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PEER

PEER USAGE STUDY
Randomised controlled trial results

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[1] OJ L 79, 24.3.2005, p. 1.

PEER USAGE STUDY

Randomised controlled trial results

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FINAL REPORT

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EXECUTIVE SUMMARY

1 **This report reviews the findings of an experiment to measure the effect of exposing early article versions in repositories on downloads of the version of record at various publishers' web sites.**

The research design used was a randomised controlled trial (RCT) involving 18,062 articles from 135 journals and 254,721 publisher downloads. 7,183 preprints were randomly allocated to a control group and temporarily withdrawn from four PEER repositories for a period of three months. Articles were allocated randomly on a title-by-title basis to the control group (`PEER-hidden') and to the treatment group ('PEER-visible'). The purpose of the experiment was to see whether this allocation made any difference to use at the publisher web site?

2 **The key finding of the trial is that the exposure of articles in PEER repositories is associated with an uplift in downloads at the publishers' web sites. This is likely to be the result of high quality PEER metadata, a liberal attitude towards allowing search engine robots to index the material, and the consequently higher digital visibility that PEER creates for scholarly content. Overall, the publisher uplift was 11.4% (95% confidence intervals (CI95), 7.5% to 15.5%) and was highly significant ($p < 0.01$). This finding is consistent with the only other experimental study that CIBER is aware of that used an RCT design to investigate the impact of institutional repository exposure on publisher downloads, albeit for a single journal (Sho and others 2011).**

3 **There was a positive effect on publisher downloads in all four broad subject areas, but this was statistically significant only in the life (20.3%, CI95 13.1% to 27.9%) and physical sciences (13.1%, CI95 5.2% to 21.6%). The uplift in medicine and in the social sciences and humanities could be a chance effect.**

4 **Larger publishers experienced a strong uplift (12.6%, CI95 8.3% to 17.0%), while the increase for smaller publishers was much weaker (3.3%) and could be a chance effect (p=0.53). It is possible to speculate that users tend to gravitate to those publisher sites that offer the best user experience, and the highest value added, but this has not been systematically investigated.**

5 **All the individual publishers, except one, gained additional downloads during the course of the trial. In one case, downloads fell by 33.5% but this is not statistically significant and the sample size was small (n=109 downloads). For three publishers, the uplift was both statistically significant (at the 5% level) and in double figures.**

6 **In a mini-experiment within the randomised controlled trial, the full content (i.e. all articles, not just those with an EU author) of two life sciences journals was ingested into PEER. The uplift in publisher downloads for these titles (19.6%, CI95 4.9% to 36.4%) was very similar to that for EU authored articles (21.2%, CI95 13.0% to 29.9%). Further research on the effects, if any, of repository critical mass, are recommended, as this was a small and indicative mini-experiment.**

7 **For ethical reasons, it was not possible to hide content across the whole of PEER and two repositories remained open as usual, with no content hidden. Users who landed on hidden content at one of the participating repositories were given an explanation and a link to the two non-participating PEER repositories where they could access the full text. Hiding content in one part of the PEER generated additional traffic for the non-participants: up 5.1% (CI95 -1.7% to 12.4%) overall but this was not statistically significant (p=0.14) so we can neither accept nor reject the `no effect' repository hypothesis, the jury is still out on this one.**

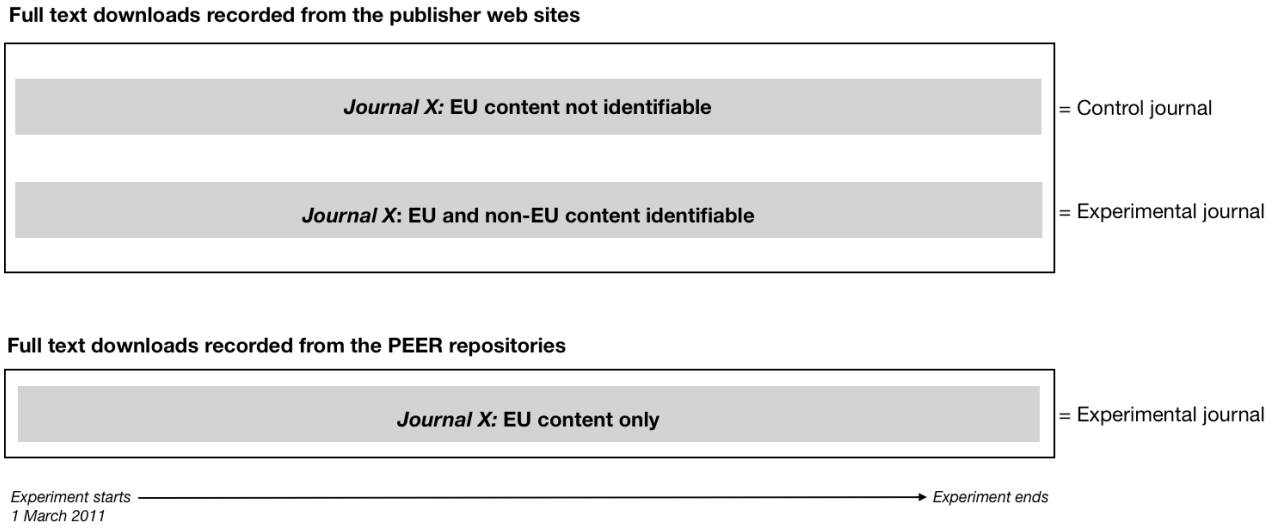
8	**However, the non-participating PEER repositories did pick up significantly more traffic in social sciences and humanities (27.0%, CI95 1.9% to 58.2%, *p*=0.03) and significantly less (-11.6%, CI95 -21.5% to +0.5%, *p*=0.04) in the life sciences. There is much variance in this data, as can be seen in the wide confidence intervals for arts and humanities downloads and the comparatively small sample (*n*=5,776 downloads) so this may not be a decisive finding. One might however speculate that life science users were more inclined to move on to the publisher site, which would be consistent with the large increase in traffic to the publisher sites outlined as key finding 3 above.**
9	**The overall conclusion of this study is that there is no experimental evidence to support the assertion that PEER repositories negatively impact publisher downloads. Further research is recommended to assess the impact of real critical mass (EU articles comprise only a minority of most journal's content) as this has only been explored at the margins of this study. Further research is also needed to better understand how users discover and navigate their way to scholarly content in an increasingly complex digital space.** **The findings may come as a surprise to some, but the important point surfaced is that we should stop thinking in binary terms - repository *versus* publisher - and acknowledge that both are players in a complex scholarly communications ecosystem where visibility is king and the key players are increasingly the general search engines.**

THE STUDY IN CONTEXT

Background and research design

In the original research design for the PEER usage study, the idea was that experimental control would be provided by a set of titles for which no content was ingested into PEER. Parallel lists of experimental and control journals were drawn up at the outset of the project, carefully matched by subject, impact factor tertile, and depth of European coverage such that they were reasonably comparable.

Figure 1: The original PEER experimental control design



The intention was to enable CIBER to make two broad comparisons:

- how does usage of experimental and control journals compare on the publisher web sites?
- for a given experimental journal, how does its usage compare between PEER repositories and publisher websites?

After long reflection, CIBER came to the conclusion that this approach offered limited experimental control and made a proposal to the Research Oversight Group for a radically different approach: a randomised controlled trial. There were two key problems with the original idea. The first was that although we could match experimental and control journals by journal impact tertile, relative numbers of EU27 papers, and so on, we had no way, a priori, of knowing whether their *usage characteristics* were similar. There was also a more practical issue. As the experimental journals are ingested into PEER, metadata is generated for each article. At this stage, articles that satisfy the inclusion condition that they have one or more European authors are flagged up as `EU' and made available to the PEER repositories. This means, for the experimental journals, that we can make a direct 1:1 comparison between the usage of EU articles in PEER and of the same articles on the publishers' web sites. However, we cannot differentiate between EU and non-EU articles in the control journal set, because they are not parsed through PEER.

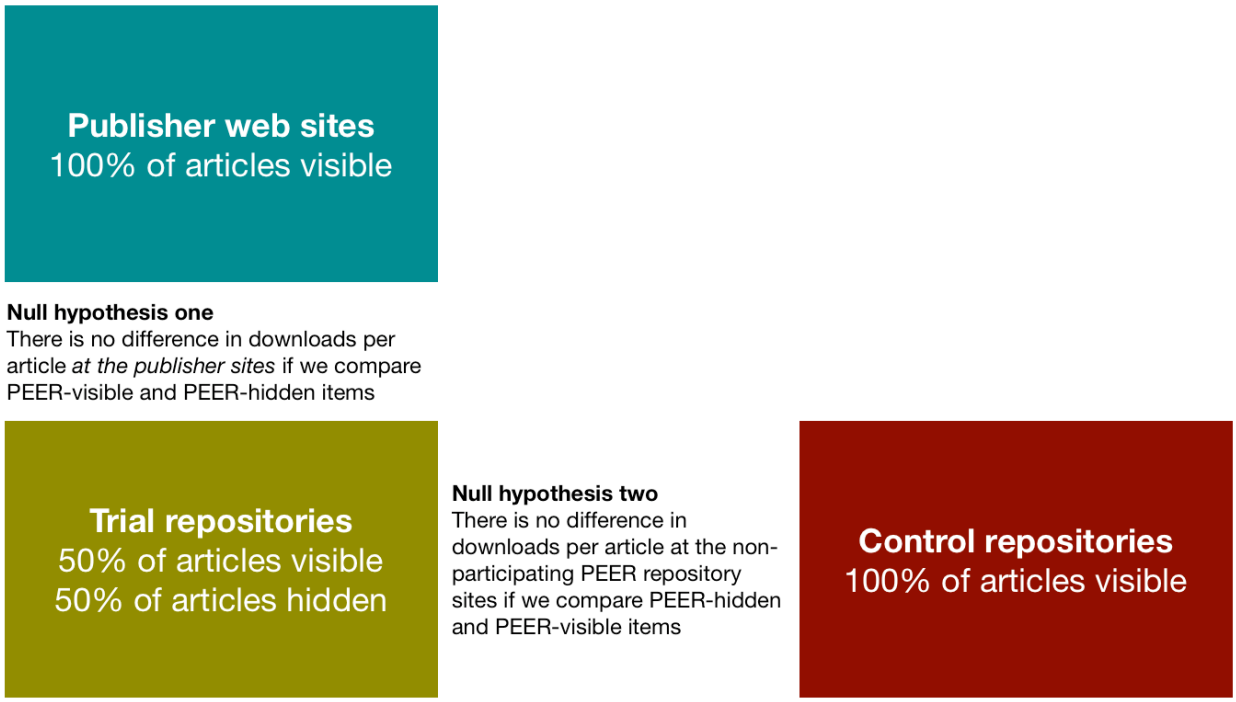
Given these two issues, control would have been weak and since the control and experimental articles were from different journals, it would not have been possible to tell as clear a story as we would wish. If there are differences in the ways that control and experimental journals are used on the publishers' web sites, to what extent is that specifically due to a PEER effect, or simply that we are looking at journals with different usage characteristics? And since we could not isolate EU articles within the control set, we have a third unknown: whether there are differences in the consumption of EU and non-EU articles?

CIBER had in fact originally suggested a randomised controlled trial, with papers being chosen at random from within each journal for inclusion in or exclusion from PEER. If half the articles in a given journal are exposed and half are hidden, then we have a much more direct way of making the comparisons. We can discount any inter-journal effects (i.e. control and experimental journals may have different usage patterns) and we can focus exclusively on EU content.

However, from the outset of the project, the practicalities of the interface between the publishers and repository ingestion made it impossible to allocate articles for PEER ingestion on a random basis within journals and so CIBER proposed a compromise solution (Figure 2).

Within each journal, roughly 50% of the articles were selected at random and the full texts of these papers made temporarily unavailable ('hidden') for three months at four of the PEER repositories. For ethical reasons, users were offered a link from the `hidden' article page to one of the other, non-participating PEER repositories so they could access the pdf there instead.

Figure 2: Overview of RCT research design



	Publisher web sites	Participating PEER repositories	Non-participating PEER repositories
Articles hidden	NONE	Random 50% **Article set A**	NONE
Articles visible	ALL	Random 50% **Article set B**	ALL

The schematic above summarises the trial. Control here is much tighter. The short time period means that we can discount seasonal effects to a large extent. Also, any wider changes in the environment, which make longitudinal analysis so problematic in this fast-moving area, are minimized. We can also discount the `trophy' effect that has blighted other studies: authors tend to be selective, depositing their better papers in institutional repositories. That clearly does not apply here. Entering the trial, which ran for three months (January to March 2012) were 135 journals from eight publishers (BMJ Group, Elsevier, Nature, Oxford University Press, Sage, Springer, Taylor & Francis and Wiley-Blackwell). The control group comprised 7,183 PEER preprints and we monitored the use of 18,062 versions of record on the publishers' web sites.

Randomised controlled trials are a well-understood and well-tested research design in the health sciences and they have been usefully applied in the social sciences in fields as diverse as criminology and information science. Like any other research design, randomised controlled trials have their strengths and weaknesses and these are summarised in the context of the PEER usage study in Figure 3 overleaf.

Figure 3: Experimental assumptions and limitations

Key assumptions

A randomised controlled trial (RCT) can be used to test the effects on publisher usage of making parallel content available through green open access.

RCTs minimise spurious causality and bias and they have been widely adopted in evidence-based policy and practice for these reasons.

The measurement of full-text downloads via log analysis is an unobtrusive research method.

The interpretative approach adopted here is a `null hypothesis': that the PEER intervention makes no difference, unless shown otherwise.

Key limitations

There are very few published papers on the use of RCTs in the context of the scholarly web in contrast, say, to health care.

By virtue of the non-obtrusive nature of the research method, no experimental control over the user popular was possible.

The outcome measure (downloads) is a crude proxy for usage, which in reality embraces a complex set of behaviours.

There may be significant interactions between the experiment and the external environment, thus making it difficult to isolate specific PEER effects.

RCTs may lack external validity and the findings may not be applicable outside of the specific circumstances and context of the experiment: triangulation with other methods (e.g. observational studies) is recommended.

The experimental hypotheses

This research design yields three null (or `no effects') hypotheses:

The `no effect' publisher hypothesis

*There is no difference in downloads per article **at the publisher sites** if we compare Article sets A (PEER-hidden) and B (PEER-visible), as defined above.*

If B articles get significantly lower use than A, then there might be a case that PEER is having a negative impact on publishers. It would appear to be a direct competitor with a `parasitic' relationship to its host. A positive finding in the other direction would tend to favour a `symbiotic' interpretation.

The `no effect' repository hypothesis

*There is no difference in downloads per article **at the non-participating repository sites** if we compare Article sets A and B, as defined above.*

Essentially as above, but the question here is what happens when you block access to a repository?

The `no critical mass effect' hypothesis

There is no difference in downloads per article at the publisher or repository sites in the case of life sciences journals which have full or European content only.

A further experiment-within-an-experiment was also devised. The full content of two life science journals (i.e. articles from all regions, not just those with an EU27 author) was ingested into PEER. The purpose of this was to explore issues of critical mass and this was included within the RCT.

TRIAL RESULTS

The `no effect' publisher hypothesis

H_0 = There is no difference in downloads per article at the publisher sites if we compare PEER-visible and PEER-hidden items.

Table 2 summarises the key findings in relation to the impact of PEER visibility on publisher usage. As noted in the previous report, one of the issues facing CIBER when looking at data from the PEER usage study is that ingestion has been uneven. PEER has not yet settled down into a steady state. For this reason, and to make comparisons more meaningful by subject and publisher, we controlled for the age of the articles (months since first online publication) and for journal impact[1].

Figure 4: PEER visibility and publisher downloads
Downloads per article (estimated marginal means)

Figure 4 and Table 1 below show that when preprints are exposed to the web in PEER repositories, publishers experience greater traffic to their web sites.

Table 1: PEER visibility and publisher downloads
Downloads per article (estimated marginal means) with confidence intervals
n=254,721 downloads, 15,754 articles, 135 journals

			95% confidence interval	
	*Mean**	*SE*	*low*	*high*
PEER-visible articles	17.1	0.21	16.7	17.5
PEER-hidden articles	15.3	0.21	14.9	15.7

*Controlling for article age (months) and journal impact factor

Table 2 shows that depositing articles in PEER is associated with increased downloads at publisher web sites: up by 11.4% (95% confidence interval 7.5% to 15.5%).

Table 2: Testing the `no effect' publisher hypothesis
Negative binomial regression: key test statistics

	Hypothesis test				95% confidence interval for Exp(B)	
	Wald chi²	*df*	*p*	*Exp(B)*	*low*	*high*
PEER-visible articles	34.558	1	**<0.01**	**1.114**	1.075	1.155
PEER-hidden articles			.	1		

[1] The analyses were negative binomial regressions run on the dummy variable (hidden/visible) on log transformed data using the Statistical Package for the Social Sciences (SPSS) V18.

This is highly statistically significant and we have to reject the `no effects' publisher hypothesis (Figure 5). There is a difference and it translates to around 6 or 7 additional downloads per article per annum.

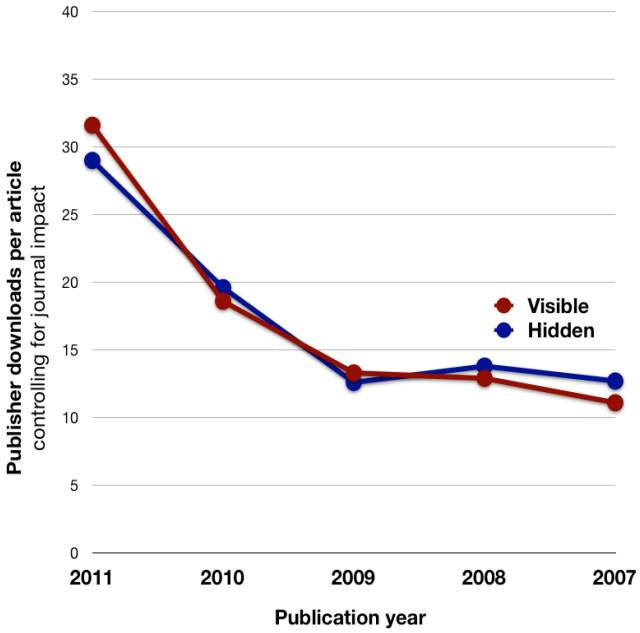
Figure 5: `No effect' publisher hypothesis: The verdict

Visibility makes a real difference	The jury is still out	Visibility makes no difference
p is 0.05 or smaller we **reject** the null hypothesis	*p* lies between 0.05 and 0.95 could just be chance	*p* is 0.95 or larger we **accept** the null hypothesis
X		

After controlling for journal impact, there is no significant difference in the age profile of articles downloaded at the publishers' web sites (Figure 6): whether they are visible or hidden at selected PEER repositories.

Figure 6: Publisher downloads per article by publication year

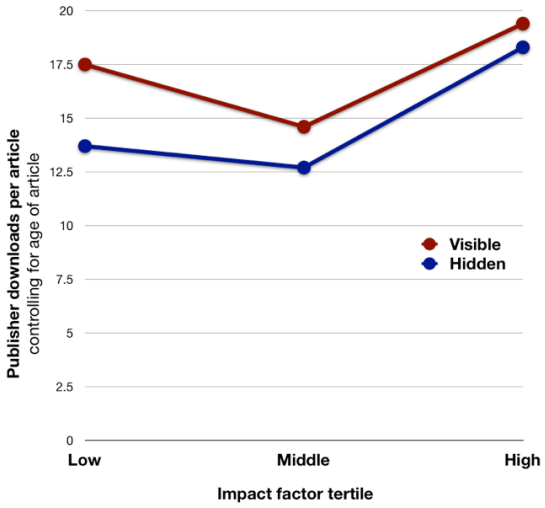
Publisher downloads (estimated marginal means controlling for journal impact)



There is a difference however when we compare publisher downloads by impact factor tertile (Figure 7 overleaf): PEER appears to be increasing interest in lower impact journals at the publisher sites, but this is not statistically significant.

Figure 7: Publisher downloads per article by impact factor tertile

Publisher downloads (estimated marginal means controlling for age of article)



The data presented so far have been for all articles in all journals. We now start to zoom in in more detail to see what kind of variation there is within the trial. Table 3 indicates that there are differences between broad subject areas. Where PEER impact is high and we can reject the `no effect' publisher hypothesis with confidence, the entry is shown in bold red. PEER is associated with an uplift (incidence rate) in publisher traffic in all four subject areas but we can only say that the trial was conclusive for the life and physical sciences, where the probability of getting these results by chance are less than one in a hundred (p<0.01).

Table 3: `No effect' publisher hypothesis: Variation by subject

Downloads per article and incident rate ratios with confidence intervals

SUBJECT VARIATION	Impact of PEER visibility on publisher downloads					
	Mean downloads*			***95% confidence interval***		
	hidden	*visible*	***Incidence rate***	*low*	*high*	*p*
Life sciences	**16.9**	**20.3**	**20.3%**	**13.1%**	**27.9%**	**<0.01**
Medicine	21.3	22.4	5.2%	-1.0%	11.7%	0.10
Physical sciences	**7.6**	**8.6**	**13.1%**	**5.2%**	**21.6%**	**<0.01**
Social sciences and humanities	16.0	16.7	4.1%	-0.05%	13.9%	0.38
THE WHOLE POPULATION	**15.3**	**17.1**	**11.4%**	**7.5%**	**15.5%**	**<0.01**

*Controlling for age of articles and journal impact

The next table (Table 4) shows that the `no effect' hypothesis has to be rejected for larger publishers and that the jury is still out for smaller publishers, although traffic did go up for them as well. Further research is needed to explore this finding. Are users perhaps gravitating towards those publishers with better platforms or more value added content?

Table 4: `No effect' publisher hypothesis: Variation by publisher size

Downloads per article and incident rate ratios with confidence intervals

PUBLISHER SIZE VARIATION	Impact of PEER visibility on publisher downloads					
	Mean downloads*			***95% confidence interval***		
	hidden	*visible*	***Incidence rate***	*low*	*high*	*p*
Larger publishers	**15.4**	**17.3**	**12.6%**	**8.3%**	**17.0%**	**<0.01**
Smaller publishers	15.0	15.5	3.3%	-6.7%	14.3%	0.53
THE WHOLE POPULATION	**15.3**	**17.1**	**11.4%**	**7.5%**	**15.5%**	**<0.01**

*Controlling for age of articles and journal impact

We are unable to identify individual publishers for reasons of commercial sensitivity, so they are anonymised in Table 5. We can reject the `no effect' hypothesis for the last three - the table is arranged in order of increasing PEER impact – and the jury is still out for the others. In one case (Publisher A) traffic decreased for those articles that were visible in PEER but this is not significant and the sample was very small (*n*=109 downloads).

Table 5: `No effect' publisher hypothesis: Variation by publisher (anonymised)

Downloads per article and incident rate ratios with confidence intervals

PUBLISHER VARIATION	Impact of PEER visibility on publisher downloads					
	Mean downloads*			***95% confidence interval***		
	hidden	*visible*	***Incidence rate***	*low*	*high*	*p*
Publisher A	19.8	15.2	-33.5%	-45.9%	-8.4%	0.13
Publisher B	10.8	11.1	3.4%	-11.6%	21.2%	0.68
Publisher C	25.5	26.5	3.9%	-3.0%	11.3%	0.27
Publisher D	5.1	5.5	7.9%	-0.5%	17.1%	0.07
Publisher E	16.6	18.4	10.8%	-3.2%	26.9%	0.14
Publisher F	**22.7**	**25.2**	**11.2%**	**0.0%**	**23.8%**	**0.05**
Publisher G	**15.6**	**17.6**	**13.3%**	**7.6%**	**19.3%**	**<0.01**
Publisher H	**19.3**	**24.2**	**25.7%**	**8.2%**	**45.9%**	**<0.01**
THE WHOLE POPULATION	**15.3**	**17.1**	**11.4%**	**7.5%**		**<0.01**

*Controlling for age of articles and journal impact

In the case of two life sciences journals, PEER ingested the whole content, not just articles that have at least one EU author. The idea behind this was to test the impact, if any, of journal critical mass on usage. Table 6 shows only a marginal difference with both sets attracting around 20% greater traffic at the publisher sites. This is far too small a sample, just two journals from the same publisher, to make any wider claims.

Table 6: `No critical mass effect' publisher hypothesis: Variation by critical mass in the life sciences

Downloads per article and incident rate ratios with confidence intervals

CRITICAL MASS VARIATION	Impact of PEER visibility on publisher downloads					
	Mean downloads*			***95% confidence interval***		
	hidden	*visible*	***Incidence rate***	*low*	*high*	*p*
Life sciences: EU content only	**16.4**	**19.8**	**21.2%**	**13.0%**	**29.9%**	**<0.01**
Life sciences: 100% content	**18.9**	**22.6**	**19.6%**	**4.9%**	**36.4%**	**<0.01**
ALL LIFE SCIENCES	**16.9**	**20.3**	**20.3%**	**13.1%**	**27.9%**	**<0.01**

*Controlling for age of articles and journal impact

It is strongly recommended that further research should be carried out to see what effect, if any, journal critical mass makes to publisher traffic.

The `no effect' repository hypothesis

H_0 = There is no difference in downloads per article at the non-participating PEER repository sites if we compare PEER-hidden and PEER-visible items.

A second objective of the randomised controlled trial was to see how users reacted if they hit on a temporarily unavailable full text document at one of the participating PEER repositories. A link through to one of the other PEER repositories (Trinity College Dublin and the University of Debrecen) was offered so that users were not too badly inconvenienced by the experiment.

When article full texts were temporarily hidden at selected PEER repositories, there was a corresponding increase in usage at the other, non-participating, repositories. This increase was of the order of 5.1% (CI95 -1.7% to 12.4%):

Figure 8: PEER visibility and repository downloads

Downloads per article (estimated marginal means)

Table 7: PEER visibility and repository downloads

Downloads per article (estimated marginal means) with confidence intervals
n=21,867 downloads, 11,491 articles, 135 journals

			95% confidence interval	
	Mean	*SE*	*low*	*high*
PEER-hidden articles	1.86	0.05	1.77	1.95
PEER-visible articles	1.77	0.04	1.69	1.85

Controlling for article age (months) and journal impact factor

This is not a large difference and Table 8 shows that the signal is not strong enough (p=0.14) for us to be able to reject the `no effect' repository hypothesis.

Table 8: Testing the `no effect' repository hypothesis

Negative binomial regression: key test statistics

	Hypothesis test				95% confidence interval for Exp(B)	
	Wald chi²	*df*	*p*	*Exp(B)*	*low*	*high*
PEER-hidden articles	2.131	1	**0.14**	**1.051**	0.983	1.124
PEER-visible articles			.	1		

Figure 9: `No effect' repository hypothesis: The verdict

Visibility makes a real difference	The jury is still out	Visibility makes no difference
p is 0.05 or smaller we **reject** the null hypothesis	*p* lies between 0.05 and 0.95 could just be chance	*p* is 0.95 or larger we **accept** the null hypothesis
	X	

When we look at the downloads for Trinity College Dublin and Debrecen over the period of the trial and compare their age profile (Figure 10) and their journal impact status (Figure 11) we find no significant difference in take-up according to whether the preprints were hidden or visible at the other repositories.

Figure 10: Repository downloads per article by publication year

PEER non-participating repository downloads (estimated marginal means controlling for journal impact)

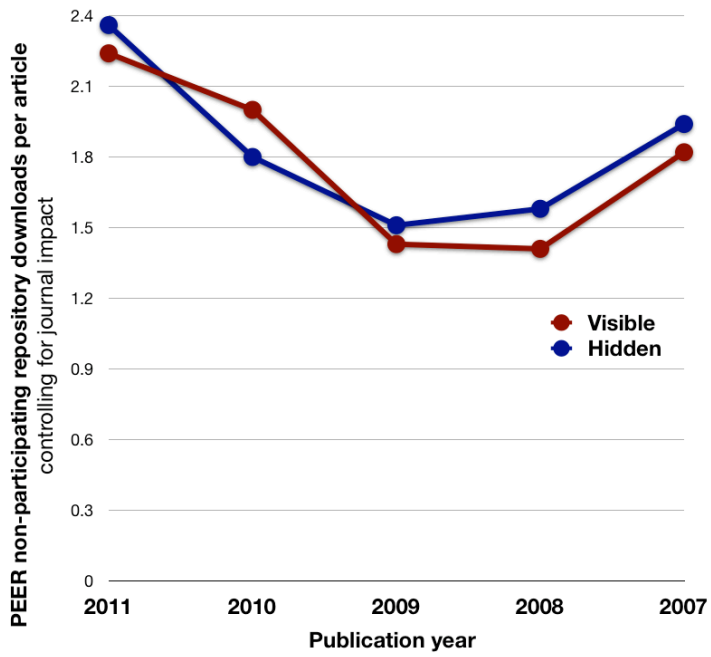
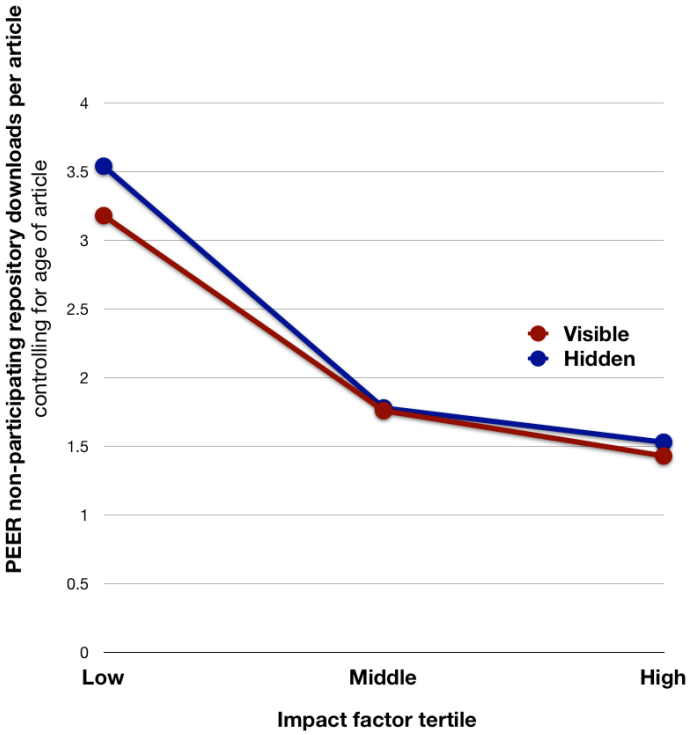


Figure 11: Repository downloads by impact factor tertile

PEER non-participating repository downloads (estimated marginal means controlling for age of articles)



This part of the trial revealed major differences between subject areas. The jury is still out for medicine and the physical sciences, where repository traffic grew but not significantly. Use rose substantially for preprints in the social sciences and humanities and fell in the life sciences. We noted earlier that there was a substantial publisher uplift (20.3%) associated with the life sciences and what we are seeing here may reflect the value that these users associate with the version of record, which may be more important in the hard sciences rather than in the social sciences and humanities.

Table 9: `No effect' repository hypothesis: Variation by subject

Downloads per article and incident rate ratios with confidence intervals

SUBJECT VARIATION			Impact of hiding articles on other PEER repositories			
	Mean downloads*			***95% confidence interval***		
	hidden	*visible*	***Incidence rate***	*low*	*high*	*p*
Life sciences	***1.45***	***1.64***	**-11.6%**	**-21.5%**	**0.5%**	**<0.04**
Medicine	*1.47*	*1.43*	2.7%	-8.4%	15.2%	0.65
Physical sciences	*1.59*	*1.54*	3.2%	-8.4%	16.2%	0.60
Social sciences and humanities	***5.55***	***4.37***	**27.0%**	**1.9%**	**58.2%**	**0.03**
THE WHOLE POPULATION	**1.86**	**1.77**	**5.1%**	**-1.7%**	**12.4%**	**0.14**

*Controlling for age of articles and journal impact

Debrecen was a strong net beneficiary of the usage `lost' at the participating repositories (Table 10) while use increased at Trinity College Dublin, but not significantly (p=0.50).

Table 10: `No effect' repository hypothesis: Variation by repository

Downloads per article and incident rate ratios with confidence intervals

REPOSITORY VARIATION			Impact of hiding articles on other PEER repositories			
	Mean downloads*			***95% confidence interval***		
	hidden	*visible*	***Incidence rate***	*low*	*high*	*p*
Trinity College Dublin	*2.48*	*2.41*	2.6%	-4.9%	10.7%	0.50
University of Debrecen	***1.19***	***1.03***	**15.1%**	**1.5%**	**30.5%**	**0.03**
THE WHOLE POPULATION	**1.86**	**1.77**	**5.1%**	**-1.7%**	**12.4%**	**0.14**

*Controlling for age of articles and journal impact

Downloads of life science preprints decreased, but not significantly. This may possibly be because users migrated instead to the publisher web site for the version of record (see Table 3). The numbers of downloads for 100% content are low in absolute terms (n=595) and so not a reliable guide as regards the very big question about the sensitivity of publisher downloads to repository critical mass.

Table 11: `No critical mass effect' repository hypothesis: Variation by critical mass in the life sciences

Downloads per article and incident rate ratios with confidence intervals

CRITICAL MASS VARIATION			Impact of hiding articles on other PEER repositories			
	Mean downloads*			***95% confidence interval***		
	hidden	*visible*	***Incidence rate***	*low*	*high*	*p*
Life sciences: EU content only	*1.68*	*1.89*	-11.0%	-21.8%	0.1%	0.08
Life sciences: 100% content	*0.78*	*0.84*	-6.8%	-29.7%	23.6%	0.63
ALL LIFE SCIENCES	**1.45**	**1.64**	**-11.6%**	**-21.5%**	**0.5%**	**<0.04**

*Controlling for age of articles and journal impact

PRIOR ART

There is a considerable body of empirical research looking at possible relationships between open access and the number and speed of citations, but little on institutional or subject repositories and publisher usage.

Davis and Fromerth found that articles in four mathematics journal that were deposited in the arXiv received around 23 per cent less downloads on the publisher site. This headline figure has been widely cited (e.g. Morris 2007) but the paper deserves closer reading. Yes, the authors concluded that "the most plausible explanation for the decrease [in publisher downloads] is the presence of a near-identical article (Davies and Fromerth, 2007, p.213). But the paper goes on to point out that cumulative publisher downloads for deposited and non-deposited articles were statistically identical in two (of the nine) years studied. Those years were 2004 and 2005 in a study covering 1997-2005, perhaps suggesting that things were beginning to change over the course of the study. A later study of arXiv and the NASA Astrophysics Data System (ADS) by Henneken and others (2007) found that the use of preprints dropped almost to zero following publication of the version of record. They concluded that "e-prints help journal articles gain more visibility" (p.21) and that articles move through different types of readership over time. Davis and Fromerth also point to functional differences between subject repositories and publisher platforms, speculating that

> "the arXiv and the publisher's website fulfil different functional needs. The publisher's website may be better for information discovery and browsing, especially for recently published articles. In contrast, the arXiv may provide some competition for known article searches" (p.214).

The paper by Davies and Fromerth is interesting and very carefully presented, but how relevant is it to PEER? Seven years is a very long time ago in terms of scholarly information on the internet. And it would be very dangerous to assume that users behaved identically when accessing an iconic subject repository like the arXiv or an institutional repository.

A more recent study by Sho and others (2011) compared the use of zoology articles on two publishing platforms (J-Stage and BioOne.2) following the deposit of 171 preprints in two institutional repositories. The study found that the deposit of preprints did not adversely affect downloads on either commercial platform. In the case of the J-Stage platform, commercial downloads increased for those articles that had been deposited, and the uplift was statistically significant. On the other platform, the direction was reversed, and commercial downloads decreased for those articles where there was an equivalent preprint available. The difference however was not significant (see Table 12).

Table 12: The Sho study findings

Average publisher platform full text downloads

	***Zoological Science* articles**	
	Preprints deposited in IRs	**Preprints not deposited in IRs**
J-Stage platform (2008-2009)	(*n*=126)	(*n*=1,192)
Mean downloads per article*	57.9	51.6
Median downloads per article	50.5	36.0
**Significant difference in Mann-Whitney U test, p<0.01*		
BioOne.2 platform (2009)	(*n*=135)	(*n*=1,476)
Mean downloads per article**	52.4	54.6
Median downloads per article	35.0	39.0
***No significant difference in Mann-Whitney U test, p>0.1*		

Reproduced from Sho and others (2011, pp161-162)

The majority of users (66.6% in 2008 and 72.4 per cent in 2009) found their way to the preprint courtesy of a search engine, predominantly Google, but the study does not speculate on any possible mechanism or mechanisms that might be driving commercial downloads upwards in the case of J-Store.

The experimental approach used did not control for the age of the articles and the authors acknowledge this as a serious limitation, as is the sample size. In conclusion, the research team drew three tentative conclusions:

1. Articles deposited in IRs were used by various people including non-researchers who accessed the information via a search engine;
2. Different countries varied in the relative balance of IR and publisher downloads;
3. Deposit in an IR did not reduce the number of e-journal downloads (or numbers of users).

They offer the following advice: "Depositing journal articles in institutional repositories after a one-year embargo will do more good than harm to scholarly journal publishers." (Sho and others, 2011, p.164).

CONCLUSIONS

The overall finding from this trial is an important one. Articles that are visible in PEER are associated with higher average downloads than those that are hidden, at least in the case of the life and physical sciences where the probability that these results may have arisen by chance is very low, less than one in a hundred. For these subjects, and in the case of larger publishers, we reject the `no effect' publisher hypothesis. Visibility does make a difference and in a positive direction for publishers.

In the case of medicine and the social sciences and humanities, visibility in a PEER repository was also associated with more publisher downloads, although here (and in the case of smaller publishers) this could be explained by chance – noise rather than a strong clear signal.

The relationship between institutional repositories and publishers has often been described in biological terms: are repositories parasitic or symbiotic with respect to publishers (Morris 2007)? This is unhelpful. In preparing this report, CIBER naturally scanned the literature for any experimental work that relates to the possible impacts of repositories on publisher usage. We began our journey using abstracting and indexing services (Scopus and the Web of Knowledge) but found nothing interesting. A Google search led us to a Powerpoint presentation given at the IFLA 2010 Pre-Conference and this was a hot lead: the researchers (Sho and others 2011) had directly compared the use of *Zoological Science* articles across the publisher and two repository platforms. Switching to Google Scholar, we found an unpaginated manuscript at the authors' local institutional repository. Google Scholar listed five versions and clicking on one of these, we were able to access a licensed copy of the final licensed version through a university library. The key players in this scenario – formal A&I services, general search engines, the IFLA web site, institutional repository, publisher, and library service all played a role in a successful conclusion to our research and they all clocked up attention, page views and downloads. The point really is that the metaphor (parasite or symbiont) is really much too stark to be a useful way of looking at things. We are talking about a complex ecosystem.

It is too early to provide an explanation of the generally positive effect on publisher usage that seems to be related to exposure in institutional and other repositories. From our long experience in the field of usage studies, CIBER offers the following conjecture. We think this forms a useful basis for further research and possibly a better understanding of cause and effect.

CIBER's digital visibility conjecture

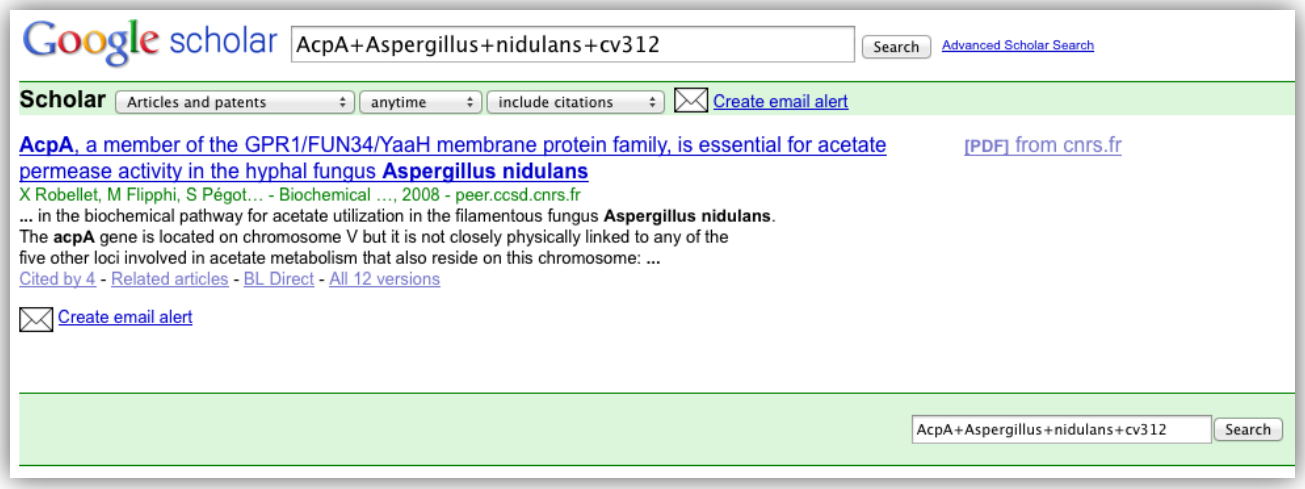
PEER repositories attract visits by a much wider range of search engine robots than any typical publisher. Repository content (in particular full-text pdf) is thus indexed by robots that are excluded by the pay-wall at publishers' sites (Google/Bing may have been granted exception). Because the content of repositories is

indexed, people find it (they do not use the on-site search at repository or publisher). Because the search engine will also pick-up links to the publisher version within and around the full-text, and because the repository links to the publisher, via DOI.org, the publisher's version will also be found in the resulting search. Hence exposure in repository will send traffic to publisher site.

To understand the mechanisms that are possibly driving publisher downloads, it may be instructive to work thorough an example.
The search query "AcpA+Aspergillus+nidulans+cv312" returns two hits on Google.com, as of 19 May 2012. The first is the publisher record and in second place we have a link to a PEER repository.

In Google Scholar, there is just the one record from HAL-INRIA, one of the members of PEER (Figure 12). Someone starting their journey here would not see the publisher link.

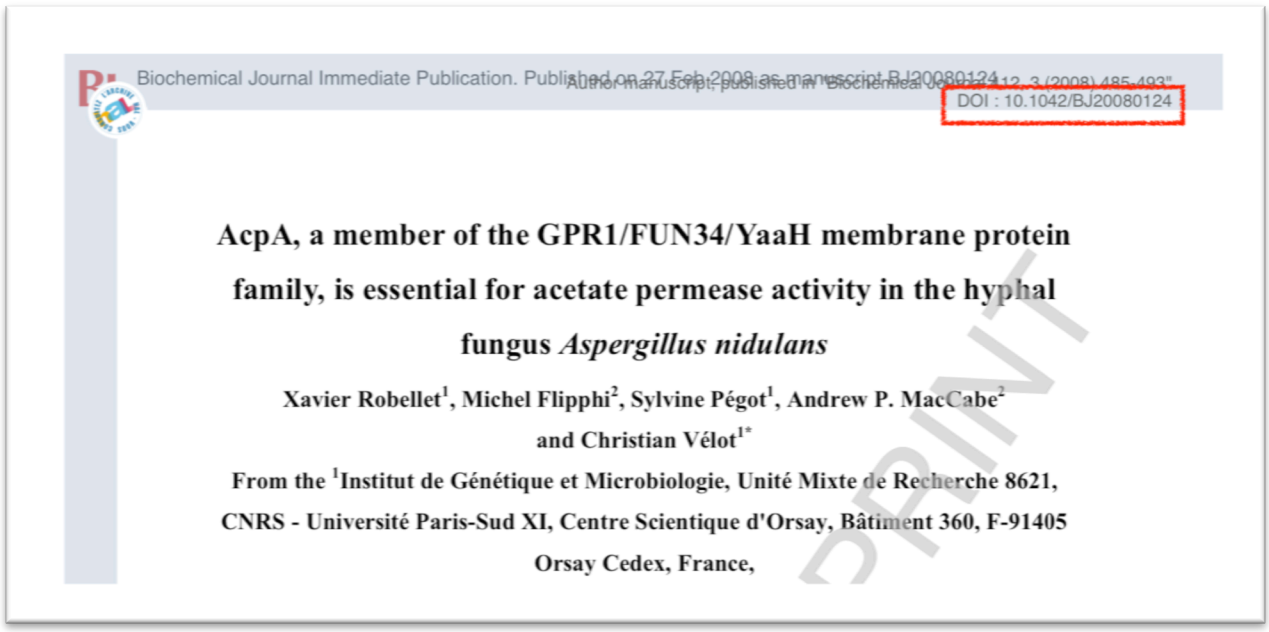
Figure 12: PEER and Google Scholar
Google Scholar screen capture



The user has several options at this point. If they click on the main link, they are directed to the PEER metadata page for that preprint and there have the option to either download it or, if they click on the DOI, to be re-directed to the publisher's web site.

If someone clicks the link on the right hand side, [PDF] from cnrs.fr, they download the author manuscript immediately (Figure 13). If they click on the DOI link (top right) within this pdf file, they are routed through to the publisher web site.

Figure 13: A PEER preprint



Biochemical Journal Immediate Publication. Published on 27 Feb 2008 as manuscript BJ20080124
Author manuscript; published in "Biochemical Journal 412, 3 (2008) 485-493"
DOI : 10.1042/BJ20080124

AcpA, a member of the GPR1/FUN34/YaaH membrane protein family, is essential for acetate permease activity in the hyphal fungus *Aspergillus nidulans*

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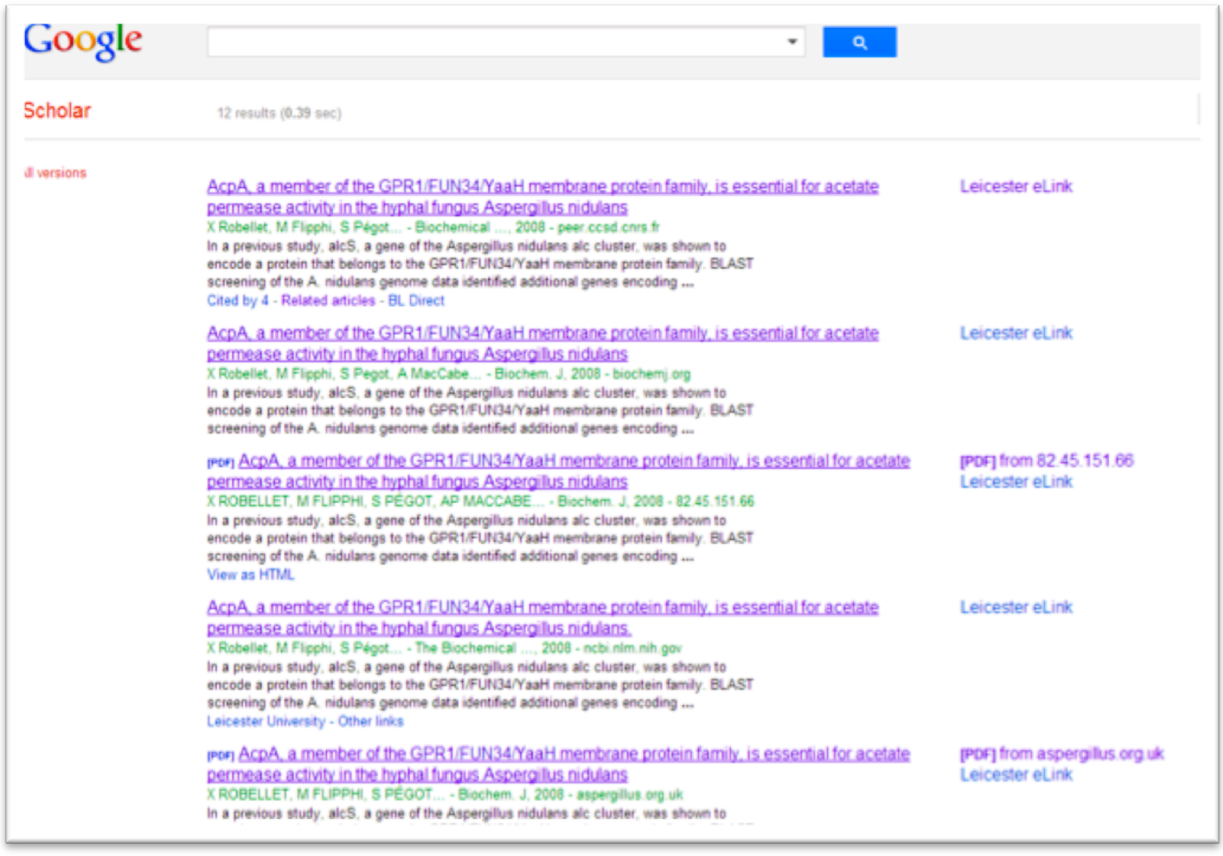
Google Scholar lists 12 versions of the paper and the screen shot below (Figure 14) was taken from inside the walled garden of a British university. Ten of the 12 records have a link through the library (Leicester eLink) where the publisher version of record can be retrieved in a couple of keystrokes.

Figure 14: PEER inside the library walls

Google Scholar screen capture



Google Scholar

12 results (0.39 sec)

all versions

AcpA, a member of the GPR1/FUN34/YaaH membrane protein family, is essential for acetate permease activity in the hyphal fungus Aspergillus nidulans — Leicester eLink
X Robellet, M Flipphi, S Pégot... - Biochemical ..., 2008 - peer.ccsd.cnrs.fr
In a previous study, alcS, a gene of the Aspergillus nidulans alc cluster, was shown to encode a protein that belongs to the GPR1/FUN34/YaaH membrane protein family. BLAST screening of the A. nidulans genome data identified additional genes encoding ...
Cited by 4 - Related articles - BL Direct

AcpA, a member of the GPR1/FUN34/YaaH membrane protein family, is essential for acetate permease activity in the hyphal fungus Aspergillus nidulans — Leicester eLink
X Robellet, M Flipphi, S Pegot, A MacCabe... - Biochem. J, 2008 - biochemj.org
In a previous study, alcS, a gene of the Aspergillus nidulans alc cluster, was shown to encode a protein that belongs to the GPR1/FUN34/YaaH membrane protein family. BLAST screening of the A. nidulans genome data identified additional genes encoding ...

[PDF] AcpA, a member of the GPR1/FUN34/YaaH membrane protein family, is essential for acetate permease activity in the hyphal fungus Aspergillus nidulans — [PDF] from 82.45.151.66 Leicester eLink
X ROBELLET, M FLIPPHI, S PÉGOT, AP MACCABE... - Biochem. J, 2008 - 82.45.151.66
In a previous study, alcS, a gene of the Aspergillus nidulans alc cluster, was shown to encode a protein that belongs to the GPR1/FUN34/YaaH membrane protein family. BLAST screening of the A. nidulans genome data identified additional genes encoding ...
View as HTML

AcpA, a member of the GPR1/FUN34/YaaH membrane protein family, is essential for acetate permease activity in the hyphal fungus Aspergillus nidulans. — Leicester eLink
X Robellet, M Flipphi, S Pégot... - The Biochemical ..., 2008 - ncbi.nlm.nih.gov
In a previous study, alcS, a gene of the Aspergillus nidulans alc cluster, was shown to encode a protein that belongs to the GPR1/FUN34/YaaH membrane protein family. BLAST screening of the A. nidulans genome data identified additional genes encoding ...
Leicester University - Other links

[PDF] AcpA, a member of the GPR1/FUN34/YaaH membrane protein family, is essential for acetate permease activity in the hyphal fungus Aspergillus nidulans — [PDF] from aspergillus.org.uk Leicester eLink
X ROBELLET, M FLIPPHI, S PÉGOT... - Biochem. J, 2008 - aspergillus.org.uk
In a previous study, alcS, a gene of the Aspergillus nidulans alc cluster, was shown to

It may well be the case that for some users, a repository pre-print is entirely sufficient for their purposes and they do not need to go the publisher for a final version. But there are other things going on as we can see above. PEER repositories, in line with best practice, offer a link to the publisher's platform via a DOI and thus also create the reverse effect: driving traffic to the publisher. The combination of repository, search engine and library link resolvers working in harmony leads to more publisher downloads.

An earlier CIBER study for the Research Information Network (CIBER 2011) showed that researchers make little use of the search facilities on publishers' own platforms. Their platforms are heavily used in terms of article downloads, but they are not the first port of call for researchers seeking e-journal content: only one in ten sessions actually starts at the publisher's web site. Qualitative work strongly reinforced researchers' preference for gateway or third-party sites as the means to search and browse for articles: gateway services are preferred for discovery; publisher platforms for delivery or pick-up. Researchers typically use services such as Google and Google Scholar, PubMed, Scopus and Web of Knowledge because they are typically seeking a wide reach in their results. This is all highly relevant context for this randomised controlled trial. Just as in a biological ecosystem, there is a niche for each player, and each is highly dependent upon the others for their survival.

LIMITATIONS AND FURTHER RESEARCH

Action research in an environment as complex as the scholarly web is fraught with difficulties and caution must be applied to the findings of this study. We absolutely must not generalise from the findings here to green open access more generally since PEER has a number of characteristics that taken together make it unique. Automated publisher deposit of content into institutional repositories is far from the norm, and while there may be on-going initiatives for repositories to harvest and share green content, we know of no example which duplicates the huge volume of quality-indexed content across multiple platforms that has has been achieved in the case of PEER. For these reasons PEER stands alone.

The build up to this experiment was long and fraught with unexpected issues along the way (Wallace 2011). A major constraint facing the usage research was that the delays in implementation meant that PEER has still not reached a steady state of ingestion and release of materials. Considerable backfill activity took place, especially during the second half of 2011, and the result is that while PEER has achieved an admirable level of content, the temporal characteristics of that content is not representative of the real world. Substantial backfill is not a normal situation in journal publishing and because of the short duration of the project, the PEER sample is particularly weak in relation to articles aged 3-10 months at one end and at the other end, papers with embargo periods longer than 18 months. In an ideal world, the usage descriptions and randomised controlled trial would have been postponed for twelve months or even longer to allow PEER to attain a natural steady state of ingestion and release following embargo expiry.

Most of CIBER's previous work has involved very detailed scrutiny of a single publisher's log records. PEER was different since so many players were involved, with different log structures and varying levels of detail. In some cases, the log record was almost perfunctory, in others very rich and granular. It would be therefore be invaluable to follow through content from one or two publishers in greater detail, avoiding the lowest common denominator issue. In-depth analysis of the referral patterns to both repository and publisher sites is essential if we are to validate or reject CIBER's conjecture that digital visibility is the likely main driver of the uplift in publisher usage that is the main finding of the trial.

Central to understanding what is going on is a grounded empirical study of the routes that users actually take to discover and navigate their way to content across the scholarly web. The PEER usage studies leave some important questions hanging: to what extent are these findings influenced by search engine factors, social media referral, Google (Scholar) indexing policies, the availability of PEER content on other green platforms such as personal web pages, or system interface design? Are these factors of little effect or significance or could they actually be more important than the experiment itself? A radical conjecture could be that search engines have now become so dominant as to render the underlying question behind

this research (do repository downloads impact on publisher usage) of little more than academic interest. We simply don't know.

As well as the `how', there are also important questions about `who' consumes green open access materials and `why'. More insights are needed into which groups benefit from green open access, especially those groups (e.g. citizen scientists, small and medium sized enterprises) who are largely outside of the licensed walled garden and who might otherwise not be able to access these materials at all. The size and demographics of these user populations would be fascinating and of considerable policy significance.

Davis and Fromerth (2007) propose the idea that repositories and publisher sites offer different user experiences and deliver different kinds of value with repositories typically supporting known item searches and publisher platforms supporting browsing and resource discovery. This is a crude dichotomy but an important one and PEER provides a huge test bed of data for understanding user behaviour more deeply.

The two CIBER PEER studies paint a broad picture of the impact of repositories on publisher usage but the precise mechanisms are not yet fully explicated. We think there would be considerable benefit in taking an homogenous sample of PEER papers with reasonably high activity levels on all platforms and examining the full range of interaction between repositories and publisher sites as well understanding how search engines, social media platforms and other tools fit into the picture.

REFERENCES

CIBER (2011)
E-journals: their use, value and impact (final report). London: Research Information Network, January 2011.

Davis and Fromerth (2007)
Philip M Davis and Michael J Fromerth, Does the arXiv lead to higher citations and reduced publisher downloads for mathematics articles? *Scientometrics* 71(2) 203-213.

Davis and others (2008)
Philip M Davis, Bruce V Lewenstein, Daniel H Simon, James G Booth and Mathew JL Connolly, Open access publishing, article downloads, and citations: randomised controlled trial, *BMJ* 337:a568.

Henneken and others (2007)

Edwin A Henneken, Michael J Kurtz, Gunther Eichhorn, Alberto Accomazzi, Carolyn S Grant, Donna Thompson, Elizabeth Bohlen, Stephen Murray, Paul Ginsparg and Simeon Warner, E-prints and journal articles in astronomy: a productive co-existence, *Learned Publishing* 20(1) (2007) 16-22.

Morris (2007)
Sally Morris, Will the parasite kill the host? Are institutional repositories a fact of life – and does it matter? *Serials* 20(3) 172-179.

Sho and others (2011)
Sho Sato, Yuko Nagai, Shigeki Sugita, Mika Saito and Hiroshi Itsumura, ZS Project: *Zoological Science* meets institutional repositories, In: Open Access to STM Information: Trends, Models and Strategies for Libraries (editor Antha Katsirikou), De Gruyter Saur, 157-166.

Wallace (2011)
Julia M Wallace, PEER: Green open access – insight and evidence, *Learned Publishing* 24(4) October 2011, 267-277.

ANNEXES

THE `NO EFFECT' PUBLISHER HYPOTHESIS

H_0 = There is no difference in downloads per article at the publisher sites if we compare PEER-visible and PEER-hidden items.

THE WHOLE POPULATION

Downloads per article

Downloads per article (estimated marginal means) with confidence intervals
n=254,721 downloads, 15,754 articles, 135 journals

			95% confidence interval	
	Mean	*SE*	*low*	*high*
PEER-visible articles	17.1	0.21	16.7	17.5
PEER-hidden articles	15.3	0.21	14.9	15.7

Controlling for article age (months) and journal impact factor

Downloads per article

Downloads per article (estimated marginal means)

Hypothesis test

Negative binomial regression: key test statistics

	Hypothesis test				95% confidence interval for Exp(B)	
	Wald chi²	*df*	*p*	*Exp(B)*	*low*	*high*
PEER-visible articles	34.558	1	**<0.01**	**1.114**	1.075	1.155
PEER-hidden articles			.	1		

Trial verdict

Visibility makes a real difference	The jury is still out	Visibility makes no difference
p is 0.05 or smaller we **reject** the null hypothesis	*p* lies between 0.05 and 0.95 could just be chance	*p* is 0.95 or larger we **accept** the null hypothesis
X		

Depositing articles in PEER is associated with increased downloads at publisher web sites: up by 11.4% (95% confidence interval 7.5% to 15.5%). This is highly statistically significant.

PEER randomised controlled trial

LIFE SCIENCES EU-27 content

Downloads per article

Downloads per article (estimated marginal means) with confidence intervals
n=61,403 downloads, 3,383 articles, 28 journals

			95% confidence interval	
	Mean	*SE*	*low*	*high*
PEER-visible articles	19.8	0.45	18.9	20.7
PEER-hidden articles	16.4	0.44	15.5	17.2

Controlling for article age (months) and journal impact factor

Downloads per article

Downloads per article (estimated marginal means)

Hypothesis test

Negative binomial regression: key test statistics

	Hypothesis test				95% confidence interval for Exp(B)	
	Wald chi^2	*df*	*p*	*Exp(B)*	*low*	*high*
PEER-visible articles	29.380	1	**<0.01**	**1.212**	1.130	1.299
PEER-hidden articles			.	1		

Trial verdict

Visibility makes a real difference	The jury is still out	Visibility makes no difference
p is 0.05 or smaller we **reject** the null hypothesis	*p* lies between 0.05 and 0.95 could just be chance	*p* is 0.95 or larger we **accept** the null hypothesis
X		

Depositing articles in PEER is associated with increased downloads at publisher web sites: up by 21.2% (95% confidence interval 13.0% to 29.9%). This is highly statistically significant.

PEER randomised controlled trial

LIFE SCIENCES 100% content

Downloads per article

Downloads per article (estimated marginal means) with confidence intervals
n=16,958 downloads, 813 articles, 2 journals

			95% confidence interval	
	Mean	*SE*	*low*	*high*
PEER-visible articles	22.6	1.03	20.6	24.6
PEER-hidden articles	18.9	0.93	17.1	20.7

Controlling for article age (months) and journal impact factor

Downloads per article

Downloads per article (estimated marginal means)

Hypothesis test

Negative binomial regression: key test statistics

	Hypothesis test				95% confidence interval for Exp(B)	
	Wald chi^2	*df*	*p*	*Exp(B)*	*low*	*high*
PEER-visible articles	7.164	1	**<0.01**	**1.196**	1.049	1.364
PEER-hidden articles			.	1		

Trial verdict

Visibility makes a real difference	The jury is still out	Visibility makes no difference
p is 0.05 or smaller we **reject** the null hypothesis	*p* lies between 0.05 and 0.95 could just be chance	*p* is 0.95 or larger we **accept** the null hypothesis
X		

Depositing articles in PEER is associated with increased downloads at publisher web sites: up by 19.6% (95% confidence interval 4.9% to 36.4%). This is highly statistically significant.

For these two journals, 100% of the content was ingested into PEER. On the previous page we see similar results for EU27-content only. There is little difference.

PEER randomised controlled trial

MEDICINE

Downloads per article

Downloads per article (estimated marginal means) with confidence intervals
n=90,746 downloads, 4,175 articles, 36 journals

			95% confidence interval	
	Mean	*SE*	*low*	*high*
PEER-visible articles	22.4	0.47	21.5	23.3
PEER-hidden articles	21.3	0.48	20.3	22.2

Controlling for article age (months) and journal impact factor

Downloads per article

Downloads per article (estimated marginal means)

Hypothesis test

Negative binomial regression: key test statistics

	Hypothesis test				95% confidence interval for Exp(B)	
	Wald chi^2	*df*	*p*	*Exp(B)*	*low*	*high*
PEER-visible articles	2.678	1	**0.10**	**1.052**	0.990	1.117
PEER-hidden articles			.	1		

Trial verdict

Visibility makes a real difference	The jury is still out	Visibility makes no difference
p is 0.05 or smaller we **reject** the null hypothesis	*p* lies between 0.05 and 0.95 could just be chance	*p* is 0.95 or larger we **accept** the null hypothesis
	X	

Depositing articles in PEER is associated with increased downloads at publisher web sites: up by 5.2% (95% confidence interval -1.0% to 11.7%). This is not statistically significant.

PEER randomised controlled trial

PHYSICAL SCIENCES

Downloads per article

Downloads per article (estimated marginal means) with confidence intervals
n=34,556 downloads, 4,375 articles, 43 journals

			95% confidence interval	
	Mean	*SE*	*low*	*high*
PEER-visible articles	8.6	0.22	8.2	9.1
PEER-hidden articles	7.6	0.21	7.2	8.1

Controlling for article age (months) and journal impact factor

Downloads per article

Downloads per article (estimated marginal means)

Hypothesis test

Negative binomial regression: key test statistics

	Hypothesis test				95% confidence interval for Exp(B)	
	Wald chi^2	*df*	*p*	*Exp(B)*	*low*	*high*
PEER-visible articles	11.026	1	**<0.01**	**1.131**	1.052	1.216
PEER-hidden articles			.	1		

Trial verdict

Visibility makes a real difference	The jury is still out	Visibility makes no difference
p is 0.05 or smaller we **reject** the null hypothesis	*p* lies between 0.05 and 0.95 could just be chance	*p* is 0.95 or larger we **accept** the null hypothesis
X		

Depositing articles in PEER is associated with increased downloads at publisher web sites: up by 13.1% (95% confidence interval 5.2% to 21.6%). This is highly statistically significant.

PEER randomised controlled trial

SOCIAL SCIENCES AND HUMANITIES

Downloads per article

Downloads per article (estimated marginal means) with confidence intervals
n=51,058 downloads, 3,008 articles, 36 journals

			95% confidence interval	
	Mean	*SE*	*low*	*high*
PEER-visible articles	16.7	0.52	15.7	17.7
PEER-hidden articles	16.0	0.54	15.0	17.1

Controlling for article age (months) and journal impact factor

Downloads per article

Downloads per article (estimated marginal means)

Hypothesis test

Negative binomial regression: key test statistics

	Hypothesis test				95% confidence interval for Exp(B)	
	Wald chi^2	*df*	*p*	*Exp(B)*	*low*	*high*
PEER-visible articles	0.775	1	**0.38**	**1.041**	0.952	1.139
PEER-hidden articles			.	1		

Trial verdict

Visibility makes a real difference	The jury is still out	Visibility makes no difference
p is 0.05 or smaller we **reject** the null hypothesis	*p* lies between 0.05 and 0.95 could just be chance	*p* is 0.95 or larger we **accept** the null hypothesis
	X	

Depositing articles in PEER is associated with increased downloads at publisher web sites: up by 4.1% (95% confidence interval -4.8% to 13.9%). This is not statistically significant.

PEER randomised controlled trial

LARGER PUBLISHERS

Downloads per article

Downloads per article (estimated marginal means) with confidence intervals
n=216,692 downloads, 13,227 articles, 107 journals

			95% confidence interval	
	Mean	*SE*	*low*	*high*
PEER-visible articles	17.3	0.23	16.9	17.8
PEER-hidden articles	15.4	0.23	14.9	15.8

Controlling for article age (months) and journal impact factor

Downloads per article

Downloads per article (estimated marginal means)

Hypothesis test

Negative binomial regression: key test statistics

	Hypothesis test				95% confidence interval for Exp(B)	
	Wald chi^2	*df*	*p*	*Exp(B)*	*low*	*high*
PEER-visible articles	36.078	1	**<0.01**	**1.126**	1.083	1.170
PEER-hidden articles			.	1		

Trial verdict

Visibility makes a real difference	The jury is still out	Visibility makes no difference
p is 0.05 or smaller we **reject** the null hypothesis	*p* lies between 0.05 and 0.95 could just be chance	*p* is 0.95 or larger we **accept** the null hypothesis
X		

Depositing articles in PEER is associated with increased downloads at publisher web sites: up by 12.6% (95% confidence interval 8.3% to 17.0%). This is highly statistically significant.

PEER randomised controlled trial

SMALLER PUBLISHERS

Downloads per article

Downloads per article (estimated marginal means) with confidence intervals
n=37,862 downloads, 2,359 articles, 28 journals

			95% confidence interval	
	Mean	*SE*	*low*	*high*
PEER-visible articles	15.5	0.56	14.4	16.6
PEER-hidden articles	15.0	0.56	13.9	16.1

Controlling for article age (months) and journal impact factor

Downloads per article

Downloads per article (estimated marginal means)

Hypothesis test

Negative binomial regression: key test statistics

	Hypothesis test				95% confidence interval for Exp(B)	
	Wald chi^2	*df*	*p*	*Exp(B)*	*low*	*high*
PEER-visible articles	0.396	1	**0.53**	**1.033**	0.933	1.143
PEER-hidden articles			.	1		

Trial verdict

Visibility makes a real difference	The jury is still out	Visibility makes no difference
p is 0.05 or smaller we **reject** the null hypothesis	*p* lies between 0.05 and 0.95 could just be chance	*p* is 0.95 or larger we **accept** the null hypothesis
	X	

Depositing articles in PEER is associated with increased downloads at publisher web sites: up by 3.3% (95% confidence interval -6.7% to 14.3%). This is not statistically significant.

THE `NO EFFECT' REPOSITORY HYPOTHESIS

H_0 = There is no difference in downloads per article at the non-participating PEER repository sites if we compare PEER-hidden and PEER-visible items.

THE WHOLE POPULATION

Downloads per article

Downloads per article (estimated marginal means) with confidence intervals
n=21,867 downloads, 11,491 articles, 135 journals

			95% confidence interval	
	Mean	*SE*	*low*	*high*
PEER-hidden articles	1.86	0.05	1.77	1.95
PEER-visible articles	1.77	0.04	1.69	1.85

Controlling for article age (months) and journal impact factor

Downloads per article

Downloads per article (estimated marginal means)

Hypothesis test

Negative binomial regression: key test statistics

	Hypothesis test				95% confidence interval for Exp(B)	
	Wald chi²	*df*	*p*	*Exp(B)*	*low*	*high*
PEER-hidden articles	2.131	1	**0.14**	**1.051**	0.983	1.124
PEER-visible articles			.	1		

Trial verdict

Visibility makes a real difference	The jury is still out	Visibility makes no difference
p is 0.05 or smaller we **reject** the null hypothesis	*p* lies between 0.05 and 0.95 could just be chance	*p* is 0.95 or larger we **accept** the null hypothesis
	X	

When article full texts were temporarily hidden at selected PEER repositories, there was a corresponding increase in usage at the other, non-participating, repositories. This increase was of the order of 5.1% (-1.7% to 12.4%). This is not however statistically significant.

PEER randomised controlled trial

LIFE SCIENCES EU-27 content

Downloads per article

Downloads per article (estimated marginal means) with confidence intervals
n=4,218 downloads, 2,359 articles, 28 journals

			95% confidence interval	
	Mean	*SE*	*low*	*high*
PEER-hidden articles	1.68	0.08	1.52	1.84
PEER-visible articles	1.89	0.08	1.72	2.05

Controlling for article age (months) and journal impact factor

Downloads per article

Downloads per article (estimated marginal means)

Hypothesis test

Negative binomial regression: key test statistics

	Hypothesis test				95% confidence interval for Exp(B)	
	Wald chi²	*df*	*p*	*Exp(B)*	*low*	*high*
PEER-hidden articles	3.130	1	**0.08**	**0.890**	0.782	1.013
PEER-visible articles			.	1		

Trial verdict

Visibility makes a real difference	The jury is still out	Visibility makes no difference
p is 0.05 or smaller we **reject** the null hypothesis	*p* lies between 0.05 and 0.95 could just be chance	*p* is 0.95 or larger we **accept** the null hypothesis
	X	

When article full texts were temporarily hidden at selected PEER repositories, there was a corresponding decrease in usage at the other, non-participating, repositories. This decrease was of the order of 11.0% (-21.7% to 1.3%). This is not however statistically significant.

PEER randomised controlled trial

LIFE SCIENCES 100% content

Downloads per article

Downloads per article (estimated marginal means) with confidence intervals
n=595 downloads, 713 articles, 2 journals

			95% confidence interval	
	Mean	*SE*	*low*	*high*
PEER-hidden articles	0.78	0.08	0.63	0.94
PEER-visible articles	0.84	0.08	0.68	1.01

Controlling for article age (months) and journal impact factor

Downloads per article

Downloads per article (estimated marginal means)

Hypothesis test

Negative binomial regression: key test statistics

	Hypothesis test				95% confidence interval for Exp(B)	
	Wald chi^2	*df*	*p*	*Exp(B)*	*low*	*high*
PEER-hidden articles	0.237	1	**0.63**	**0.932**	0.703	1.236
PEER-visible articles			.	1		

Trial verdict

Visibility makes a real difference	The jury is still out	Visibility makes no difference
p is 0.05 or smaller we **reject** the null hypothesis	*p* lies between 0.05 and 0.95 could just be chance	*p* is 0.95 or larger we **accept** the null hypothesis
	X	

When article full texts were temporarily hidden at selected PEER repositories, there was a corresponding decrease in usage at the other, non-participating, repositories. This decrease was of the order of 6.8% (-29.7% to 23.6%). This is not however statistically significant.

PEER randomised controlled trial

MEDICINE

Downloads per article

Downloads per article (estimated marginal means) with confidence intervals
n=4,820 downloads, 3,322 articles, 36 journals

			95% confidence interval	
	Mean	*SE*	*low*	*high*
PEER-hidden articles	1.47	0.06	1.35	1.59
PEER-visible articles	1.43	0.06	1.32	1.55

Controlling for article age (months) and journal impact factor

Downloads per article

Downloads per article (estimated marginal means)

Hypothesis test

Negative binomial regression: key test statistics

	Hypothesis test				95% confidence interval for Exp(B)	
	Wald chi^2	*df*	*p*	*Exp(B)*	*low*	*high*
PEER-hidden articles	0.210	1	**0.65**	**1.027**	0.916	1.152
PEER-visible articles			.	1		

Trial verdict

Visibility makes a real difference	The jury is still out	Visibility makes no difference
p is 0.05 or smaller we **reject** the null hypothesis	*p* lies between 0.05 and 0.95 could just be chance	*p* is 0.95 or larger we **accept** the null hypothesis
	X	

When article full texts were temporarily hidden at selected PEER repositories, there was a corresponding increase in usage at the other, non-participating, repositories. This increase was of the order of 2.7% (-8.4% to 15.2%). This is not however statistically significant.

PEER randomised controlled trial

PHYSICAL SCIENCES

Downloads per article

Downloads per article (estimated marginal means) with confidence intervals
n=6,458 downloads, 3,973 articles, 43 journals

			95% confidence interval	
	Mean	*SE*	*low*	*high*
PEER-hidden articles	1.59	0.07	1.45	1.72
PEER-visible articles	1.54	0.07	1.41	1.67

Controlling for article age (months) and journal impact factor

Downloads per article

Downloads per article (estimated marginal means)

Hypothesis test

Negative binomial regression: key test statistics

	Hypothesis test				95% confidence interval for Exp(B)	
	Wald chi^2	*df*	*p*	*Exp(B)*	*low*	*high*
PEER-hidden articles	0.271	1	**0.60**	**1.032**	0.916	1.162
PEER-visible articles			.	1		

Trial verdict

Visibility makes a real difference	The jury is still out	Visibility makes no difference
p is 0.05 or smaller we **reject** the null hypothesis	*p* lies between 0.05 and 0.95 could just be chance	*p* is 0.95 or larger we **accept** the null hypothesis
	X	

When article full texts were temporarily hidden at selected PEER repositories, there was a corresponding increase in usage at the other, non-participating, repositories. This increase was of the order of 3.2% 8.4% to 16.2%). This is not however statistically significant.

SOCIAL SCIENCES AND HUMANITIES

Downloads per article

Downloads per article (estimated marginal means) with confidence intervals
n=5,776 downloads, 1,106 articles, 36 journals

			95% confidence interval	
	Mean	*SE*	*low*	*high*
PEER-hidden articles	5.55	0.44	4.69	6.42
PEER-visible articles	4.37	0.35	3.69	5.06

Controlling for article age (months) and journal impact factor

Downloads per article

Downloads per article (estimated marginal means)

Hypothesis test

Negative binomial regression: key test statistics

	Hypothesis test				95% confidence interval for Exp(B)	
	Wald chi^2	*df*	*p*	*Exp(B)*	*low*	*high*
PEER-hidden articles	4.522	1	**0.03**	**1.270**	1.019	1.582
PEER-visible articles			.	1		

Trial verdict

Visibility makes a real difference	The jury is still out	Visibility makes no difference
p is 0.05 or smaller we **reject** the null hypothesis	*p* lies between 0.05 and 0.95 could just be chance	*p* is 0.95 or larger we **accept** the null hypothesis
X		

When article full texts were temporarily hidden at selected PEER repositories, there was a corresponding increase in usage at the other, non-participating, repositories. This increase was of the order of 27.0% 1.9% to 58.2%). This is highly statistically significant.

PEER randomised controlled trial

LARGER PUBLISHERS

Downloads per article

Downloads per article (estimated marginal means) with confidence intervals
n=16,089 downloads, 10,118 articles, 107 journals

			95% confidence interval	
	Mean	*SE*	*low*	*high*
PEER-hidden articles	1.54	0.04	1.46	1.62
PEER-visible articles	1.59	0.04	1.51	1.66

Controlling for article age (months) and journal impact factor

Downloads per article

Downloads per article (estimated marginal means)

Hypothesis test

Negative binomial regression: key test statistics

	Hypothesis test				95% confidence interval for Exp(B)	
	Wald chi^2	*df*	*p*	*Exp(B)*	*low*	*high*
PEER-hidden articles	0.772	1	**0.38**	**0.969**	0.904	1.039
PEER-visible articles			.	1		

Trial verdict

Visibility makes a real difference	The jury is still out	Visibility makes no difference
p is 0.05 or smaller we **reject** the null hypothesis	*p* lies between 0.05 and 0.95 could just be chance	*p* is 0.95 or larger we **accept** the null hypothesis
		✔

When article full texts were temporarily hidden at selected PEER repositories, there was a corresponding decrease in usage at the other, non-participating, repositories. This decrease was of the order of 3.1% (-9.6 to 3.9%). In this case, with $p > 0.95$, we are able to accept the null hypothesis: the experiment revealed *no difference* between the two populations of articles.

PEER randomised controlled trial

SMALLER PUBLISHERS

Downloads per article

Downloads per article (estimated marginal means) with confidence intervals
n=5,367 downloads, 1,271 articles, 28 journals

			95% confidence interval	
	Mean	*SE*	*low*	*high*
PEER-hidden articles	4.45	0.32	3.83	5.07
PEER-visible articles	3.27		2.82	3.73

Controlling for article age (months) and journal impact factor

Downloads per article

Downloads per article (estimated marginal means)

Hypothesis test

Negative binomial regression: key test statistics

	Hypothesis test				95% confidence interval for Exp(B)	
	Wald chi^2	*df*	*p*	*Exp(B)*	*low*	*high*
PEER-hidden articles	9.280	1	**<0.01**	**1.359**	1.116	1.656
PEER-visible articles			.	1		

Trial verdict

Visibility makes a real difference	The jury is still out	Visibility makes no difference
p is 0.05 or smaller we **reject** the null hypothesis	*p* lies between 0.05 and 0.95 could just be chance	*p* is 0.95 or larger we **accept** the null hypothesis
X		

When article full texts were temporarily hidden at selected PEER repositories, there was a corresponding increase in usage at the other, non-participating, repositories. This increase was of the order of 35.9% 11.6% to 65.6%). This is highly statistically significant.