different affordances in tweets, it is not well-known which type of events are more valuable for research impact assessment. The Twitter uptake of publications is usually counted from the number of *raw tweets*, i.e., all tweets and retweets mentioning a specific scientific publication. However, it is easy to spam and manipulate the raw tweet counts. In order to tackle this problem *Altmetric.com* offers the count of *unique Twitter users* posting tweets along with the raw tweets. This approach prevents from duplicate counting tweets from the same Twitter account. Another challenge is that it is not well known to what extent bots (i.e., automated Twitter accounts) are influencing the numbers. It is also unclear whether automatically created or disseminated tweets should be considered as valuable as original

human-created tweets. Current study investigates differences in the content of original tweets and retweets, and discusses the implications of these different Twitter events for research impact assessment. Based on the research goals this research will answer the following research questions:

1. How do tweets and retweets differ in terms of engagement of various Twitter users?
2. How do tweets and retweets differ in terms of text and media content?

## **Background**

### *Extent of scientific tweets and retweets*

Previous studies have explored a broad range of fields showing that scientists tend to retweet frequently. Holmberg and Thelwall (2014) discovered that scientists retweet between 22% in Digital Humanities and 42% in Biochemistry. Holmberg and Thelwall (2014) suggested that scholars are retweeting scientific products more than typical Twitter users, biochemists being the most active retweeters. Ke, Ahn and Sugimoto (2017) discovered even higher proportions of retweeting, as they found 66% (30,204) of the investigated 45,867 scientists retweeting. With regards to retweeting tweets to scientific publications, Haustein (2019) investigated tweets and retweets in 14 fields, discovering that overall 50% were retweets. The proportion of retweets with links to scientific articles varied across fields, as Physics (30%), Engineering and Technology (33%) and Arts (39%) had fewer retweets than Biology (54%), Social Sciences (53%) and Health and Humanities (both 52%) (Haustein, 2019). Didegah, Mejlgaard and Sørensen (2018) investigated 6,388 tweets to 300 articles in five broad fields (60 per field) identifying between 21.5% retweets in Life and Earth Sciences to 68.4% in Physical Science and Engineering. Other studies have reported similar proportions. For instance, Arroyo-Machado, Torres-Salinas and Robinson-Garcia (2021) found that original tweets constitute about 44% of all tweets (vs. 56% retweets) to Microbiology and Information and Library Science publications from 2012 to 2018. Hassan, Bowman and Shabbir (2019) found retweets to count for 39% (4,061) of the investigated total of 10,345 tweets to 820 articles in Library and Information Science. Tur-Viñes, Segarra-Saavedra and Hidalgo-Mari (2018) found that 38.5% of tweets to 30 Spanish journals in Communication were retweeted. Maleki (2018) identified only 30% retweets among tweets linking to Astrophysical Journal articles. Maleki (2018) also analyzed friendship relation between users retweeting astronomy and astrophysics articles finding that retweets targeted at friends (56%) were more common than non-friends (44%). Na (2015) found that retweets accounted for 19% of a total of 2,016 tweets to Psychology articles, while later, Ye and Na (2018) found the retweets to account for 56.8% of the tweets linking to a set of Psychology publications. Earlier studies also vary in how they report original tweets versus retweets. Some of the earlier studies have only reported the extent of original tweets to publications, such as the study of Díaz-Faes, Bowman, and Costas (2019), which reported the mean original tweets by users with scientific tweets was (5.36 tweets, median=0). Other studies only report extent of retweets, such as the study of 162 publications in the journal *Cell*, reporting a median of 17.5 retweets (Cui et al., 2018). Fang, Costas and Wouters (2022) reported varying extent of retweets across fields, from 0.95 mean retweets in Physical Sciences and Engineering to 2.07 in Life and Earth Sciences, and 2.18 in Social Sciences and Humanities. More recently, Fang, Costas and Wouters (2022) analyzed different actions connected to about seven million *unique original tweets* linking to over two million WoS-indexed publications. They found that about 36% of original tweets were disseminated through about 13.5 million retweets, and 9% through 1.2 million so called quote retweets. Only 2% of the original tweets were disseminated through all these different forms of dissemination. Although liking was a very common event on majority of original tweets (52%), the overlap of retweeting and liking the same articles was fairly common (30%) (Fang, Costas and Wouters, 2022), possibly suggesting that the actions

are relatively similar. In a different study, Fang, Dudek and Costas (2020) introduced two indicators: Degree of Originality (proportion of original tweets to an article) and Degree of Concentration (proportion of retweets to an article). They reported about 28% median Originality and 20% median Concentration per article for 1,154 highly tweeted publications with over 2.6 million tweets. The many reported differences between tweets and retweets already suggest, that these two types of events are very different actions, and that they should be treated separately.

#### *Use of different affordances on Twitter*

The so-called *reply* and *quote* tweets contain, in addition to the original tweet content, some original content by the tweeters and can thus be considered as original tweets rather than retweets. Reply tweets can technically be identified by their connection to a conversation thread that links to a scientific publication. Kumar et al. (2019) discovered that 6% to 8% of the tweets linking to scientific publications were reply tweets in Medicine, Environmental Science and Chemistry. Didegah, Mejlgaard and Sørensen (2018) found between 4.8% of tweets in Life and Earth Sciences and 24.5% in Mathematics and Computer Science to be replies. Htoo and Jin-Cheon (2017) discovered that organizations, both academic or non-academic, reply (both about 6%) to scientific tweets less than individuals do (9% academic versus 12% non-academic individuals). Addressing other users by writing their @username in the tweet, however, is more common than use of reply tweets. Hassan, Bowman and Shabbir (2019) found 81% (8,373) of a total of 10,345 tweets to 820 articles in Library and Information Science to contain @username mentions.

It would appear that majority of tweets to scientific publications only contain the title and hyperlink of the paper. Thelwall et al. (2013) found that between 17% of tweets linking to the journal *Science* and 87% linking to *Nature* only contained a mention of the title of the research publication. Didegah, Mejlgaard and Sørensen (2018) reported that 92.4% of tweets in Life and Earth Sciences did not have any additional content beyond the title and article hyperlink. In Physical Science and Engineering and in Mathematics and Computer Science the proportion of tweets without any additional content were 16.6% and 57.6% respectively. In a study of tweets to publications in the institutional repository of Georgia Southern University, Sergiadis (2018) found that 48% of the tweets mentioned only the title, 14% contained a summary of the research and 15.5% indicated some opinions of and interest towards the research. Kumar et al. (2019) also reported that majority of the tweets in Medicine (74.3%) and Chemistry (65.7%) do not contain any additional text other than the title of and a link to the article. They also concluded that 8.3% of the tweets in Medicine contained @user mentions and questions, 7.9% contained a summary of the research results, 4.2% contained some praise or criticism-related sentiments, and 1.3% expressed the tweeters' desire to access the article.

Results from recent studies about inclusion of media content in tweets linking to scientific publications suggests that visuals can significantly enhance the engagement with tweets. Hoffberg et al. (2020) created a randomized control trial group to compare dissemination of tweets with visual abstracts to textual tweets linking to 50 PubMed articles, finding that visual abstracts had significantly higher number of impressions, retweets and link clicks. Oska, Lerma and Topf (2020) also conducted a prospective case-control analysis of 40 articles in *American Journal of Nephrology*. Researchers tweeted the articles in three different formats: text only; with a key figure; and with a visual abstract. The results showed that visual abstracts attracted twice as many views as the tweets with key figures and text only, and that they gained five

times more user engagement than the text only tweets and 3.5 times more than the tweets containing key figures.

## Methods

Both quantitative and qualitative methods were used in the analysis. A random sample of 1,000 tweets and 1,000 retweets mentioning papers published in PLoS ONE were first collected and used for categorization of the Twitter users (tweeters/retweeters). For content analysis a smaller sample of 371 original tweets and 371 retweets was randomly selected.

### *Twitter user categorization*

Twitter user categorization was done in an exploratory way by analyzing the content of profile descriptions. The profile descriptions were systematically classified manually by identifying frequently appearing words or specifically descriptive content (Hsieh & Shannon, 2005). This qualitative content analysis used inductive reasoning, allowing for the themes and categories to emerge from the classification process (Zhang & Wildemuth, 2009). As the main aim of the classification of the tweeters was to differentiate between academic tweeters and the general public, the categorization was made based on this. This classification resulted in seven broad, yet distinct categories (Table 1). When classifying the tweeters and retweeters as part of the scientific community or those outside of it, the aim was to see differences in the act of tweeting and retweeting and understanding the impact research may have had.

**Table 1. Twitter user categories and types of users included in each category**

<i>Twitter User Categories</i>	<i>User subtypes</i>
Academia	post doc, professor, doctor, universities, colleges, faculty of a university, research group of a university, university library, researcher, scientist, research project, program, research institution/society, phd student, library, university student, conference, doctoral student
Bots	Bot
Business	Corporations, companies
Communication	journalist
Information/News resources	news service, science publication, science news group or organisation, information database
Organization	non-profit organisation, society or organisation, online community
Personal	Individual, professionals
Unassigned	Unassigned

### *Tweet content categorization*

The smaller random sample of tweets and retweets was also used to code the content based on text and media features. In terms of content features, three categories were assigned (1) Only paper hyperlink and/or title; (2) added slight changes such as #hashtag, @username or short linking words; (3) communication and natural language sentences (any phrase or sentence other than title of the tweeted paper). Additionally, tweets and retweets were identified for containing hashtags, @usernames, and for being Reply or Quote tweets. All tweets and retweets were opened in a web browser to analyze the content features. This approach was taken as the Twitter API indicates media content only as shortened hyperlinks. These shortened hyperlinks could then link to the linked paper, webpages, quoted tweets, images, or videos. After following these

hyperlinks in a web browser, three main codes were assigned; (1) images, (2) videos, (2) article link previews, which are small snippets of the article displayed from the publisher website and containing a short summary of the paper. Then, image content was further classified to images (a) from papers (key figures, snapshots of article content) and (b) being from elsewhere (related to subject of paper, related to the author (e.g., while presenting at a conference), and journal cover or database logo). Majority of the hyperlinks to the papers were not shown in preview mode and not all preview modes contained a figure from the paper. If the article link preview contained a figure as a thumbnail it was coded as an image/figure from paper.

### *Statistical analysis*

Odds ratio was calculated to demonstrate the strength of the association between tweets and retweets for each content feature. Values close to 1 show that the odds of tweets are the same in either the presence or absence of them in retweets. Power Analysis was used for assessing the probability of detecting an effect when it exists. Difference of proportions between tweets and retweets were examined using Pearson Chi<sup>2</sup> test and pooled standard deviation was conducted for independent samples. Samples sizes (both n = 371) and confidence interval of 95% was assigned for the power estimates of the proportions. Power Analysis was utilized to estimate the impact of independent samples of original tweets and retweets on the observed proportions of content features which were dummy-coded for the binomial analysis. This study uses the *Power* value to estimate how significant the differences in observation of factors for each group are. In the present study, the power of 0.8 and above means that with 95% confidence interval occurrence of false negatives or type two errors is not likely in 80% or more of the cases.

## **Findings**

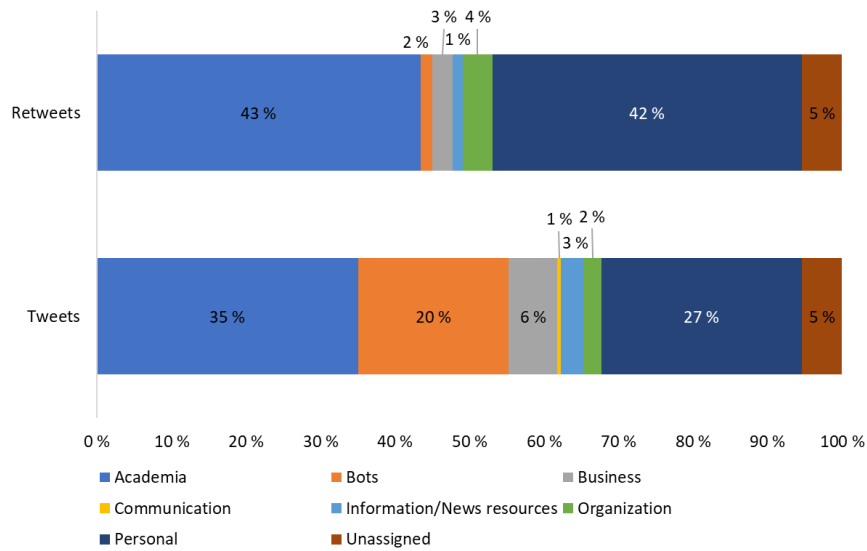
### *Comparing Tweets and Retweets by Types of Twitter Users*

In answer to the first research question, Figure 1 indicates the proportion of tweets and retweets posted by Twitter users categorized based on their profile descriptions and Table 2 indicate the poser of differences between proportions of tweets and retweets poster by each user type. The results show that Academia (35%) and Personal (27%) categories account together for about half of the tweets, but almost 85% of the retweets (43.4% and 41.5%, respectively). Bots and Businesses on the other hand, both have significantly higher contribution to tweets (20.2% and 6.5%, respectively) than retweets (1.6% and 2.7%). The estimated power and odds ratios in the table suggest that the differences between proportions of users tweeting and retweeting behaviour is significant for Academia and Personal user types (both with higher contribution to Retweets), and Bot and Business (both with lower contribution to Retweets), but not significantly different for Organization, Information/News resources, Communication, and Unassigned.

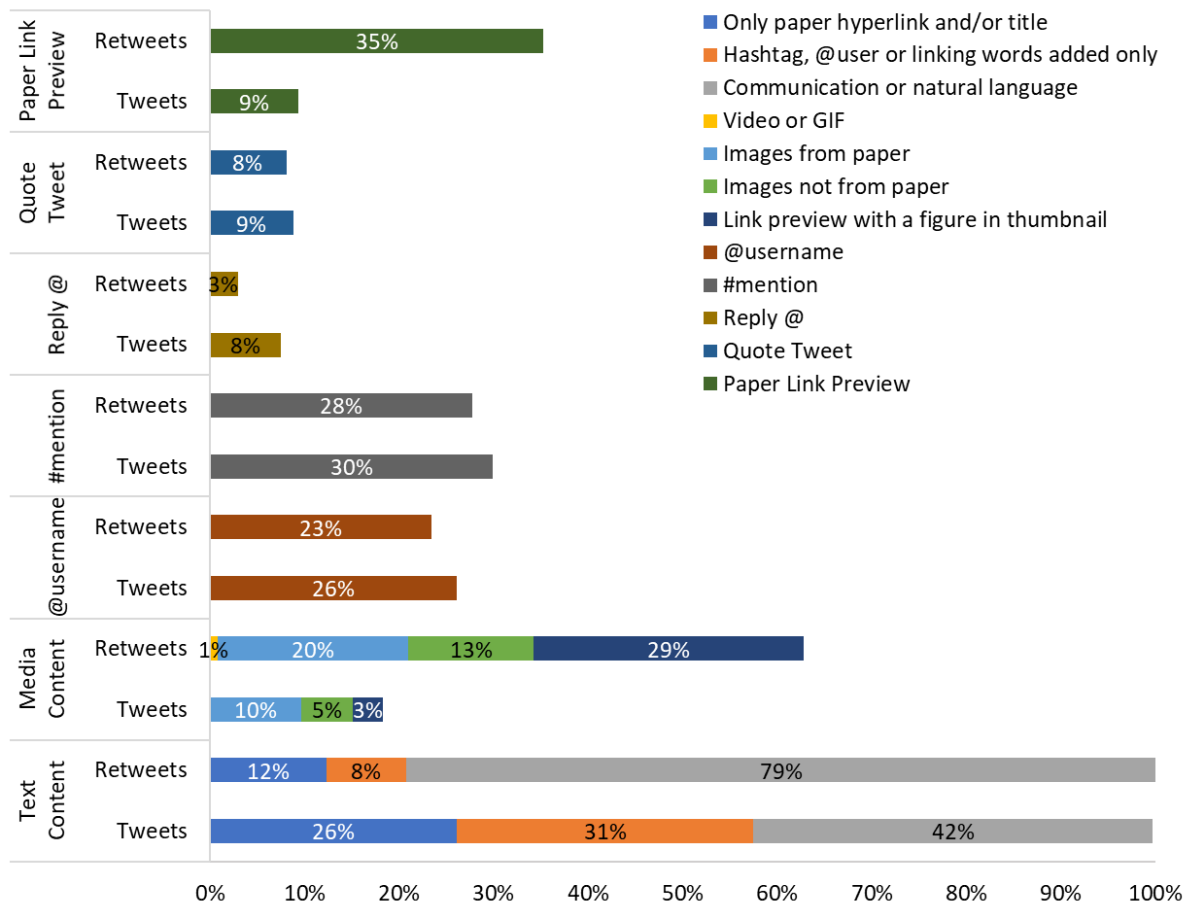
**Table 2. Proportion of various Twitter users' contribution to (Original) tweets and retweets and the Estimated Power of proportions, Odds Ratios in the condition of equal tweet sample sizes (both n = 371) based on the Pearson Chi-Square test. All power estimates conducted at  $\alpha = 0.05$ .**

<i>Twitter User Categories</i>	<i>Proportion of</i>		<i>Estimated Power</i>	<i>Odds Ratio</i>
	<i>Tweets</i>	<i>Retweets</i>		
Academia	35.0 %	<b>43.4 %</b>	0.984	0.521
Bots	<b>20.2 %</b>	1.6 %	1	0.702
Business	<b>6.5 %</b>	2.7 %	0.796	15.568
Communication	0.5 %	0.0 %	-	-
Information/News resources	3.0 %	1.3 %	0.268	2.348

Organization	2.4 %	4.0 %	0.176	0.59
Personal	27.0 %	<b>41.5 %</b>	0.984	0.521
Unassigned	5.4 %	5.4 %	0.034	1



**Figure 1. Cumulative proportion of user categories in Tweet and Retweet datasets.**



**Figure 2. Comparison of Tweets and Retweets in terms of various text and media content.**

### Comparing Tweets and Retweets by Content Features

In answer to the second research question, Figure 2 gives the proportion of various content features seen in the samples and Table 3 shows the significance of difference in proportions between tweets and retweets.

*Text Content.* Over a quarter of tweets contain just a paper hyperlink and/or title (26.1%), compared to only one-eighth of the retweets (12.4%). Hashtags are present in about one third and @username in about one fourth of both tweets and retweets. Almost equal proportions of original Quote tweets (8.9%) and retweeted Quote tweets (8.1%) were discovered. However, Reply @username or Reply tweets were significantly less retweeted (3%) than tweeted (7.5%). The results showed that natural language sentences or phrases are twice as likely in retweets (79.2%) than in tweets (42.3%).

*Media Content.* Video-sharing in tweets linking to papers is rare, however the chances of finding such content in retweets is slightly higher (0.8%) than in original tweets (0%). *Paper link previews* account for 9.4% of the tweets, but it appears to significantly improve the chances of being retweeted (35.3%). Similarly, *link previews with a figure* are much less frequent in tweets (3.2%) compared to retweets, in which they are clearly more common (28.6%). Approximately one in ten tweets (9.7%) contain one or more full size *image of a figure in a paper*, while the appearance of them is almost twice as likely in retweets. This suggests that the presence of figures from papers in the tweets can increase the chances of redistribution on Twitter. It can also be noted that based on the power estimation statistics, including a photo that is not from the scientific paper but still about the subject of the paper (e.g., natural phenomena or manufactured objects) has significantly higher chances to get retweeted (13.2%) compared to their presence in original tweets (5.4%).

**Table 3. Proportion of tweet content features in (Original) tweets and retweets and the Estimated Power of proportions, Odds Ratios in the condition of equal tweet sample sizes (both n = 371) based on the Pearson Chi-Square test. All power estimates conducted at  $\alpha = 0.05$ .**

Content Features of Tweets	Proportion of		Estimated Power	Odds Ratio
	Tweets	Retweets		
<i>Text Content</i>				
Only paper hyperlink and/or title	<b>26.1%</b>	12.4%	0.997	2.495
Hashtag, @user or proposition added only	<b>31.3%</b>	8.4%	1	4.968
Communication/Natural language sentences	42.3%	<b>79.2%</b>	1	0.193
@username	26.1%	23.5%	0.112	1.15
#mention	29.9%	27.8%	0.083	1.108
Reply @	<b>7.5%</b>	3.0%	0.735	2.622
Quote Tweet*	8.9%	8.1%	0.051	1.108
Paper Link Preview	9.4%	<b>35.3%</b>	1	0.19
<i>Media Content</i>				
Video or GIF	18.3%	56.3%	1	0.174
Image	0.0%	0.8%	-	-
: From paper	18.3%	<b>55.5%</b>	1	0.18
:: figure	9.7%	<b>20.2%</b>	0.981	0.424
:: snapshot of article	9.7%	15.6%	0.677	0.581
: Not from paper	0%	4.6%	-	-
	5.4%	<b>13.2%</b>	0.957	0.375

:: related to subject of article	3.2%	<b>10.2%</b>	0.969	0.291
:: related to author	0.3%	0%	-	-
:: journal cover or database logo	1.9%	3.0%	0.11	0.626
: Link preview with a figure in thumbnail	3.2%	<b>28.6%</b>	1	0.083

\* In Twitter, Quote tweets are type of retweets, but as they have an original contribution from users and are possible to be retweeted we identify them as original tweets and it is “retweet at a Quote tweet” that is counted in retweet category.

It was further investigated how different content features appear in in tweets and retweets (Table 4 and 5). In terms of text content, majority of original tweets contain *non-title, Communication sentences* produced by *Academia* (21%) and *Personal* accounts (14%), whilst these account types retweet *Communication sentences* (31.5% and 36%, respectively) significantly more compared to original tweets. Although *Academia* accounts post most of the original tweets to scientific publications, they tend to use hashtags and @username mentions significantly more in original tweets (10%) compared to retweets (4.6%). Retweets by *Academia* include hyperlinks and/or titles (7.3%) more than the original tweets do (3.5%), although the differences are not significant. *Personal* accounts, however, indicate significantly less interest in retweeting hyperlinks and titles (3%), while showing significantly higher number of tweets with those features (7.8%) (Power > 0.8). Bots tend to mainly publish original tweets with hyperlinks and titles (10% vs. 0.3% retweets) and hashtags and @username mentions (9.2% vs. 0% retweets), rather than retweet these.

In terms of media content, Table 4 demonstrates that usage of images is more frequent in original tweets by *Academia* (7.5%) than by *Personal* accounts (3.8%), however they both retweet them significantly more (22% and 25%, respectively). Paper URL Previews in the sample were mostly tweeted by *Organizations* (e.g., publishers and journals), whilst *Academia* and *Personal* categories both accounted for only 0.3% of the original tweets with link previews, but retweet them significantly more (17% and 14%, respectively).

**Table 4. Proportion of various Twitter users’ contribution to (Original) tweets and retweets with specified Twitter *text* content type and the range of significant Power of proportions based on the Pearson Chi-Square test. All power estimates conducted at  $\alpha = 0.05$ .**

Twitter User Categories	Hyperlink & title		Only # or @ added		Communication sentences	
	Tweets	Retweets	Tweets	Retweets	Tweets	Retweets
Academia	3.5%	7.3%	<b>10.2%</b> <sup>c</sup>	4.6%	21.0%	<b>31.5%</b> <sup>b</sup>
Bots	<b>10.0%</b> <sup>a</sup>	0.3%	<b>9.2%</b>	0.0%	1.1%	1.3%
Business	<b>3.0%</b> <sup>c</sup>	0.3%	2.2%	1.1%	1.3%	1.3%
Communication	0.3%	0.0%	0.3%	0.0%	0.0%	0.0%
Information/News	0.5%	0.3%	0.5%	0.0%	1.9%	1.1%
Organization	0.8%	0.5%	0.5%	0.3%	1.1%	3.2%
Personal	<b>7.8%</b> <sup>c</sup>	3.0%	5.1%	2.4%	14.0%	<b>36.1%</b> <sup>a</sup>
Unassigned	0.3%	0.8%	3.2%	0.0%	1.9%	4.6%

\*The power of proportion differences between tweet (n=371) and retweet (n=371) events was <sup>a</sup> approximately 100%; <sup>b</sup> >90%; <sup>c</sup> >80% based on Pearson Chi<sup>2</sup> test and pooled standard deviation.

**Table 5. Proportion of various Twitter users’ contribution to (Original) tweets and retweets with specified Twitter *media* content type and the range of significant Power of proportions based on the Pearson Chi-Square test. All power estimates conducted at  $\alpha = 0.05$ .**

Twitter User Categories	Images		Paper URL Preview	
	Tweets	Retweets	Tweets	Retweets
Academia	7.5%	<b>22.1%*</b>	0.3%	<b>16.7%*</b>

Bots	3.0%	1.1%	0.3%	0.5%
Business	0.5%	1.1%	0.0%	0.8%
Communication	0.0%	0.0%	0.5%	0.0%
Information/News	0.5%	0.5%	0.3%	0.5%
Organization	0.5%	2.7%	3.8%	0.8%
Personal	3.8%	<b>25.3%*</b>	0.3%	<b>14.3%*</b>
Unassigned	2.4%	2.7%	0.3%	1.3%

\*The power of proportion differences between tweet (n=371) and retweet (n=371) events was approximately 100% based on Pearson Chi<sup>2</sup> test and pooled standard deviation.

## Discussion

This study investigated how different user types tweet and retweet on Twitter, and if certain types of content was more common in either tweets or retweets.

Answering the first research question, the results from this study showed how the contribution of different user types differed between tweets and retweets. The findings showed how academic and individual user types account for clearly more retweets than original tweets (85% retweets vs. 62% tweets), indicating that different user types contribute differently to tweets and retweets. This finding suggests that tweets and retweets possibly reflect different kinds of impact or attention, and that they should be treated separately when considering them as a measure of impact or attention. The findings also show significantly fewer bots in retweets than tweets. Future research that would want to investigate bots in altmetric context, might benefit from focusing on original tweets only.

Some of the findings confirm those from earlier studies. For instance, the proportion of *quote* tweets was consistent across original tweets and retweets (8.9% and 8.1%, respectively) and with previous observations (9% reported by Fang, Costas and Wouters, 2022). Similarly, the proportion of replies in original tweets (7.5%) was very close to earlier results (7% in Fang, Costas and Wouters, 2022), although we observed significantly fewer replies retweeted (3%) than was reported in the earlier study (7%).

Answering the second research question, the results showed significant differences in the text and media content of original tweets and retweets. Firstly, *communicative* sentences were seen about twice as often in retweets than in tweets, suggesting that majority of retweets (about 80%) could be result of actual human interaction. It would also appear that perhaps personal commenting, rather than just sharing the title of a scientific articles, invites more engagement. Secondly, results suggested that *media content* and *hyperlink previews* too are significantly more common in retweets (photos 55.5%, and link previews 35.3%). The inclusion of such content in the tweets appear to attract more engagement in the form of retweeting, thus increasing the reach of the tweeted research papers. As this finding casts some doubt on the usefulness of tweets and retweets as indicators of impact or attention, future research should further investigate the reasons for tweeting and retweeting, and the influence specific characteristics of the tweet content or the scientific paper in itself, that may influence the attention it receives on Twitter.

## Conclusion

This research investigated differences in user engagement, text content and media content between tweets and retweets that link to scientific publications. The findings indicate significant differences, suggesting that Twitter reach of scientific publications is heavily depended on the

chosen strategies to include communicative and visual content, such as images, figures, and other visual media. The findings also suggest that scientific publications that get retweeted more frequently benefit from the inclusion of visual content and that the gained attention may not thus be due to the significance of the research results or reflect public interest towards the research, at least not alone. Further research is needed to identify how these differences between tweets and retweet associate with conventional impact of research and what are the implications of occurrence of different events for research impact evaluation.

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