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Comparison of Altmetrics across Multiple Disciplines: Psychology, History, and Linguistics

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Abstract

Since their emergence in 2010, altmetrics as new indicators of research impact receive considerable attention from scientometricians and various other parties including librarians, who have long been providing citation analysis and bibliometric services in academic and research institutions. Despite their rapid popularity, the validity of altmetrics in research evaluation is not yet clear. One way of assessing a new metric for its suitability in research evaluation is to find out its correlation with an established source of evidence. This study investigates the correlation between altmetrics and citation count in Psychology, History and Linguistics disciplines. In addition, the study also explores the coverage of altmetric measures in each of these disciplines to identify the presence and potential usefulness of different altmetric measures in different disciplines. Altmetrics data from altmetrics.com and citation data from Web of Science database are used for articles published between 2010 and 2012 in top 70 journals of Psychology and Linguistics disciplines and 53 journals of History discipline. Out of 10, 5 metrics (Twitter, Facebook, Blogs, Mendeley and CiteULike) are found to have significant correlation with citation in Psychology while only 2 metrics (Mendeley and Twitter) are in Linguistic and History. In terms of coverage, discipline with higher citation rate (Psychology) attracts higher altmetric coverage while disciplines with lower citation rate (Linguistics and History) attract lower altmetric coverage. Of the three disciplines studied, Psychology is found to be the most likely candidate where altmetrics could be meaningful measures.

Keywords: Altmetrics, Bibliometrics, Scientometrics, Research Impact, Social Media

Topic: Profession

1. Introduction

During the past decade, the world witnesses the rise of social media in various aspects of our society bringing about phenomena that are far reaching with astonishing impact. A Facebook

page would ignite a nation-wide revolution (Vargas, 2012). People would make and break their lives on YouTube ("List of YouTube personalities", n.d.). Twitter has outstripped news wires and become the quickest source of financial news (Ritholtz, 2013). In scientific community, scientometricians are now exploring the possibility of using social media activities as indicators of research impact.

Measuring research impact is a critical task for universities, research organizations and funding agencies in decision making and policy setting including recruitment, promotion and grant allocation. As a measurement, citation count has been a strong indicator upon which to draw conclusions about research impact. It is also the machinery behind other major research measures such as journal impact factor, g-index, and h-index.

However, citation count and those traditional metrics which were originated in print processes and are based on literary output alone are increasing failing to keep pace with the new ways that a researcher can generate impact in today's digital world ("Alternative Metrics Initiative Phase 1 White Paper", 2014). A key limitation is timeliness since it may take years for an article to get cited (Sud & Thelwall, 2014). In addition, these metrics do not recognize non-scholarly and other online uses of an article in today's digital environment (Galligan & Dyas-Correia, 2013). It is also pointed out that they do not assess other forms of research outputs such as datasets, software tools, etc. that are increasingly being shared online and used for both academic and non-academic purposes (Piwowar, 2013; Priem, 2013). Observations such as these have led to the calls for more timely metrics.

Among the attempts to develop non-citation-based metrics, altmetrics receive considerable attention due to the ease with which data can be collected and the availability of a wide range of open data sources (Thelwall, Haustein, Larivière, & Sugimoto, 2013a). There are several descriptions of altmetrics including the following:

- "Altmetrics—short for alternative metrics—aims to measure Web-driven scholarly interactions, such as how often research is tweeted, blogged about, or bookmarked" (Howard, 2012).
- "Altmetrics go beyond traditional citation-based indicators as well as raw usage factors (such as downloads or click-through rates) in that they focus on readership, diffusion and reuse indicators that can be tracked via blogs, social media, peer production systems, collaborative annotation tools (including social bookmarking and reference management services)" (Taraborelli, n.d.).

Proponents of altmetrics see it as a much-needed complement or alternative to traditional metrics. The highly cited altmetrics manifesto lays out key advantages of altmetrics including their potential in identifying important publications, their capacity in being able to track various kinds of research outputs and their relevance in today's Internet age where much knowledge is being disseminated online (Priem, Taraborelli, Groth, & Neylon, 2010). However, altmetrics based on social media are not yet well understood and it is not clear what exactly they measure. In order to understand the validity of altmetrics in research evaluation, it is important to examine the nature of impact measured by altmetrics.

To that extent, some research has been done to investigate the relationship between altmetrics and citation count. The assumption is that, if there is a correlation, altmetrics and citation might measure the same phenomenon (Thelwall et al., 2013a). Studies have so far indicated a positive correlation in general but the scopes of most studies do little to shed light on the disciplinary differences. Since social media practices such as Twitter usage (Holmberg & Thelwall, 2014) and citation behaviours are known to vary across disciplines, it is worthwhile to investigate the

relationship between altmetrics and citations in different disciplines. Our pilot study of about 1,700 publications from different disciplines, using data from Altmetric.com, also reveals different patterns, in terms of coverage and altmetrics scores, across disciplines with Psychology articles attracting the highest altmetrics coverage and scores and computer science articles the lowest.

Given this scenario, it is necessary to do more comprehensive studies to find out disciplinary differences in altmetrics. This study contributes to this discussion by investigating the correlation between altmetrics and citation counts in Psychology, History and Linguistics and compares the result with the findings from a previous study in Biomedical and Life Sciences (Thelwall, Haustein, Larivière, & Sugimoto, 2013b). In addition, the study also explores the presence of altmetrics data in each of these disciplines to identify the validity of different metrics in different disciplines. Specifically, this study seeks to answer the following research questions:

1. Is there a correlation between altmetric measures and citation counts in Psychology, History and Linguistics disciplines?
2. Is the coverage of altmetric measures different across disciplines?

2. Related Work

When assessing a new metric for their suitability in research evaluation, a quite common technique is to test its correlation with an established source of evidence such as journal impact factor or citation count. This technique was used in several studies for webometric and other non-citation-based metrics before altmetrics (Kousha & Thelwall, 2007, 2008, 2009; Kousha, Thelwall, & Rezaie, 2010; Vaughan & Hysen, 2002; Vaughan & Shaw, 2003). For altmetrics, finding their correlation with citation was said to be a logical first step before carrying out other kinds of evaluation such as interviews or questionnaires, content analysis and pragmatic evaluations (Sud & Thelwall, 2014).

So far, a few studies have investigated the relationship between altmetrics and citation count at different settings. Some have focused on a single metric, such as Twitter (Eysenbach, 2011; Shuai, Pepe, & Bollen, 2012), blogs (Shema, Bar-Ilan, & Thelwall, 2014), F1000 (Waltman & Costas, 2014), while others on specific genre, such as readership counts based on Mendeley and CiteULike reference managers (Li, Thelwall, & Giustini, 2012; Priem, Piwowar, & Hemminger, 2011). Others have tested a variety of metrics on a single source, such as PubMed (Thelwall et al., 2013a) or a selected set of publications (Zahedi, Costas, & Wouters, 2014). In those studies, Mendeley and CiteULike were found to have significant correlation with citation for Nature and Science (Zahedi et al., 2014), PLoS (Priem et al., 2011) and JASIST (Bar-Ilan, 2012) journals. Between the two reference managers, Mendeley is more strongly correlated with citation and data is much richer.

Mendeley was also tested thoroughly across 10 Social Sciences and Humanities disciplines and found to have correlation for WoS articles in social sciences and the humanities (Mohammadi & Thelwall, 2014). The same study also revealed that the 44% of articles in social sciences have Mendeley readership mentions in comparison to only 13% in the humanities. However, apart from Mendeley, no other metrics have been tested for specific disciplines in Social Sciences and Humanities. It is also not known the amount of altmetrics data present for each metric in these disciplines.

On the disciplinary level, correlation between citation and 11 metrics were investigated in a comprehensive study of PubMed articles published during 2010-2012 with the data from

altmetric.com (Thelwall et al., 2013a). The study made use of Spearman as well as a new sign test to eliminate biases caused by the slow nature citation and the tendency of altmetrics in generating high altmetric scores for newer articles. The results showed that six of the metrics were associated with citation but the coverage of all metrics was low (below 20%) except for Twitter in biomedical and life sciences. In this paper, we use the same techniques for WoS articles of the same age, published during 2010-2012, to compare disciplinary differences between 'social sciences and the humanities' and 'biomedical and life sciences'.

3. Research Methods

For this study, altmetric data from altmetrics.com and citation data from Web of Science (WoS) database were used for articles published between 2010 and 2012 in top 70 journals of Psychology and Linguistics disciplines and 53 of History discipline.

3.1 Selection of journals from WoS

Based on finding from our initial data exploration, we decided to collect data for 70 journals to get a decent size of altmetric data.

The top 70 journals were chosen from each discipline based on their 2013 impact factor. For Psychology discipline, there are 10 sub-categories in WoS. When selecting the top 70 in Psychology, we chose the first 10 journals with the highest impact factor from each category. Each journal was chosen only once and therefore, for cases where a journal appears in more than one category, additional journal with the next highest impact factor was chosen from the category with more journals to get 70 journals in total. The journals with no altmetric data were also ignored. In History discipline, out of a total of 72 journals in WoS, only 53 were covered in altmetric.com. Therefore, History was left with 53 journals instead of 70. Table 1 shows the total number of publications in WoS and the number of publications in the selected journals for each discipline. This study covers 15%, 64% and 93% of the total number of publications during 2010-2012 in WoS for Psychology, Linguistics and History respectively (Figure 1).

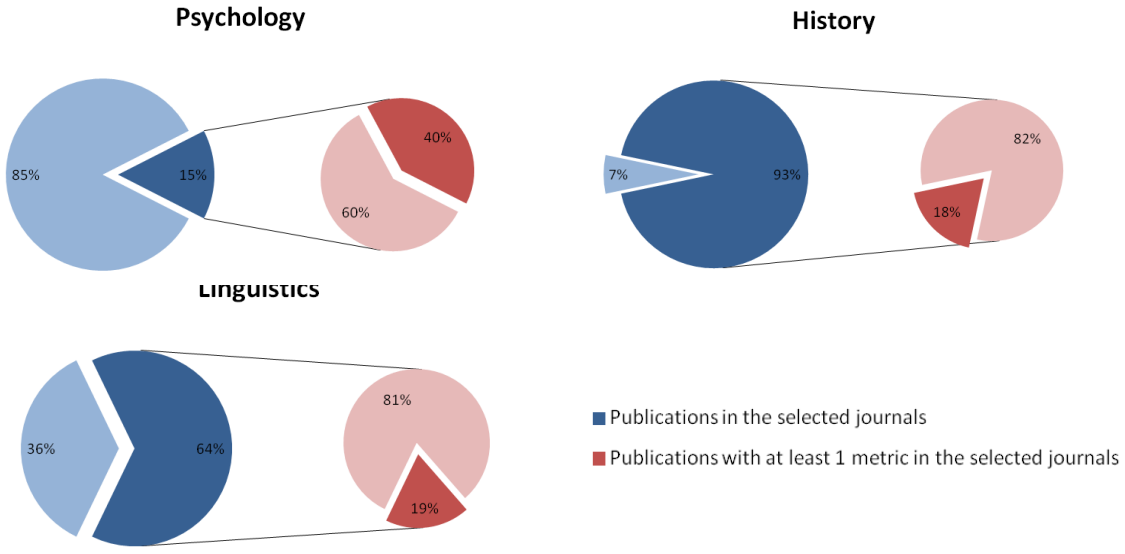

Figure 1: Altmetric coverage in different disciplines

Table 1: Coverage of WoS publications in altmetric.com

	No. of publications in each discipline in WoS (2010-2012)	No. of publications in the selected journals (2010-2012)	No. of publications with at least 1 metric in the selected journals (2010-2012)
Psychology	87135	13094	5285
Linguistic	10932	7033	1310
History	3990	3727	684

3.2 Data collection

All articles from the selected journals and associated altmetric data were exported from altmetric.com using Altmetric Explorer. Publications of all dates were downloaded but only those published during the period 2010-2012 were used for analysis. Citation count, publication year, volume, issue and ISSN for each article were downloaded from WoS using Links Article Match Retrieval Service (Links AMR) API by matching DOIs. In some cases where DOI is not available or incorrect, PMID was used. For very few articles with no identifier at all, citation counts were manually gathered from WoS. We also looked for duplicate records by checking items with the same DOI or PMID but found only a negligible number of records (i.e. two or three records). In the last column of Table 1 is the number of publications that were covered in altmetric.com for the selected journals. 40% of publications have at least one metric in Psychology, 19% in Linguistics and 18% in History (Figure 1).

3.3 Finding correlation

The common type of correlation used in several altmetric studies is Spearman instead of Pearson because typically both altmetric and citation data are too skewed. However, these correlation tests are not ideal for altmetrics and citation because, on average, recent articles are likely to have more mentions in the social web but low in citation counts while older articles are likely to have more citation counts but low in social media mentions thereby causing a bias towards negative correlation between altmetric and citation (Sud & Thelwall, 2014). Therefore, a sign test was introduced in more recent studies to avoid biases caused by time differences (Sud & Thelwall, 2014; Thelwall et al., 2013a). For the completeness of the information, the summary of the sign test presented in the papers by Sud & Thelwall (Sud & Thelwall, 2014) and Thelwall et. al. (Thelwall et al., 2013a) is described below.

In the sign test, each article is compared only against the two articles which are published immediately before and after it within the same journal. For the three articles, the sign test assesses whether a prediction of the difference in citations for the middle article compared to the others would be successful, based upon any difference in altmetric score for the middle article compared to the altmetric scores of the others.

To illustrate how the sign test is carried out to find correlation between tweets and citation, consider the three article A, B and C are in choronological order with 4, 5, 8 tweets and 1, 4, 3 citation counts respectively. The altmetric score of B(5) is compared with the average altmetric score of A and C ((4+8)/2=6). Since 5<6, it results in a prediction that B will have less citation than the average citation of A and C. The sign test gives three possible outcomes:

Success: the altmetric score of middle article is *higher* than the average altmetric score of the two adjacent articles and its citation is *higher* than the average citation of the two adjacent

articles OR the altmetric score of middle article is *lower* than the average altmetric score of the two adjacent articles and its citation is *lower* than the average citation of the two adjacent articles

Failure: the altmetric score of middle article is *higher* than the average altmetric score of the two adjacent articles and its citation is *lower* than the average citation of the two adjacent articles OR the altmetric score of middle article is *lower* than the average altmetric score of the two adjacent articles and its citation is *higher* than the average citation of the two adjacent articles

Null: All other cases.

In the above example, the citation of B (4) is higher than the average citation of A and C ((1+3)/2=2). So this test will count as a failure. Following these tests, the ratio of success and failure cases are counted. The higher the ratio of success to failure, the more strongly altmetric is correlated with citation. On the other hand, if the number of successes are not statistically different from the number of failure, it indicates that there is no correlation.

In this study, we use both Spearman and the sign test to find correlation. The sign test was done in the following way:

For each altmetric, a list was created with all articles that have at least one altmetric mention. The list was then ordered by ISSN first to group articles from the same journal. Within the groups, articles were then ordered by year, issue number and volume number to obtain the chronological order. The sign test was carried out for articles within the same groups. Z test was used to determine if the proportion of successes is significantly different from the default 0.5 as shown in Table 3, Table 5 and Table 7. Bonferroni correction is used to reduce the chances of obtaining false-positive results. This reduces p value to 0.005 for 10 metrics and to 0.00625 for 8 metrics when using the significant level of 5%. This also reduces p value to 0.001 for 10 metrics and to 0.00125 for 8 metrics when using the significant level of 1%.

4. Results and Discussion

4.1 Coverage

Of the 56 disciplines in WoS Social Science Citation Index, Psychology journals, in general, rank top in terms of impact factor while Linguistics and History journals are among the lowest. This means that psychology articles attract citation more than articles in Linguistics and History journals do. As shown in Figure 1, similar pattern exists in altmetrics. 40% of Psychology articles attract altmetric mentions while the other two disciplines attract only 18% and 19%. It seems that there are enough altmetric data in Psychology for altmetrics to be useful and valid. However, the low coverage of publications with altmetrics could challenge the reliability of altmetrics in Linguistics and History.

It is necessary to acknowledge here a limitation with the coverage of altmetric.com. The articles that have only Mendeley or CiteULike mention are not covered by altmetric.com. In Mendeley and CiteULike, the person who bookmarks an article or added a pdf to a library is not identifiable. To appear in altmetric.com, an article must have at least one mention in other auditable sources such as Facebook and Twitter where the identity of the person is verifiable.

Our study adds to the previous findings that the altmetrics sources that provide the most metrics are Mendeley and Tweeter (Robinson-García, Torres-Salinas, Zahedi, & Costas, 2014; Thelwall et al., 2013a; Zahedi et al., 2014) by confirming that it is also true at the disciplinary specific level and for social sciences and humanities, at least in the three disciplines studied in this paper. As shown in Figure 2, altmetrics coverage is low except for Mendeley and Tweets. For instance, 96% of the publications in Psychology have no-zero scores on Mendeley metric, 95% in Linguistics and 64% in History.

Bookmarks and tweets are considered less significant and given less weightage in altmetric.com as compared to news or blog posts. Each metric has different contribution. For example, a newspaper article contributes more than a blog post which contributes more than a tweet. If altmetrics are to be useful, more coverage of other metrics with more significance or contribution, besides Mendeley and Tweeter, is needed.

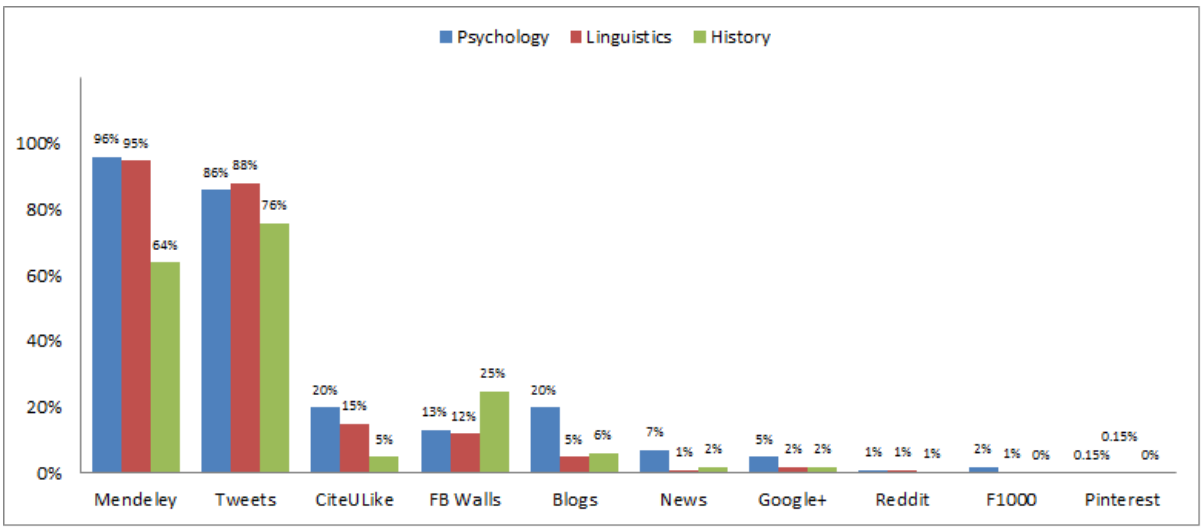

Figure 2: Coverage of 10 altmetric measures in different disciplines

4.2 Correlation

Psychology

We conducted correlation tests, Spearman and sign test, with a total of 5,285 publications in Psychology. For the test with each metric, only journal papers with non-zero scores on the corresponding metric are considered. As shown in Table 2, 5,097 (96%) and 4,533 (86%) journal papers have non-zero scores on Mendeley and Tweets metrics respectively. The other metrics have less than 20% of the publications which have non-zero scores on their metrics.

Both Spearman and sign test indicate significant correlation with Mendeley, Tweets, CiteULike, Facebook Walls, and Blogs (Tables 2 and 3). We observed that Mendeley has stronger correlation with citation than the other four metrics. Also, given that success rate is higher than failure rate in Table 3 for News and Google+, there is a reasonable chance of obtaining statistically significant result if there is enough data. This correlation test in Psychology reveals similar patterns with findings from the study in biomedical and life sciences where Tweets, Facebook walls, research highlights, blog mentions, news and forum posts were found to have correlation with citation.

Table 2: Correlation between metric values and citations for all articles with non-zero scores on each altmetric (Psychology)

Metric	Spearman	Articles (>0)
Mendeley	0.5**	5097 (96%)
Tweets	0.14**	4533 (86%)
CiteULike	0.26**	1074 (20%)
FB Walls	0.11*	690 (13%)
Blogs	0.16**	1078 (20%)
News	-0.07	364 (7%)
Google+	-0.01	284 (5%)
Reddit	-0.12	68 (1%)
F1000	-	102 (2%)
Pinterest	-	8 (less than 1%)

**Significant at p=0.01, Bonferroni corrected for n=10.
*Significant at p=0.05, Bonferroni corrected for n=10.

Table 3: The number of successes and failures for comparisons of citations and metric scores for articles with non-zero metric scores (Psychology)

Metric	Successes	Failures	Z	Null	Total Tests	Journals	Articles
Mendeley**	2880(65%)	1540(35%)	19.9	539	4959	70	5097
Tweets**	1718(56%)	1374(44%)	6.7	1301	4393	70	4533
CiteULike**	328(57%)	245(43%)	3.4	385	958	63	1074
FB Walls**	171(62%)	103(38%)	4	303	577	60	690
Blogs**	312(60%)	206(40%)	4.6	449	967	58	1078
News	83(54%)	72(46%)	1	115	270	52	364
Google+	49(54%)	41(46%)	0.8	107	197	49	284
Reddit	4(44%)	5(56%)	-0.6	15	24	28	68
F1000	-	-	-	70	70	20	102
Pinterest	-	-	-	-	-	6	8

**Significant at p=0.01, Bonferroni corrected for n=10.

Linguistics

We conducted correlation tests with a total of 1,310 publications in Linguistics. As shown in Table 4, 1,240 (95%) and 1,154 (88%) journal papers have non-zero scores on Mendeley and Tweets metrics respectively. The other metrics have less than 15% of the publications which have non-zero scores on their metrics.

Both Spearman and sign test indicate significant correlation with Mendeley and Tweets, but no correlation with the other metrics (Tables 4 and 5). The results are different from the ones in Psychology. We observed that the total number of the publications in Linguistics is relatively smaller than the one in Psychology, and the low coverage of the publications on the other metrics produced the small dataset for correlation tests and affected the result of non-correlation. So we plan to collect more data in the future study for further investigation.

Table 4: Correlation between metric values and citations for all articles with non-zero scores on each altmetric (Linguistics)

Metric	Spearman	Articles (>0)
Mendeley	0.5**	1240 (95%)
Tweets	0.09*	1154 (88%)
CiteULike	0.18	198 (15%)
FB Walls	-0.05	153 (12%)
Blogs	0.2	68 (5%)
News	-0.12	15 (1%)
Google+	0.14	29 (2%)
Reddit	-	19 (1%)
F1000	-	7 (less than 1%)
Pinterest	-	2 (less than 1%)

**Significant at p=0.01, Bonferroni corrected for n=10.
* Significant at p=0.05, Bonferroni corrected for n=10.

Table 5: The number of successes and failures for comparisons of citations and metric scores for articles with non-zero metric scores (Linguistics)

Metric	Successes	Failures	Z	Null	Total Tests	Journals	Articles
Mendeley**	615(64%)	344(36%)	8.7	148	1107	70	1240
Tweets**	379(60%)	259(40%)	5	384	1022	68	1154
CiteULike	47(58%)	34(42%)	1.4	42	123	43	198
FB Walls	16(59%)	11(41%)	0.9	53	80	44	150
Blogs	0(0%)	3(100%)	-1.7	27	30	32	68
News	3(100%)	0 (0%)	1.7	0	3	11	15
Google+	3(75%)	1(25%)	1	3	7	19	29
Reddit	-	-	-	8	8	8	19
F1000	-	-	-	3	3	2	7
Pinterest	-	-	-	-	-	2	2

**Significant at p=0.01, Bonferroni corrected for n=10.

History

We conducted correlation tests with a total of 684 publications in History. As shown in Table 6, 439 (64%) and 522 (76%) journal papers have non-zero scores on Mendeley and Tweets metrics respectively. The other metrics have less than 25% of the publications which have non-zero scores on their metrics.

Spearman result indicates significant correlation with Mendeley, but both Mendeley and Tweets are correlated with citation in the sign test (Tables 6 and 7). The results are similar to the ones in Linguistics except for non-correlation of Tweets in the Spearman test. In our evaluation, sign test seems more reliable to detect correlation between altmetrics and citation count since it detected expected correlation between Tweets and citation count. However, it needs further experiments with a larger dataset in the future study.

Table 6: Correlation between metric values and citations for all articles with non-zero scores on each Altmetric (History)

Metric	Spearman	Articles (>0)
Mendeley	0.31**	439 (64%)
Tweets	0.07	522 (76%)
CiteULike	0.36	31 (5%)
FB Walls	0.19	173 (25%)
Blogs	0.11	41 (6%)
News	0.49	13 (2%)
Google+	-	15 (2%)
Reddits	0.73	5 (1%)

**Significant at p=0.01(0.00125), Bonferroni corrected for n=8.

Table 7: The number of successes and failures for comparisons of citations and metric scores for articles with non-zero metric scores (History)

Metric	Successes	Failures	Z	Null	Total Tests	Journals	Articles
Mendeley**	120 (64%)	67(36%)	3.8	163	350	50	439
Tweets**	106 (63%)	63(37%)	3.4	268	437	53	522
CiteULike	6 (86%)	1(14%)	1.9	10	17	12	31
FB Walls	13 (81%)	3(19%)	2.5	96	112	38	173
Blogs	0 (0%)	1(100%)	-1	13	14	18	41
News	-	-	-	2	2	9	13
Google+	-	-	-	1	1	9	15
Reddits	-	-	-	-	-	4	5

**Significant at p=0.01, Bonferroni corrected for n=8.

5. Conclusion

This study investigated the correlation between altmetrics and citation count in Psychology, History and Linguistics disciplines. In addition, the study also explored the coverage of altmetric measures in each of these disciplines to identify the presence and potential usefulness of different altmetric measures in different disciplines. There are several key findings from the study. Firstly, discipline with higher citation rate attracts higher altmetric coverage while disciplines with lower rate attract lower coverage. Secondly, there are enough altmetric data in Psychology for altmetrics to be potential meaning indicators. On the other hand, the low coverage of publications with altmetrics could challenge the reliability of altmetrics in Linguistics and History. But in all cases, altmetrics coverage is low except for Mendeley and Tweeter. If altmetrics are to be useful, more coverage of other metrics with more significance or contribution is needed. Also there are interdisciplinary differences in coverage and validity of different altmetric measures in different disciplines. Thirdly, Twitter, Facebook, Blogs, Mendeley and CiteULike are found to have significant correlation with citation in Psychology while only 2 metrics (Mendeley and Twitter) are in Linguistic and History.

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