Creating a browser extension to improve PubMed record full text linking

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Presented to

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In Partial Fulfillment

of the Requirements for the

Master of Science Degree

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SUNY POLYTECHNIC INSTITUTE

DEPARTMENT OF COMMUNICATION AND HUMANITIES

CERTIFICATE OF APPROVAL

Approved and recommended for acceptance as a thesis in partial fulfillment of the requirements for the degree of Master of Science in Information Design and Technology

Thesis Advisor: ______________________________________ Date: _______________

Russell L. Kahn, Ph.D.

Second Reader: ______________________________________ Date: _______________

Ibrahim Yucel, PhD

Abstract

PubMed is a free search engine developed and maintained by the National Center for Biotechnology Information (NCBI) at the National Library of Medicine (NLM) which searches the MEDLINE database of references and abstracts on life sciences and biomedical topics. As such it is a valuable search tool for researchers in the health sciences. In my work as a Digital and Technical Services librarian at SUNY College of Optometry, I have registered complaints from frustrated users seeking to connect to full text articles from PubMed. They have reported finding the process confusing and containing too many steps which disrupt their search process. This project took a critical look at PubMed's linking service, LinkOut, used information design theory to propose improvements, and implemented those improvements through the design and development of a browser extension which will be presented to the SUNY Optometry community. This paper describes the process taken to complete this project.

FIGURES

TABLE OF CONTENTS

BACKGROUND

As the World Wide Web gained popularity, online databases containing bibliographic citations became the primary places where users conduct research for scholarly articles. The advent of link resolver technology which uses OpenURL standards in the 2000s allowed users to connect to the full text articles within their institutions' holdings from the bibliographic citations within those databases. A boon for libraries and their users, link resolvers are now ubiquitous within libraries.

While the technology that led to easier full text linking was being developed, the interfaces of the bibliographic databases on which the searches were being conducted were becoming more usable. Commercial search engines informed user search habits on these interfaces as well (Griffiths 2005). This has made users come to expect their search and retrieval process to be easy and seamless. When these expectations are not met it negatively impacts users' overall research process.

Librarians face pressure to make sure that the design of their systems meets user expectations which have been shaped outside of these systems. When the design of these library systems and interfaces does not align with user search processes the result is frustration leading to less use of the system and poorer research outcomes. Librarians can only do so much, however, since they do not have a lot of outside control over the interfaces of the bibliographic databases on which users perform their searches.

PubMed provides various ways to link from their records to an institution's full text articles through their LinkOut service. LinkOut is a valuable tool for libraries yet it has significant shortfalls which do not align with user search processes. As a librarian I provide instruction to users on how to use LinkOut to get full text articles. However, instruction is not enough to overcome deficiencies in design. The goal of this project was to design a browser extension which makes linking to full text articles align with how users search, improving the user experience. This paper will discuss the steps I took to assess LinkOut, applying information design theory to identify specific shortfalls and provide solutions to them, and design and develop a browser extension which implements these solutions.

LITERATURE REVIEW

Introduction

As I began this project it was important to understand how users of library interfaces search for information and retrieve articles. Once I understood this I wanted to identify which best practices in information design would support this search behavior. From there I could begin to examine PubMed's LinkOut and determine how a browser extension may be able to modify the interface to provide a better user experience.

Information Seeking Behavior

There have been a number of studies which explore the behavior of library users in their online search process. The importance of online linking to full text articles is abundant throughout. De Groote, Shultz, and Blecic's (2014) survey of information seeking behavior of health sciences faculty emphasized the importance of online access to full text articles, as 70% of their respondents selected an article to read based on online availability. Highsmith and Ponsford's (2010) analysis of link resolver search logs revealed that "in more than 80 percent of cases where full text was available, users clicked only on the full text links and did nothing else"

(p. 55). Additional studies such as the one performed by Wakimoto, Walker, and Dabbour (2006) have shown that users not only prefer online access to full text articles when they search, they expect it. Expanding upon this, providing access is not enough. That access must be seamless for users. Griffiths and Brophy (2005) found that ease of use plays a large part in student search behavior explaining that "students may trade quality of results for effort and time spent searching" (p. 550). This further demonstrates Marchionini's (1992) finding in his study of essential features of interfaces to support information seeking that users choose the "path of least cognitive resistance" (p. 157).

Best Practices in Information Design to Support Information Seeking Behavior

Users expect that articles will be available in full text online and will be easily accessible. A number of best practices have been offered from the available literature to be applied to the design of the student search experience in support of established information seeking behavior. Chen's (2012) analysis of broken link reports stresses that links to full text must be clear and intuitive. In their report on improving Open URL linking technology Trainor and Price (2010) argue for better interoperability among different platforms and recognize the need for "seamless connectivity" (p.30).

Information design literature from outside of the library world further expands upon these best practices and offers deeper insight into the theory behind them. Oviatt (2006) discusses the application of Cognitive Load Theory to Human-Centered Design stressing importance of minimizing "extraneous cognitive load that users experience due to an interface" by removing distractions (p. 873). Krug's (2014) recommendations also rely on the cognitive load theory, by taking into account what he calls the user's "reservoir of goodwill" (p. 166). Information designers must avoid obstacles which deplete this "reservoir". Moreover, Lidwell's (2010) explanation of Hick’s Law, which states that “the time it takes to make a decision increases as the number of alternatives increases,” rounds out the message that information designers need to avoid superfluous elements that may distract users (p. 120).

Usability of PubMed’s Current Linking Services

The usability of PubMed’s linking services has been evaluated both directly and indirectly. De Groote, Shultz, and Blecic’s (2014) survey found that while users heavily favored both MEDLINE and Google Scholar, Google Scholar was lauded for its ease of use, while frustration was expressed by users seeking full text articles from MEDLINE through PubMed. This difficulty was due to PubMed’s LinkOut service; which links records in PubMed to an institution’s full text holdings, being unknown, misunderstood, and unwieldy. In their study of PubMed usage, Mirel et al. (2013) note that getting from the record in PubMed to the full text of the article was disruptive to the user.

Other studies praise the outside linking services that PubMed offers, yet still provide caveats to this praise. Cecchino (2008) acknowledges the limitations of PubMed’s LinkOut service and offers that some of these limitations may be overcome by institutions configuring their link resolver in PubMed. In their article on implementing and administering LinkOut, Armstrong, McGowan, and Scherrer (2004) describe several challenges ranging from incomplete coverage of full text content to limitations on icons representing full text access. Despite recommending LinkOut they acknowledge, “Librarians considering its use must take several issues into account before and after it is activated” (p. 47).

Browser Extensions

There are some browser extensions already being used by libraries in various capacities. De Sarkar's (2015) exploratory study provides a thorough look at many of these and explains how they can provide "value-added services" and "quicker access to resources" (p. 334). DeVoe's (2013) broader look at browser extensions similarly outlines their potential to enhance library services while noting that "they only serve their purpose if users know about them and know how to use them" (p. 79). Tsai et al. (2009) discuss the creation of a browser extension specifically for PubMed which seeks to enhance its functionality by marking up search results with additional text-mining information.

METHODOLOGY

PubMed's LinkOut

To begin to solve the problem at hand I took a critical look at PubMed's interface and how it incorporates its current linking service, LinkOut. This critical look was through the lens of Cognitive Load Theory which "refers to the mental resources a person has available for solving problems or completing tasks at a given time" and further focuses on "limited attention and working memory capacity as specific bottlenecks that continually exert load during human information processing" (Oviatt 2006). Interfaces should seek to minimize the user's cognitive load to support user's information search and retrieval processes.

LinkOut is a service provided by National Library of Medicine (NLM) which uses OpenURL technology to link from PubMed to articles on publisher websites. Libraries can participate in LinkOut by using their "Submission Utility" which allows libraries to provide journal holdings information to PubMed as well as a library icon that will be displayed on PubMed records when the content is available from the library and will serve as a button which links out to the full text article. Libraries can alternatively participate in LinkOut through use of their "Outside Tool" which involves the library registering their link resolver with PubMed and providing a library icon to be displayed on all records, again serving as a button which links out to the full text article through the individual library's link resolver. For the purposes of this paper I will conform to the common usage and refer to LinkOut by Submission Utility as "LinkOut" and LinkOut by Outside Tool as "Outside Tool".

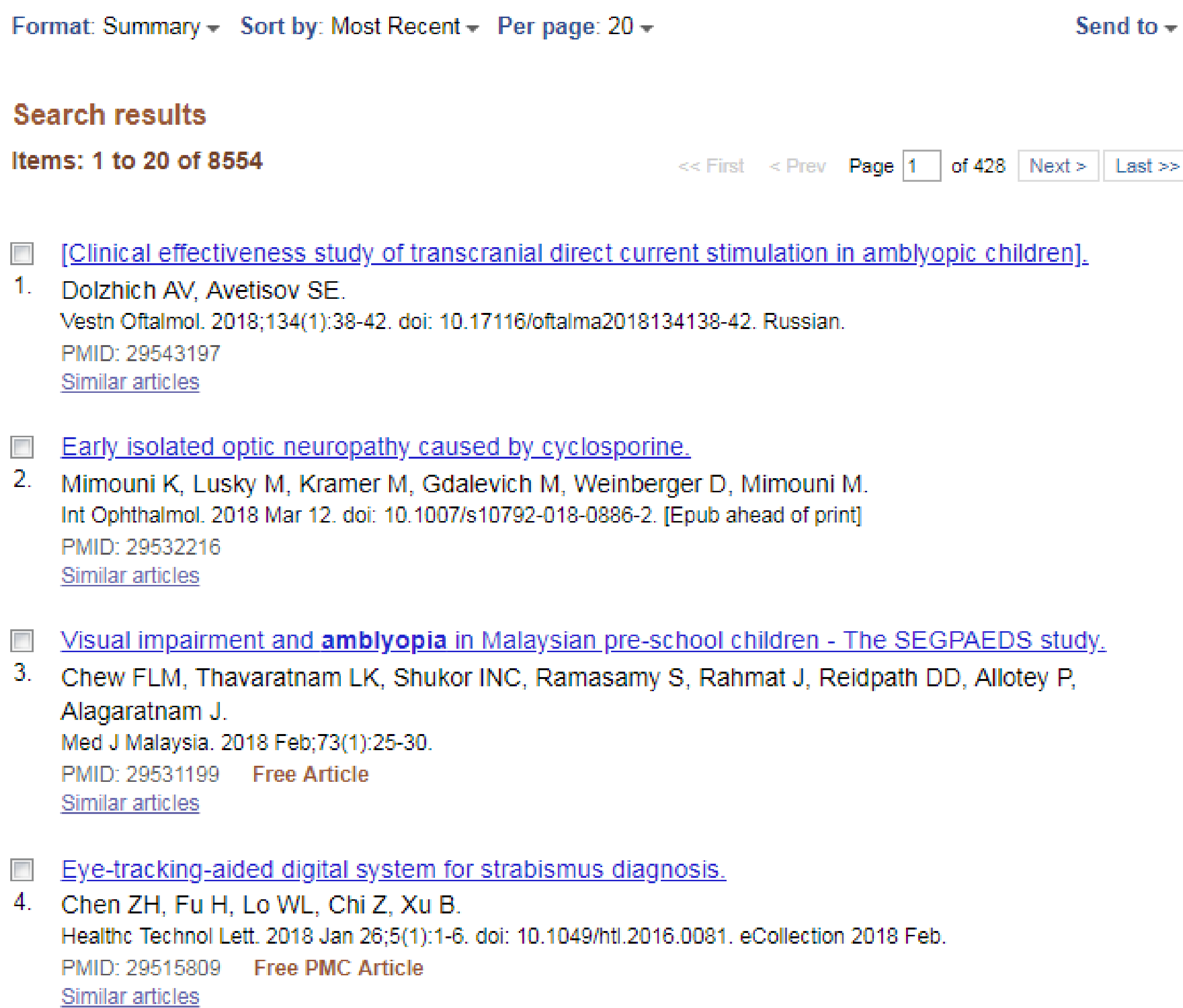
General Issues with LinkOut and Outside Tool

As link resolvers using OpenURL technology began to be adopted on a wide scale in the early 2000s, LinkOut and Outside Tool were valuable in providing users a way to connect to full text articles from bibliographic records within PubMed. However, as users have become accustomed to the ease of use of search engines like Google Scholar, which also allows libraries to register their link resolver, connecting users to full text articles available from the library, LinkOut and Outside Tool's usability shortcomings have become more pronounced in comparison. Users want to be able to go from the bibliographic record to an article as seamlessly and with as few distractions as possible. Each obstacle in the path from getting from the bibliographic record to the full text article increases the user's cognitive load, causing frustration. Both LinkOut and Outside Tool provide many opportunities for the user to encounter these obstacles.

LinkOut: Usability Problems

In order to minimize the cognitive load on the user, the goal of any bibliographic database interface should be to connect users to full text articles as seamlessly as possible. To use LinkOut a user must enter through a URL provided by PubMed, specific to the library. If a user enters PubMed through other means such as Google, typing the PubMed into their web browser, or being linked from another webpage PubMed will not be able to recognize the institutional affiliation of that user and they will not be able to access the full text articles to which they are entitled. Additionally, even if a user accesses PubMed through their PubMed provided URL, if they attempt to connect to articles outside of their institution's IP range, they will hit a paywall on many publisher sites and access will be denied, making remote access nearly impossible. The only way for users to know any of this is through instruction and that may not always be readily available. Even when it is, it is either likely to be forgotten by the time they need to perform a search or unlikely to be recalled while a user they are in the middle of their search. Since "any problem that requires a large number of items to be stored in short-term memory may contribute to an excessive cognitive load" this is a significant obstacle for a user to encounter at the beginning stages of their search as their search may then be abandoned before completion (Sweller 1988). Being able to connect users from a bibliographic record in PubMed to the full text article provided by their library is the crux of LinkOut, yet the way that PubMed determines which library's holdings a user has access to (having the user use the library specific URL) does not align with user search behavior. Moreover, in this situation there is no way for the user to realize their mistake, as there is no error feedback.

The display of LinkOut and the library icons that indicate and link out to full text are another area of potential obstacles for users. When a user performs a search in PubMed the default view of results is "Summary".


Format: Summary Sort by: Most Recent Per page: 20 Send to

Search results

Items: 1 to 20 of 8554 << First < Prev Page 1 of 428 Next > Last >>

1. [Clinical effectiveness study of transcranial direct current stimulation in amblyopic children].
Dolzhich AV, Avetisov SE.
Vestn Oftalmol. 2018;134(1):38-42. doi: 10.17116/oftalma2018134138-42. Russian.
PMID: 29543197
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2. Early isolated optic neuropathy caused by cyclosporine.
Mimouni K, Lusky M, Kramer M, Gdalevich M, Weinberger D, Mimouni M.
Int Ophthalmol. 2018 Mar 12. doi: 10.1007/s10792-018-0886-2. [Epub ahead of print]
PMID: 29532216
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3. Visual impairment and **amblyopia** in Malaysian pre-school children - The SEGPAEDS study.
Chew FLM, Thavaratnam LK, Shukor INC, Ramasamy S, Rahmat J, Reidpath DD, Allotey P, Alagaratnam J.
Med J Malaysia. 2018 Feb;73(1):25-30.
PMID: 29531199 **Free Article**
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4. Eye-tracking-aided digital system for strabismus diagnosis.
Chen ZH, Fu H, Lo WL, Chi Z, Xu B.
Healthc Technol Lett. 2018 Jan 26;5(1):1-6. doi: 10.1049/htl.2016.0081. eCollection 2018 Feb.
PMID: 29515809 **Free PMC Article**
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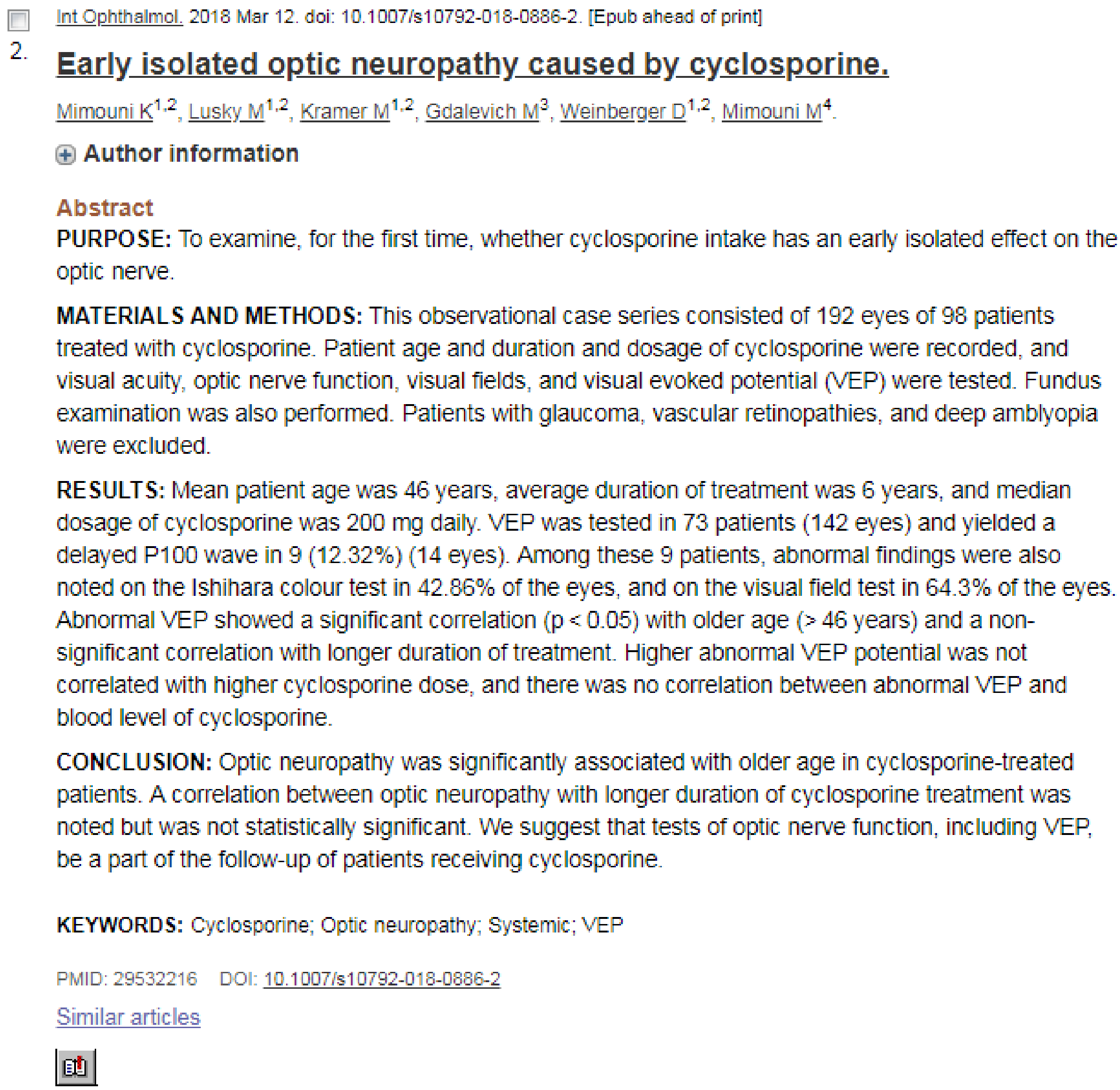
Figure 1. Default "Summary" view with no icons

In order to see if their LinkOut icon, which indicates the availability of a full text article and links out to it, is present they must either click on the title link to view the full record or choose “Abstract” view from the drop down “Format” menu. Not having the full text linking icons viewable on the default results list forces the users to take additional steps to reach the full text article. Moreover, while each library is able to upload their library icon, the specifications are restrictive and icons are small and difficult to notice.



Int Ophthalmol. 2018 Mar 12. doi: 10.1007/s10792-018-0886-2. [Epub ahead of print]

2. **Early isolated optic neuropathy caused by cyclosporine.**

Mimouni K[1,2], Lusky M[1,2], Kramer M[1,2], Gdalevich M[3], Weinberger D[1,2], Mimouni M[4].

Author information

Abstract

PURPOSE: To examine, for the first time, whether cyclosporine intake has an early isolated effect on the optic nerve.

MATERIALS AND METHODS: This observational case series consisted of 192 eyes of 98 patients treated with cyclosporine. Patient age and duration and dosage of cyclosporine were recorded, and visual acuity, optic nerve function, visual fields, and visual evoked potential (VEP) were tested. Fundus examination was also performed. Patients with glaucoma, vascular retinopathies, and deep amblyopia were excluded.

RESULTS: Mean patient age was 46 years, average duration of treatment was 6 years, and median dosage of cyclosporine was 200 mg daily. VEP was tested in 73 patients (142 eyes) and yielded a delayed P100 wave in 9 (12.32%) (14 eyes). Among these 9 patients, abnormal findings were also noted on the Ishihara colour test in 42.86% of the eyes, and on the visual field test in 64.3% of the eyes. Abnormal VEP showed a significant correlation ($p < 0.05$) with older age (> 46 years) and a non-significant correlation with longer duration of treatment. Higher abnormal VEP potential was not correlated with higher cyclosporine dose, and there was no correlation between abnormal VEP and blood level of cyclosporine.

CONCLUSION: Optic neuropathy was significantly associated with older age in cyclosporine-treated patients. A correlation between optic neuropathy with longer duration of cyclosporine treatment was noted but was not statistically significant. We suggest that tests of optic nerve function, including VEP, be a part of the follow-up of patients receiving cyclosporine.

KEYWORDS: Cyclosporine; Optic neuropathy; Systemic; VEP

PMID: 29532216 DOI: 10.1007/s10792-018-0886-2

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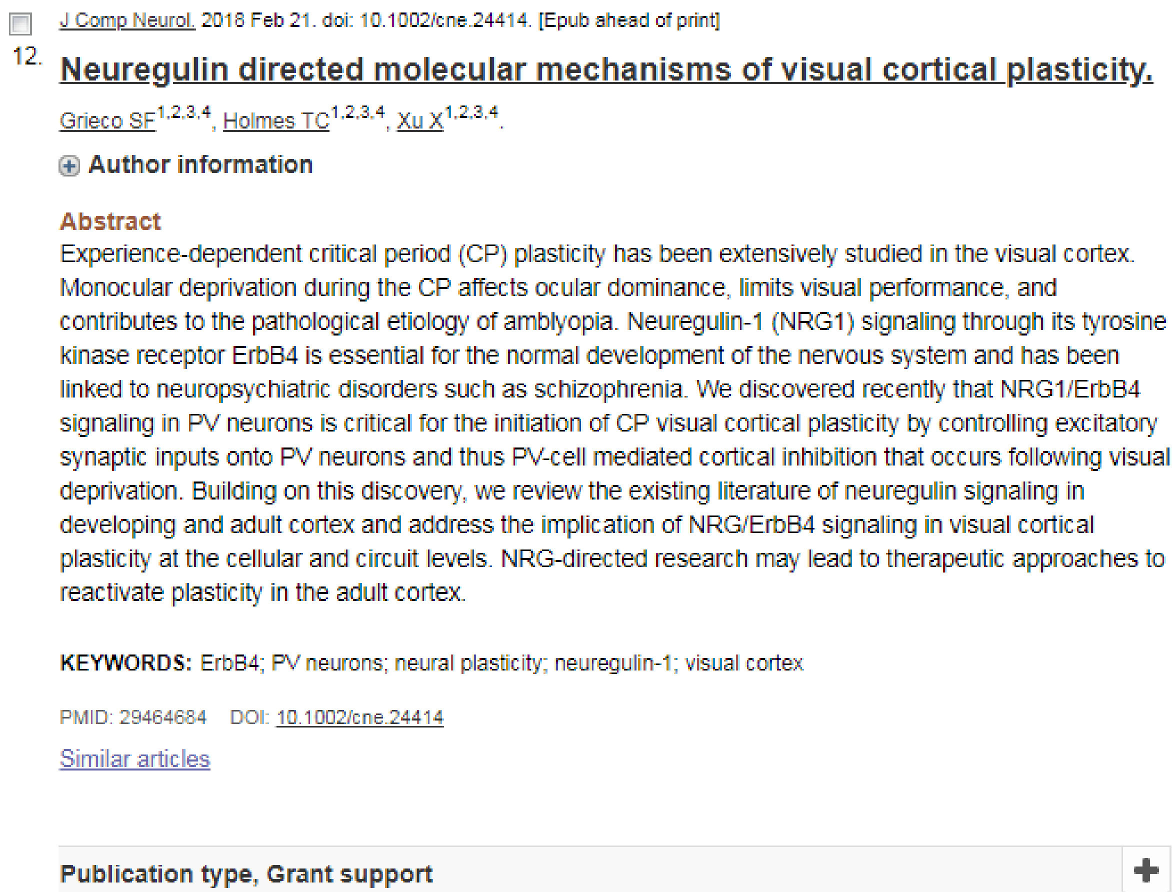
Figure 2. View of record in "Abstract" view with small full text linking icon at the very bottom

The links out to the content are inconsistent as well. As noted above LinkOut provides a link to full text articles via the library's full text icon. However, not every publisher participates in LinkOut. The library icons only appear for articles when both the publishers participate in LinkOut and also when libraries have indicated that they subscribe to that content. This means that when results are displayed, some records do not have any library icon even if a library may have access to the content.



J Comp Neurol. 2018 Feb 21. doi: 10.1002/cne.24414. [Epub ahead of print]

12. **Neuregulin directed molecular mechanisms of visual cortical plasticity.**

Grieco SF[1,2,3,4], Holmes TC[1,2,3,4], Xu X[1,2,3,4].

Author information

Abstract

Experience-dependent critical period (CP) plasticity has been extensively studied in the visual cortex. Monocular deprivation during the CP affects ocular dominance, limits visual performance, and contributes to the pathological etiology of amblyopia. Neuregulin-1 (NRG1) signaling through its tyrosine kinase receptor ErbB4 is essential for the normal development of the nervous system and has been linked to neuropsychiatric disorders such as schizophrenia. We discovered recently that NRG1/ErbB4 signaling in PV neurons is critical for the initiation of CP visual cortical plasticity by controlling excitatory synaptic inputs onto PV neurons and thus PV-cell mediated cortical inhibition that occurs following visual deprivation. Building on this discovery, we review the existing literature of neuregulin signaling in developing and adult cortex and address the implication of NRG/ErbB4 signaling in visual cortical plasticity at the cellular and circuit levels. NRG-directed research may lead to therapeutic approaches to reactivate plasticity in the adult cortex.

KEYWORDS: ErbB4; PV neurons; neural plasticity; neuregulin-1; visual cortex

PMID: 29464684 DOI: 10.1002/cne.24414

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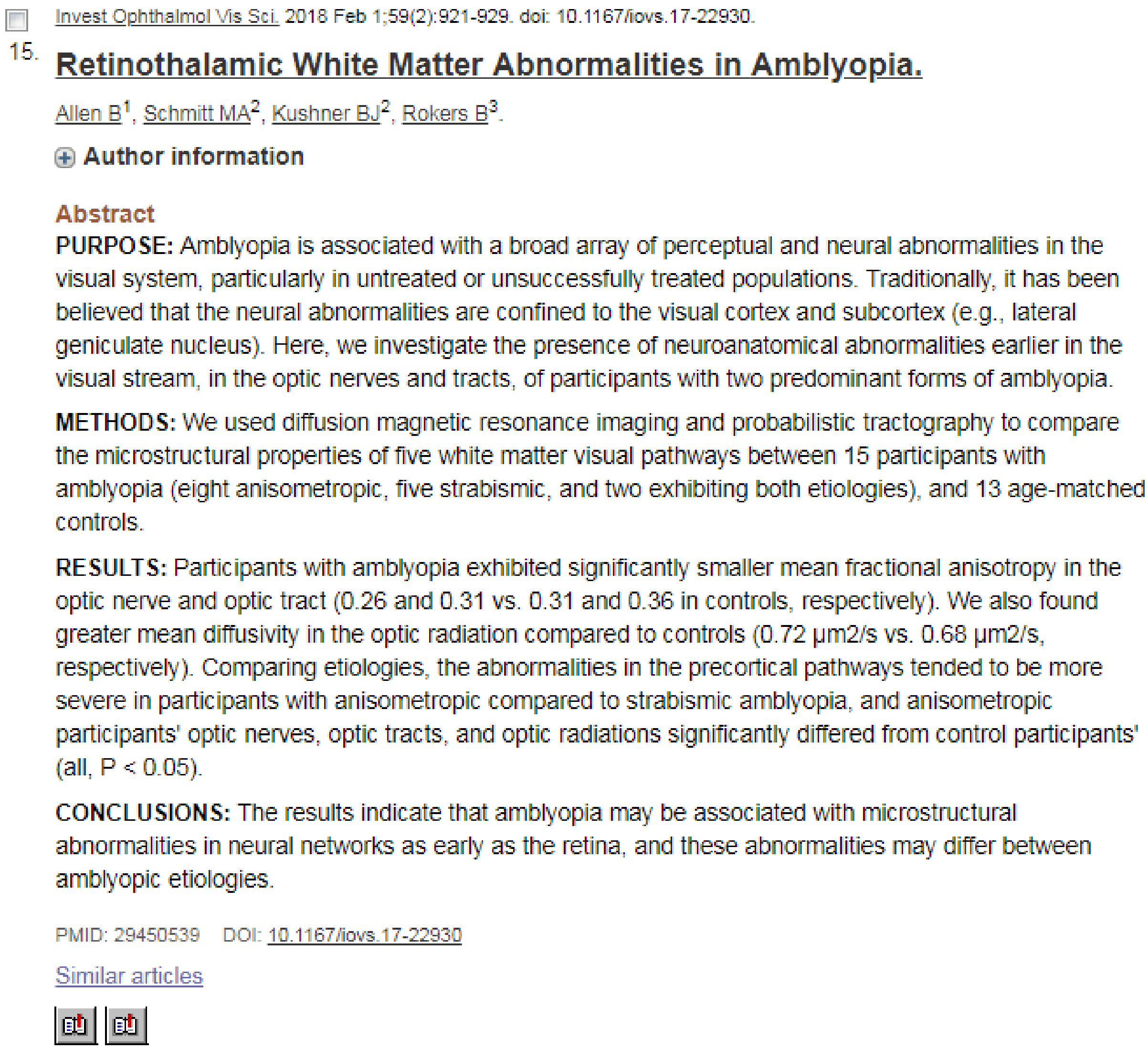
Publication type, Grant support +

Figure 3. Example of a record with no library icon/link to content

The user has no way of knowing which scenario is the case.

On the other end of the spectrum, on certain records LinkOut provides two of the library's full text buttons.



Invest Ophthalmol Vis Sci. 2018 Feb 1;59(2):921-929. doi: 10.1167/iovs.17-22930.

15. **Retinothalamic White Matter Abnormalities in Amblyopia.**

Allen B[1], Schmitt MA[2], Kushner BJ[2], Rokers B[3].

Author information

Abstract

PURPOSE: Amblyopia is associated with a broad array of perceptual and neural abnormalities in the visual system, particularly in untreated or unsuccessfully treated populations. Traditionally, it has been believed that the neural abnormalities are confined to the visual cortex and subcortex (e.g., lateral geniculate nucleus). Here, we investigate the presence of neuroanatomical abnormalities earlier in the visual stream, in the optic nerves and tracts, of participants with two predominant forms of amblyopia.

METHODS: We used diffusion magnetic resonance imaging and probabilistic tractography to compare the microstructural properties of five white matter visual pathways between 15 participants with amblyopia (eight anisometropic, five strabismic, and two exhibiting both etiologies), and 13 age-matched controls.

RESULTS: Participants with amblyopia exhibited significantly smaller mean fractional anisotropy in the optic nerve and optic tract (0.26 and 0.31 vs. 0.31 and 0.36 in controls, respectively). We also found greater mean diffusivity in the optic radiation compared to controls (0.72 μm2/s vs. 0.68 μm2/s, respectively). Comparing etiologies, the abnormalities in the precortical pathways tended to be more severe in participants with anisometropic compared to strabismic amblyopia, and anisometropic participants' optic nerves, optic tracts, and optic radiations significantly differed from control participants' (all, $P < 0.05$).

CONCLUSIONS: The results indicate that amblyopia may be associated with microstructural abnormalities in neural networks as early as the retina, and these abnormalities may differ between amblyopic etiologies.

PMID: 29450539 DOI: 10.1167/iovs.17-22930

Similar articles

Figure 4. Record with redundant buttons

Usually these buttons are redundant, leading to the same article on the same platform. However, sometimes they lead to different platforms and in rare cases one link is broken while the other leads to the full text. This set up shows a lack of functional and internal consistency. The user should be able to know what to expect when they click on a familiar icon. The display of these icons should be consistent to foster trust in the system (Lidwell 2010). Being caught off guard adds to the cognitive load of the user and increases stress.

If a publisher does not participate in LinkOut but the library has titles from that publisher in its collection, the users will not be able to gain access to the articles in that title from PubMed and will need to find other means of getting it, providing another obstacle in their search path, increasing their cognitive load. Similarly, if, in these cases, the library does not have access to the article (even if the publisher does participate in LinkOut), the user is not easily able to navigate to their library's interlibrary loan (ILL) portal to order it. The user must leave the PubMed interface, find their library's ILL form, and then manually enter all of the bibliographic information on the form, a significant detour from their search process.

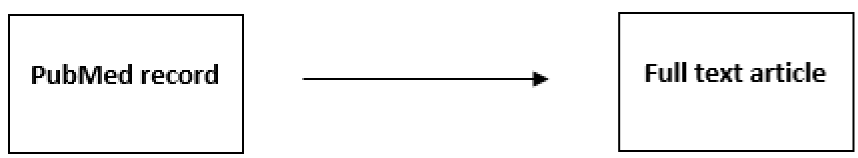


Figure 5. An ideal search path

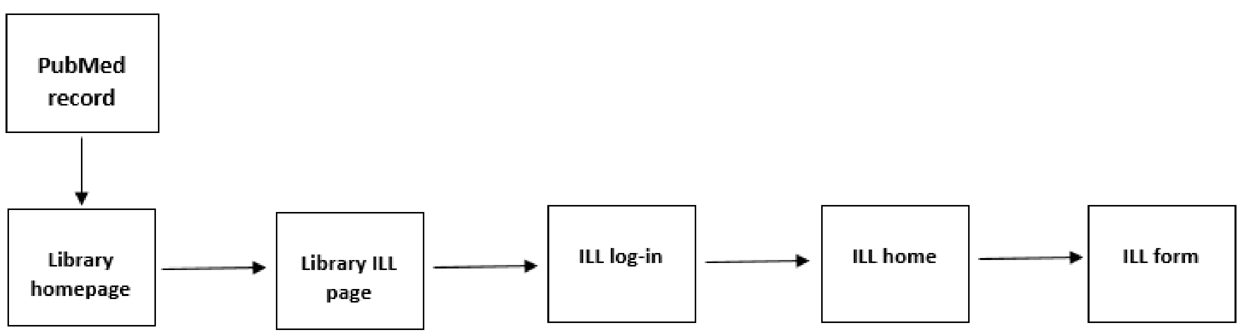


Figure 6. Search patch when item unavailable in LinkOut

LinkOut depends on publishers and librarians alike putting in labor to maintain accurate metadata and holdings information. When a library enables LinkOut they must provide all of the library's holdings through the Submission Utility and routinely maintain this information. Any discrepancy could cause issues for the user if there is an article that they need and cannot get to because the holdings information in LinkOut is not precise. These kinds of errors are another cause for frustration among users who see the library icon indicating full text access to the article but upon clicking it, find a broken link.

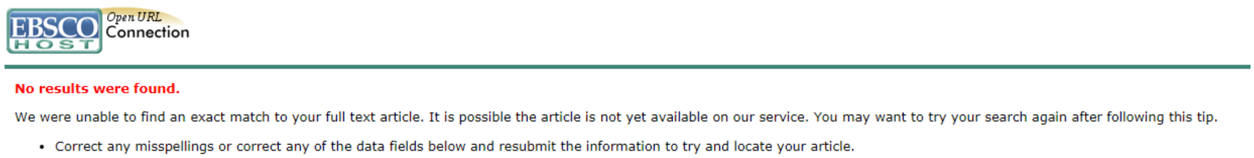


Figure 7. Error message from LinkOut

The placement of the icons which link to full text on the full record page also causes confusion for users. Since the icons are small to begin with users do not notice the buttons which are off to the side in the margin, grouped with other elements.

Adding to this confusion is the “LinkOut – More resources” link toward the bottom of the record. Once expanded the user sees a link to the publisher’s page that they may or may not have access to.

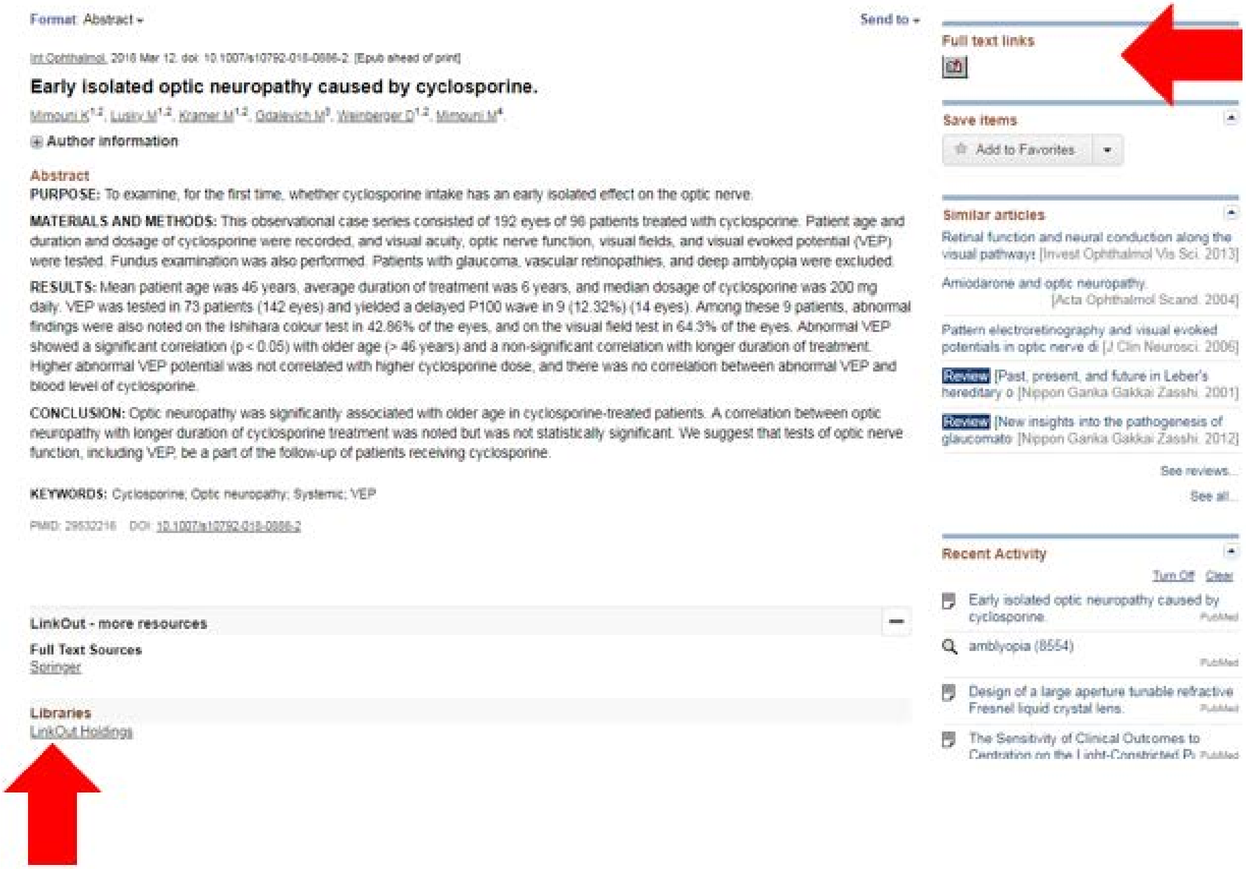


Figure 8. Full record view in PubMed with multiple confusing possible links out to full text

Taken altogether it is a confusing experience for users. While the intent may be to provide the user flexibility with choosing full text options, this type of flexibility in a design sacrifices usability (Lidwell 2010). Moreover, it increases the possibility for errors which will further increase the user's cognitive load.

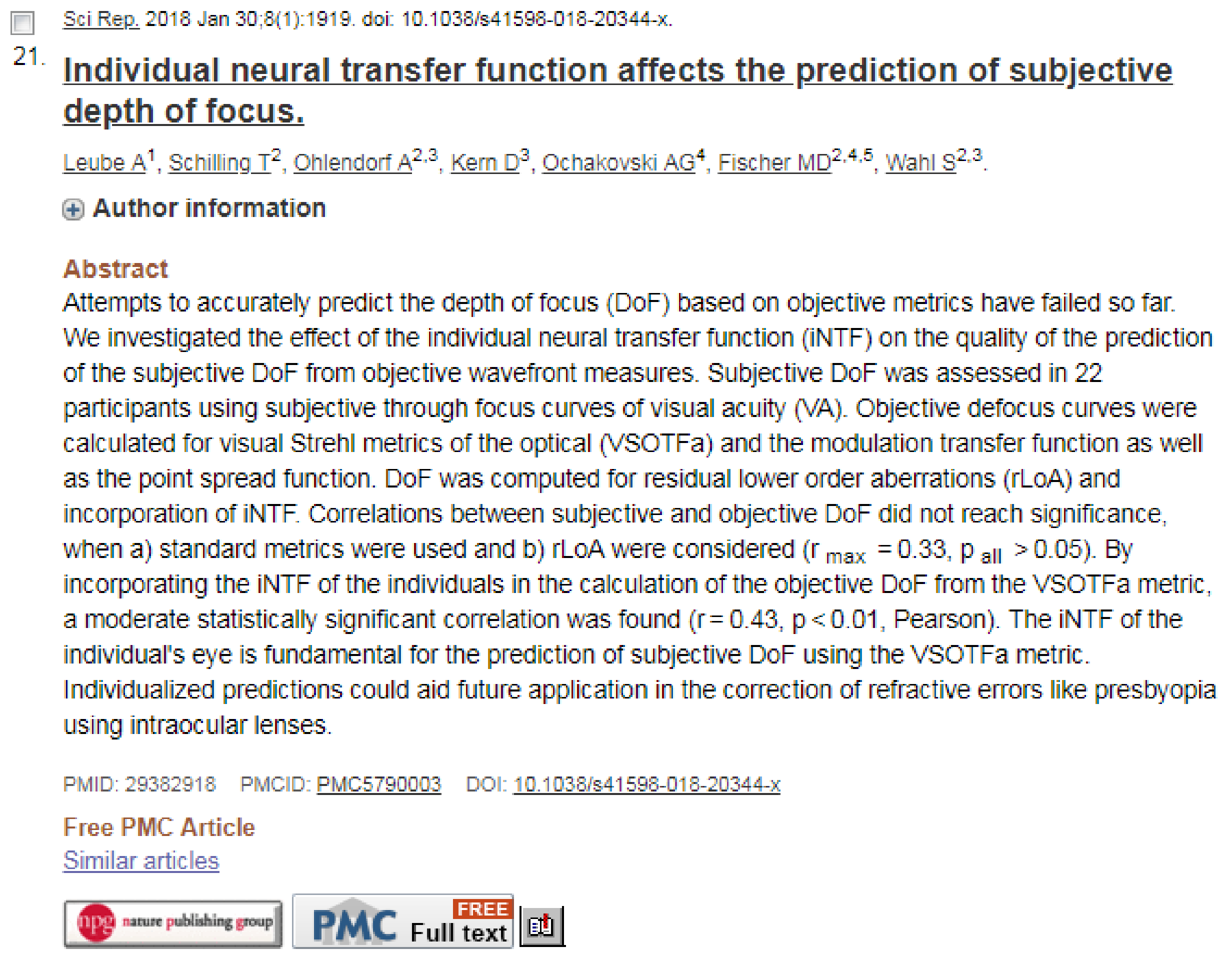
Any one of these issues would be enough to confuse and frustrate users. Any search may result in the user encountering several of these roadblocks. When a user is focused on retrieving a full text article from a search these roadblocks derail the user. These roadblocks must be removed in order to support user search habits and improve the user experience by reducing the cognitive load.

Outside Tool: Usability Problems

PubMed's LinkOut service also allows one to configure an Outside Tool which is a library's link resolver that they register with LinkOut. The Outside Tool removes some of the obstacles associated with LinkOut's Submission Utility but it does not go far enough in providing easy seamless linking to full text articles.

The main positive of using the Outside Tool is that the library's full text icon appears on every PubMed record acting as a button which links out to the link resolver. Whether or not a publisher participates in LinkOut and whether or not librarians are able to maintain their holdings in PubMed is no longer a concern. This provides consistency and allows the user to follow the same patterns with every search. Additionally, when the library does not have access to the full text article the user is able to directly connect to their ILL form with the bibliographic information prepopulated in the form via the link resolver. Going directly through the Outside Tool also means that users can access their library's full text articles remotely unlike previously when they would often times be brought directly to the publisher's platform and hit a paywall.

The improvements to user experience, however, stop there. The user still faces many of the same obstacles including having to use the library specific URL and the confusion regarding the size and placement of the icons indicating the library's access full text. Additionally, Outside Tool adds a further roadblock in that it provides direct publisher provided links to content along with the library's own button, whether the library has access to that publisher's content or not. On some records the user can see as many as three different buttons that indicate full text access to an article but the user may not have access on each of those platforms.



Sci Rep. 2018 Jan 30;8(1):1919. doi: 10.1038/s41598-018-20344-x.

21. **Individual neural transfer function affects the prediction of subjective depth of focus.**

Leube A[1], Schilling T[2], Ohlendorf A[2,3], Kern D[3], Ochakovski AG[4], Fischer MD[2,4,5], Wahl S[2,3].

Author information

Abstract

Attempts to accurately predict the depth of focus (DoF) based on objective metrics have failed so far. We investigated the effect of the individual neural transfer function (iNTF) on the quality of the prediction of the subjective DoF from objective wavefront measures. Subjective DoF was assessed in 22 participants using subjective through focus curves of visual acuity (VA). Objective defocus curves were calculated for visual Strehl metrics of the optical (VSOTFa) and the modulation transfer function as well as the point spread function. DoF was computed for residual lower order aberrations (rLoA) and incorporation of iNTF. Correlations between subjective and objective DoF did not reach significance, when a) standard metrics were used and b) rLoA were considered ($r_{max} = 0.33$, $p_{all} > 0.05$). By incorporating the iNTF of the individuals in the calculation of the objective DoF from the VSOTFa metric, a moderate statistically significant correlation was found ($r = 0.43$, $p < 0.01$, Pearson). The iNTF of the individual's eye is fundamental for the prediction of subjective DoF using the VSOTFa metric. Individualized predictions could aid future application in the correction of refractive errors like presbyopia using intraocular lenses.

PMID: 29382918 PMCID: PMC5790003 DOI: 10.1038/s41598-018-20344-x

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Figure 9. Outside Tool result with three different full text buttons in abstract view

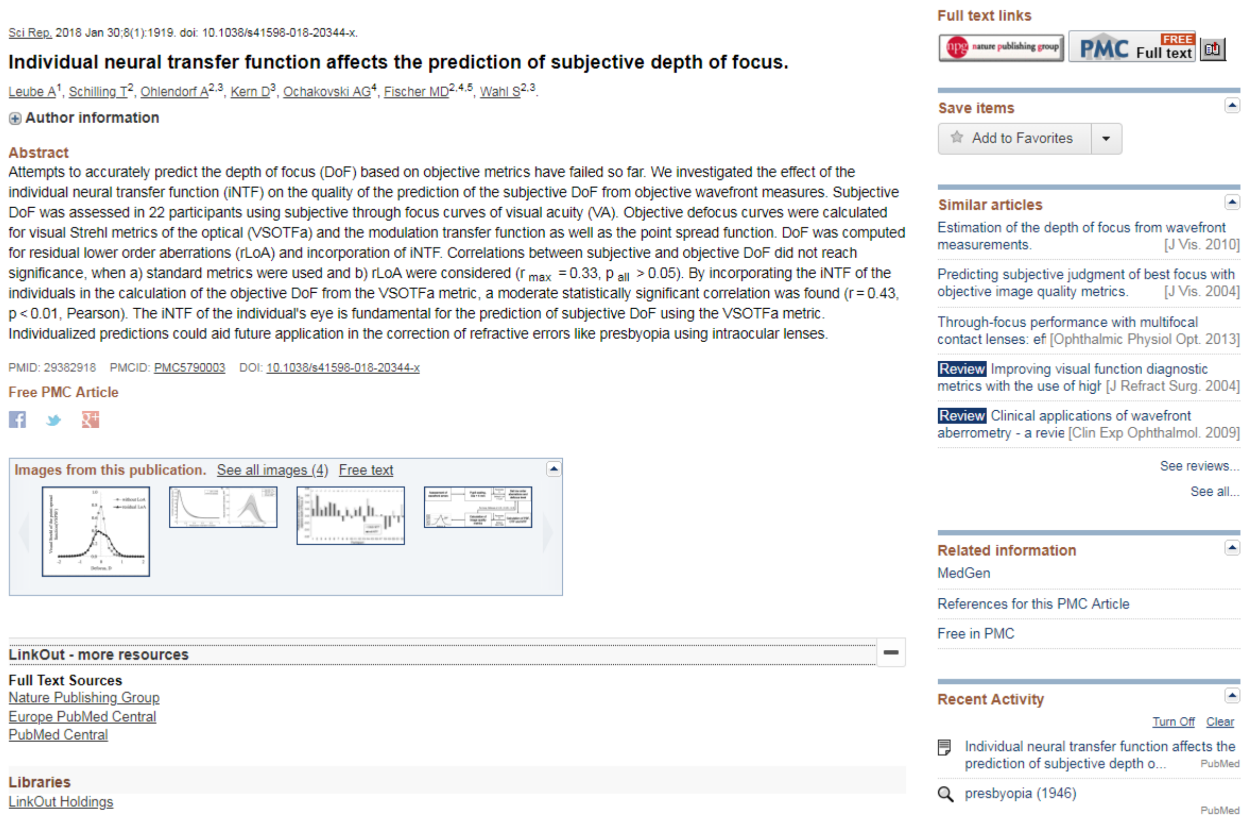


Figure 10. Full record view with multiple possible full text links both off to the side and down on the bottom

Additionally when more than one option is displayed and the user does not click on the "correct" one, they run the risk of hitting a paywall on the publisher's platform. According to Hick's Law "the amount of time required to make a decision is a function of the number of available options" (Lidwell 2010). Having users pause to consider options that may not even correctly lead to the full text article increases the possibility of errors and removes the user from their search flow, adding to their cognitive load and causing frustration.

The user should have to consider only one button to access full text. This button should be the one that works with the library's link resolver to connect to the full text of the articles when available and the ILL platform when unavailable. Providing multiple paths complicates the process and provides opportunities for errors along the way.

Lessons from Google Scholar

Providing access to full text articles is one of the most important features of any bibliographic database. However, simply providing for linking to full text is not enough if the process of getting to that full text causes the user frustration. As noted above, one of the primary caveats in using LinkOut is that the user must be aware of using their library specific URL to access PubMed and be expected to always remember to use it. This is taxing to users who have a limited amount of working memory to begin with. A user's mental resources should be expended on the process of evaluating research itself, not on deciphering the interface on which that research resides.

Google Scholar, which is often favored over other search tools even by health science researchers, links to a library's link resolver much like PubMed does but does not require user's to go through a special URL (DeGroote 2014). Instead, libraries register with Google Scholar and users set up "Library links" in their browser which allows users to pick their institution and save it.

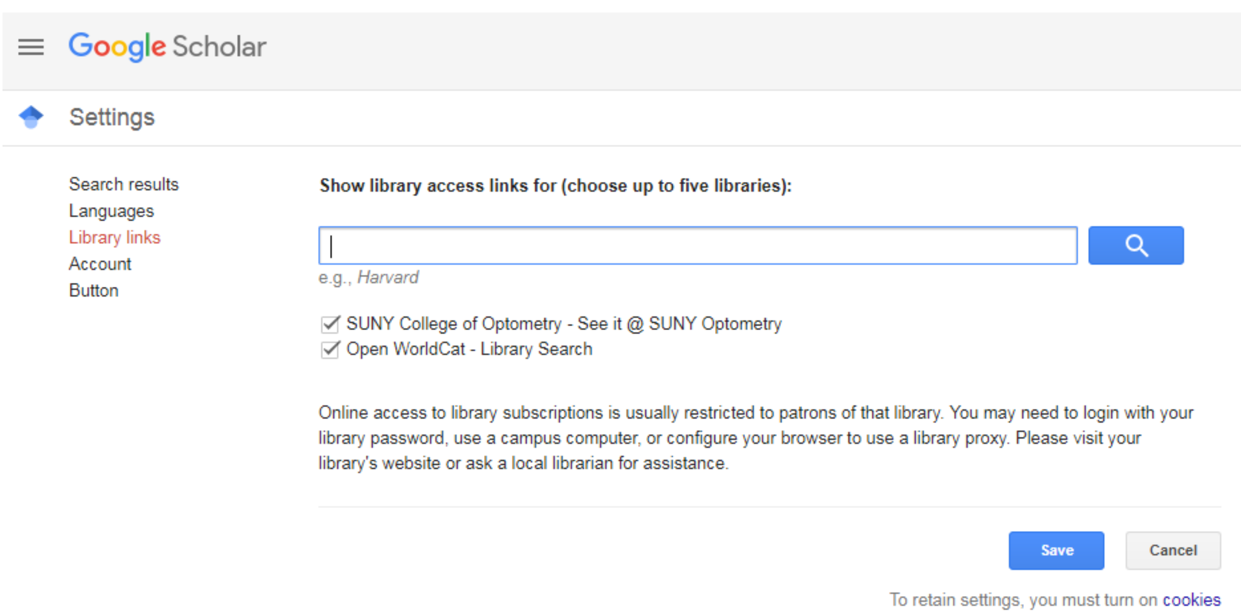


Figure 11. Google Scholar's library links set up page

Each time they use Google Scholar from that point on they see the links to their institution’s holdings to the right hand side of the screen if the material is available from the library.

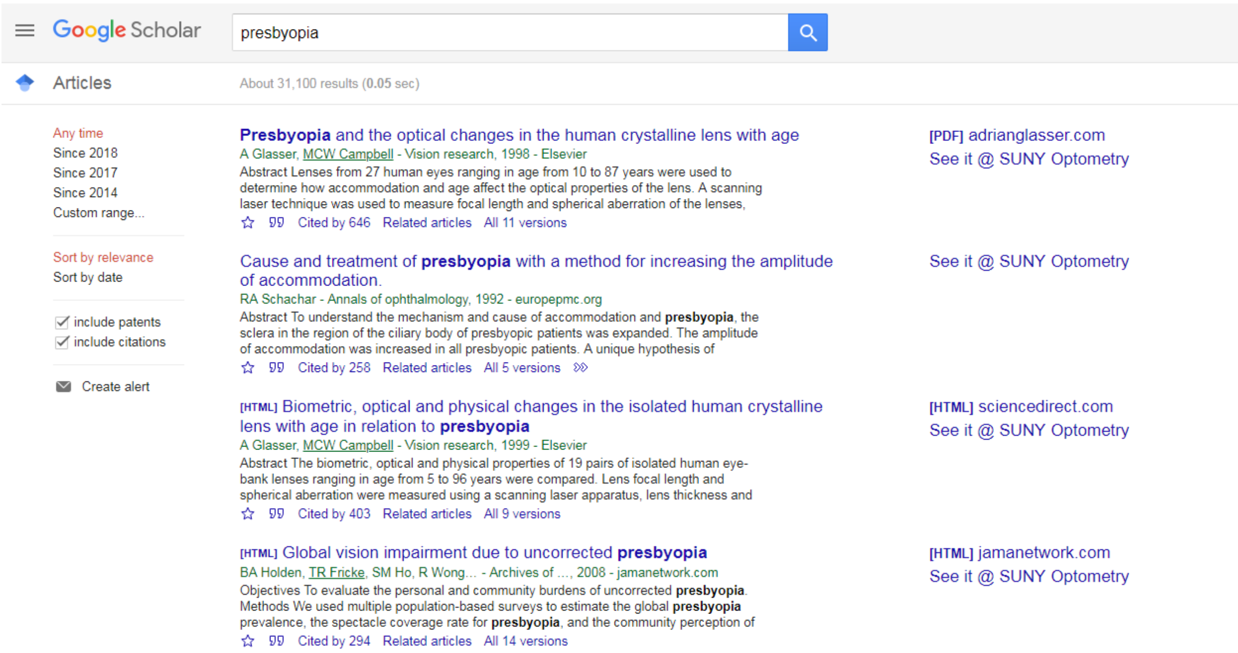


Figure 12. Google Scholar's results page with ibrary links enabled

The simple interface with the seamless connection to an institution's holdings through their link resolver lends to Google Scholar an ease of use that PubMed could benefit from, particularly since PubMed has powerful searching features absent from Google Scholar for those doing research in academic medicine. Google Scholar’s two biggest advantages over PubMed are its “library links” and its clean interface which makes full text linking seamless. Creating a browser extension that would modify PubMed’s interface by removing the obstacles previously identified would incorporate those two advantages into the search experience of PubMed.

Designing the Extension

A browser extension is a small snippet of code that one installs into their web browser which modifies a webpage once that code is executed. I decided that the optimal solution was to make this a simple browser extension that would use JQuery to modify the PubMed interface.

The modifications would be based on the elements I identified as obstacles to the user's seamless connection to full text articles. Implementing these modifications through a browser extension achieves a functionality similar to Google Scholar's "Library links" since once the user has installed the extension, it will be enabled in their browser and they will not have to think about it further. With the primary obstacle of having to use the library specific URL solved by creating a browser extension, I could move on to removing the other obstacles in LinkOut that add to the user's cognitive load which were identified above.

The major obstacle is the placement and appearance of the icons which link to full text articles. The page displaying the full record provides multiple possible full text links in two different locations confusing the users. I would eliminate the multiple full text options and then use chunking to provide one large clear button directly after the abstract providing a visibly direct connection to the library's link resolver. Chunking "seeks to accommodate short-term memory limits by formatting information into a small number of units" (Lidwell 2010). This logical grouping of elements helps to reduce the noise on the page so the user has the main elements sharing the same space.

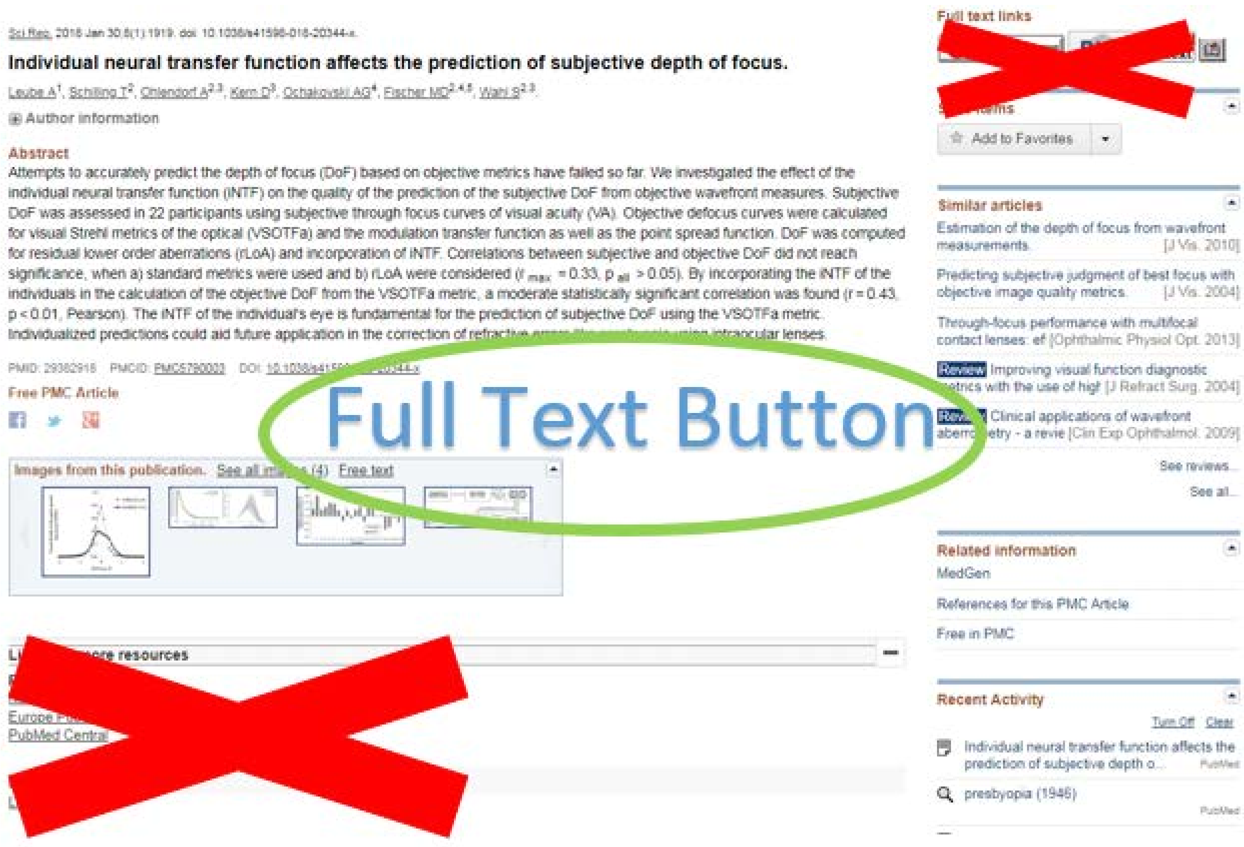


Figure 13. Full record view marked up with proposed changes

Additionally it is important that button consistently appears in the same place on all result views. The button connecting to the full text article would need to be large and clear in order to effectively signal to users that clicking on it would connect them to our full text holdings.

Figure 14 Old button to connect to full text articles (actual size)

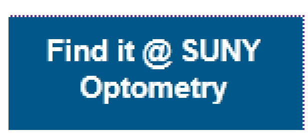


Figure 15. New button to connect to full text articles (actual size)

I used the university's specific shade of blue to provide continuity in our branding which exists across various platforms that we use.

Writing the Code

After identifying what needed to be modified on PubMed's interface I wrote a very basic pseudocode outline to layout the exact steps. Pseudocode uses plain language to map out a program with the intent of going back to it and plugging in the actual terms and logic. I used this outline as a foundation and used the developer tools of both the Chrome and Firefox web browsers to identify which specific elements on the Document Object Model (DOM) that I would be working with so I could plug them into the pseudocode.

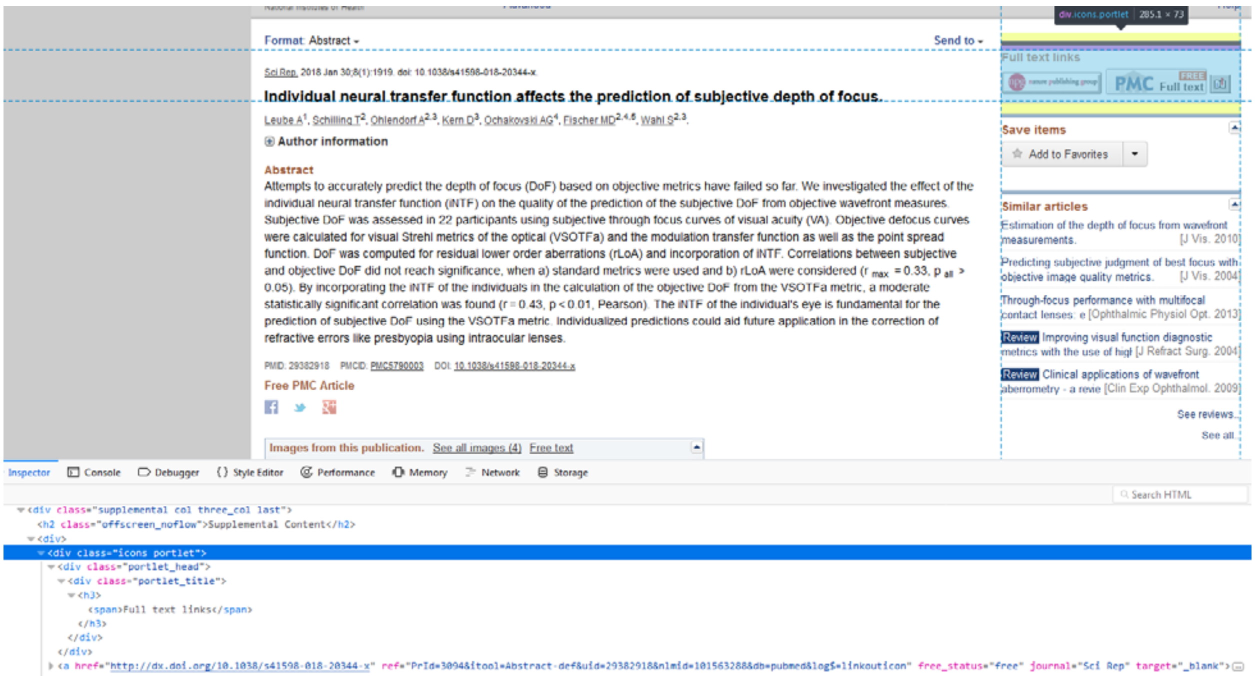


Figure 16. Using developer tools to identify the elements I wanted to target

I then wrote lines of JQuery in the console targeting the elements that I wanted to remove, testing each line.

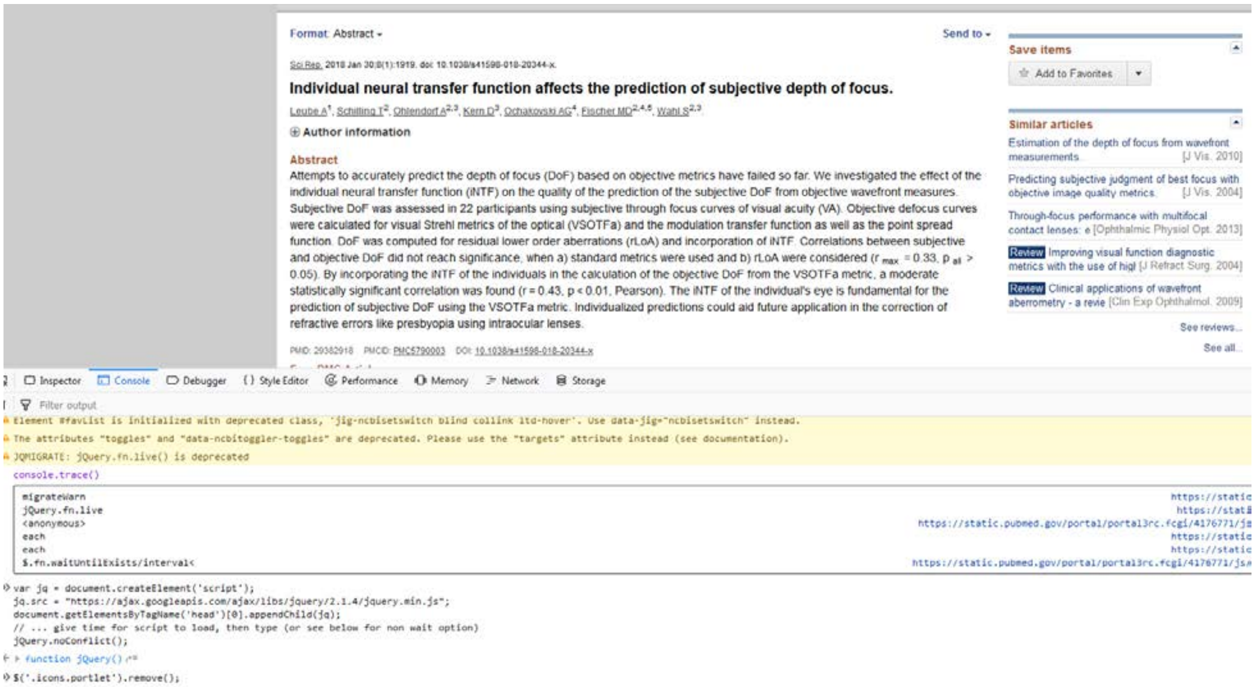


Figure 17. Using JQuery in the console to test remove the "Full Text" links section that had previously appeared at the top right (see above)

Writing the code to remove the elements that I identified as obstacles was fairly straightforward. Once I began to compile them into lines of code I did so using the Sublime Text text editor.

```
$('.icons.portlet').remove();

$('.morecit').find('a:contains("Link")').remove();

$('.icons').remove();
```

Figure 18. The first 3 lines of the code, removing the elements previously identified, in Sublime Text

From there I began to write the code to insert the button on each record in all results views. While inserting the button was straightforward since I just needed to append it to the final child element of the main content I was interested in preserving, there were a couple of other considerations involved. The first was that I needed to make sure that the button would link out to the individual article of the corresponding record. To do this I examined the linking syntax for the outside tool in PubMed which makes use of PubMed ID numbers (PMIDs).

```
ares.sunyopt.edu:2048/login?url=http://resolver.ebscohost.com/openurl?sid=Entrez:PubMed&id=pmid:29208809
```

Figure 19. Linking syntax for SUNY Optometry's link resolver

PMIDs are unique identifiers assigned to each bibliographic record in PubMed. When creating the linking syntax to be used in the button, I had to make sure that the PMID would be grabbed and stored a variable so each button would link to the correct article.

```
var baseUrl = "http://ares.sunyopt.edu:2048/login?url=http://resolver.ebscohost.com/openurl?sid=Entrez:PubMed&id=pmid:";
var pubMedId = $j('dl.rprtid').find('dd:first').html();

var fullAddress = baseUrl + pubMedId;

$j('.rprt').append('<a href="' + fullAddress + '" target="_blank"><img src="https://www.sunyopt.edu/wp-content/uploads/findItAtSUNY.png" /></a>');
```

Figure 20. Code for the placement and syntax of the full text button 1

This worked on my initial tests. However, my initial tests only took place on the full record view page. When I went to test under the “Summary” and “Abstract” views I quickly realized that I had made a mistake. The code was grabbing the PMID for the first record and using that for every record, creating links to the same article for different records. I went back and wrote more code that I hoped would loop through each element where the PMID was stored and grab the value of each to store in the variable.

```
$j('.aux').each(function(index, element) {
var baseUrl = "http://ares.sunyopt.edu:2048/login?url=http://resolver.ebscohost.com/openurl?sid=Entrez:PubMed&id=pmid:";
var pubMedId = $j('dl.rprtid').find('dd:first').html();

var fullAddress = baseUrl + pubMedId;

$j(this).append('<a href="' + fullAddress + '" target="_blank"><img src="https://www.sunyopt.edu/wp-content/uploads/findItAtSUNY.png" /></a>');});
```

Figure 21. Code for the placement and syntax of the full text button 2

Once again, the code grabbed the PMID for the first record and used that for every record, creating links to the same article for different records. I thought that I was grabbing each element (‘dl.rptid ‘) that held the element where the PMID (‘dd ‘) was and applying that value to each record accordingly but I was actually grabbing the first ‘dl.rptid’ element on the page and then getting the first ‘dd’ element within that. What I needed to do was somehow scope this to be within the elements (‘aux ‘) the code was looping over. To do that I needed to use the element variable that I already had.

```
var baseUrl = "http://ares.sunyopt.edu:2048/login?url=http://resolver.ebscohost.com/openurl?sid=Entrez:PubMed&id=pmid:";

$j('.aux').each(function(index, element) {
var pubMedId = $j(element).find('dd').html();

var fullAddress = baseUrl + pubMedId;

$j(this).append('<a href="' + fullAddress + '" target="_blank"><img src="https://www.sunyopt.edu/wp-content/uploads/findItAtSUNY.png" /></a>');});
```

Figure 22. Code for the placement and syntax of the full text button 3 (final)

Once things were finally working from the console, I created a bookmarklet to run in my browser and test the code.

```
javascript:(function(){var jq = document.createElement('script');
jq.src = "https://ajax.googleapis.com/ajax/libs/jquery/2.1.4/jquery.min.js";
document.getElementsByTagName('head')[0].appendChild(jq);
setTimeout(function() {
var $j = $.noConflict(true);

$j('.icons.portlet').remove();

$j('.morecit').find('a:contains("Link")').remove();

$j('.icons').remove();

var baseUrl = "http://ares.sunyopt.edu:2048/login?url=http://resolver.ebscohost.com/openurl?sid=Entrez:PubMed&id=pmid:";

$j('.aux').each(function(index, element) {
var pubMedId = $j(element).find('dd').html();

var fullAddress = baseUrl + pubMedId;

$j(this).append('<a href="' + fullAddress + '" target="_blank"><img src="https://www.sunyopt.edu/wp-content/uploads/findItAtSUNY.png" /></a>');});



 }, 500);
})();
```

Figure 23. Full bookmarklet code

When those tests proved successful I next needed to figure out how to convert the bookmarklet to a browser extension.

Converting the Code to a Browser Extension

I decided to make the extension for the Google Chrome web browser since it is a popularly used web browser. Chrome provides a detailed overview on how to create and install browser extensions. Each Chrome extension requires a manifest file which is a .JSON file that contains important metadata associated with the extension such as its name, version, and the content scripts contained within. The content scripts are the most important part of the extension as they contain the code that I want to execute on the page and give instructions on its execution.

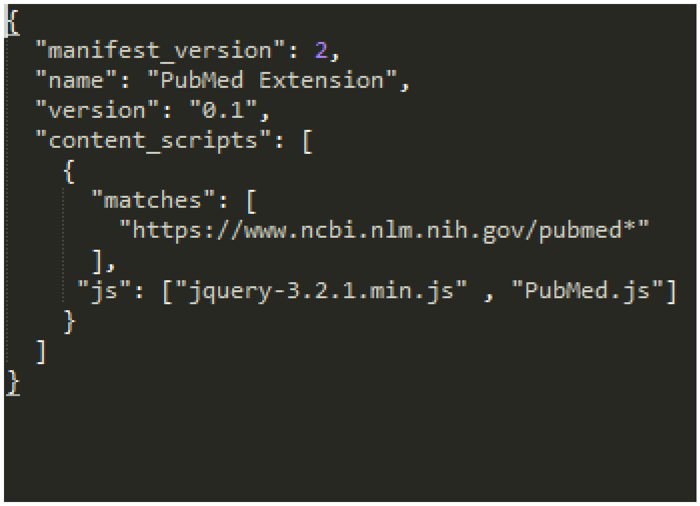


Figure 24. The manifest.json file

The content script is telling the browser that when the user loads any page that begins with “https://www.ncbi.nlm.nih.gov/pubmed” the browser needs to execute the two JavaScript files included. The first JavaScript file makes sure the correct version of JQuery is running. The second file is the JavaScript file I created in Sublime Text. My initial JavaScript file was a bookmarklet so I changed it back to a regular JavaScript file that would load on any PubMed page.

```
if (window.location.href.indexOf("/pubmed") > -1) {
    var jq = document.createElement('script');
jq.src = "https://ajax.googleapis.com/ajax/libs/jquery/2.1.4/jquery.min.js";
document.getElementsByTagName('head')[0].appendChild(jq);
setTimeout(function() {
var $j = $.noConflict(true);

$j('.icons.portlet').remove();

$j('.morecit').find('a:contains("Link")').remove();

$j('.icons').remove();

var baseUrl = "http://ares.sunyopt.edu:2048/login?url=http://resolver.ebscohost.com/openurl?sid=Entrez:PubMed&id=pmid:";

$j('.aux').each(function(index, element) {
var pubMedId = $j(element).find('dd').html();

var fullAddress = baseUrl + pubMedId;

$j(this).append('<a href="' + fullAddress + '" target="_blank"><img src="https://www.sunyopt.edu/wp-content/uploads/findItAtSUNY.png" /></a>');});


 }, 500);
}
```

Figure 25. Initial JavaScript file to be included in the manifest file

However, I realized that the manifest file contains the instructions on when and how to execute the code so I needed to modify my JavaScript file to remove those instructions I had included in the code.

```
$('.icons.portlet').remove();

$('.morecit').find('a:contains("Link")').remove();

$('.icons').remove();

var baseUrl = "http://ares.sunyopt.edu:2048/login?url=http://resolver.ebscohost.com/openurl?sid=Entrez:PubMed&id=pmid:";

$('.aux').each(function(index, element) {
var pubMedId = $(element).find('dd').html();

var fullAddress = baseUrl + pubMedId;

$(this).append('<a href="' + fullAddress + '" target="_blank"><img src="https://www.sunyopt.edu/wp-content/uploads/findItAtSUNY.png" /></a>');});
```

Figure 26. Final modified PubMed.js file

Once I had the three files ready in a folder, I uploaded the zipped folder to the Chrome Developer Dashboard and from there installed it into my browser. The extension, once successfully deployed, addressed all of the usability issues I previously identified with PubMed's LinkOut services.

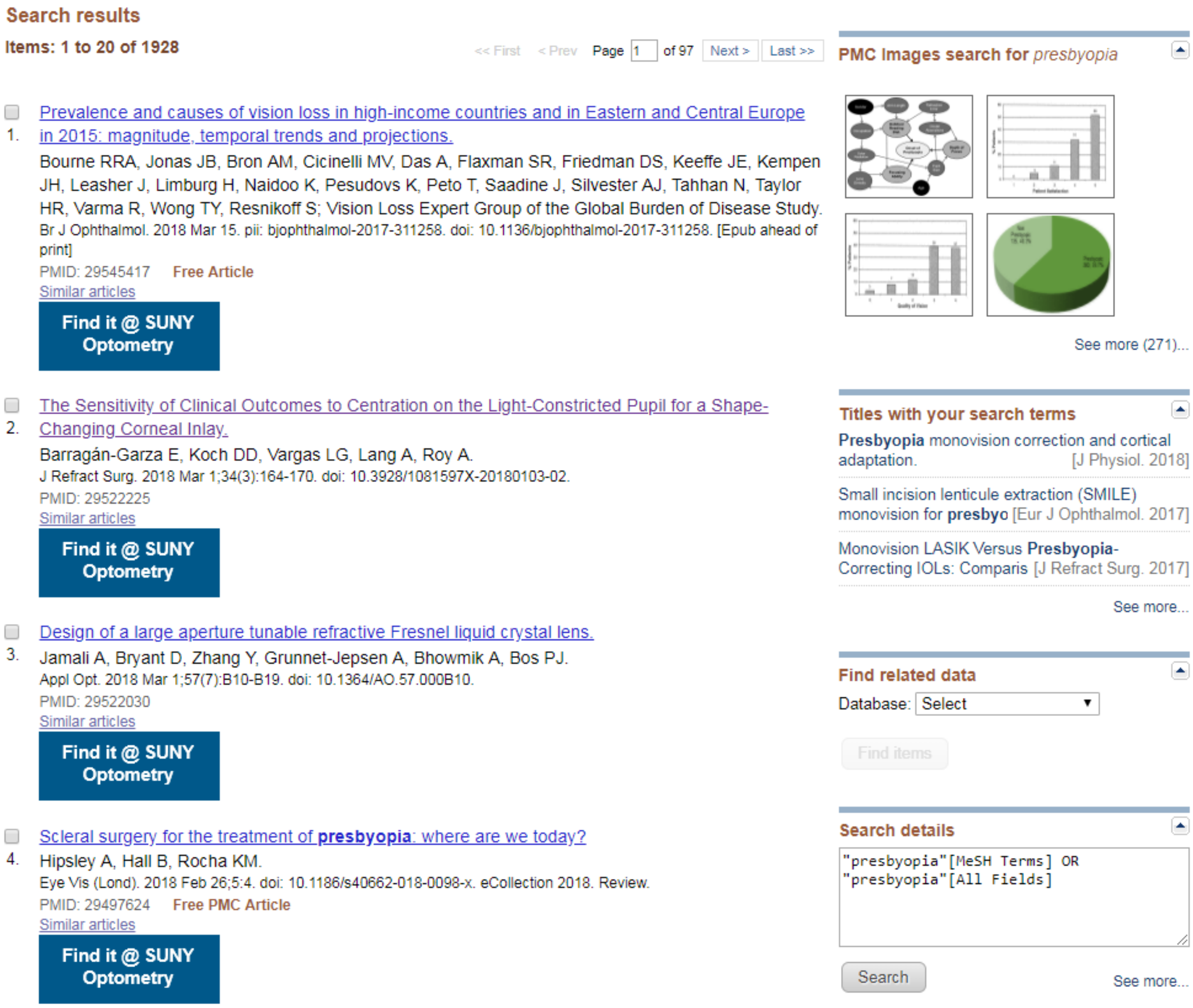
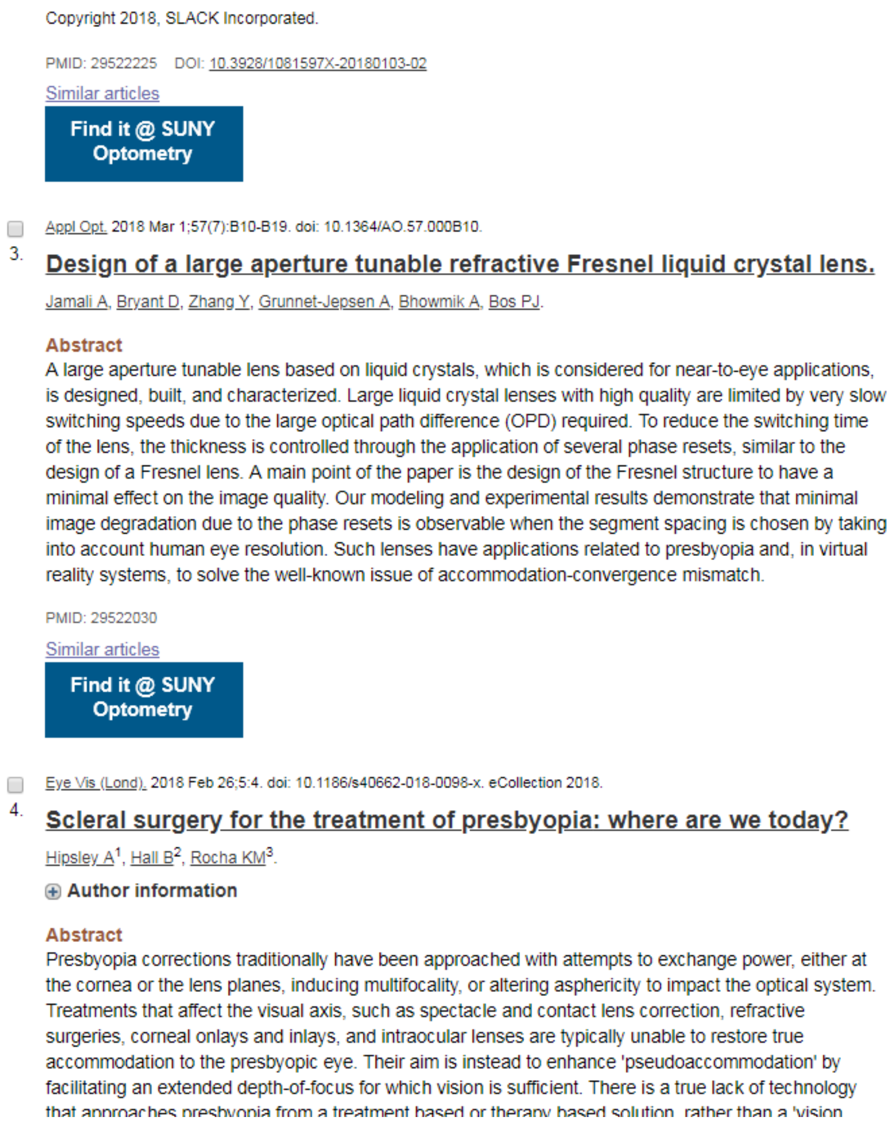


Figure 27. Default summary view results page modified by extension



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PMID: 29522225 DOI: 10.3928/1081597X-20180103-02

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Appl Opt. 2018 Mar 1;57(7):B10-B19. doi: 10.1364/AO.57.000B10.

3. **Design of a large aperture tunable refractive Fresnel liquid crystal lens.**

Jamali A, Bryant D, Zhang Y, Grunnet-Jepsen A, Bhowmik A, Bos PJ.

Abstract

A large aperture tunable lens based on liquid crystals, which is considered for near-to-eye applications, is designed, built, and characterized. Large liquid crystal lenses with high quality are limited by very slow switching speeds due to the large optical path difference (OPD) required. To reduce the switching time of the lens, the thickness is controlled through the application of several phase resets, similar to the design of a Fresnel lens. A main point of the paper is the design of the Fresnel structure to have a minimal effect on the image quality. Our modeling and experimental results demonstrate that minimal image degradation due to the phase resets is observable when the segment spacing is chosen by taking into account human eye resolution. Such lenses have applications related to presbyopia and, in virtual reality systems, to solve the well-known issue of accommodation-convergence mismatch.

PMID: 29522030

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Eye Vis (Lond). 2018 Feb 26;5:4. doi: 10.1186/s40662-018-0098-x. eCollection 2018.

4. **Scleral surgery for the treatment of presbyopia: where are we today?**

Hipsley A[1], Hall B[2], Rocha KM[3].

Author information

Abstract

Presbyopia corrections traditionally have been approached with attempts to exchange power, either at the cornea or the lens planes, inducing multifocality, or altering asphericity to impact the optical system. Treatments that affect the visual axis, such as spectacle and contact lens correction, refractive surgeries, corneal onlays and inlays, and intraocular lenses are typically unable to restore true accommodation to the presbyopic eye. Their aim is instead to enhance 'pseudoaccommodation' by facilitating an extended depth-of-focus for which vision is sufficient. There is a true lack of technology that approaches presbyopia from a treatment based or therapy based solution, rather than a 'vision

Figure 28. Abstract view results page modified by extension

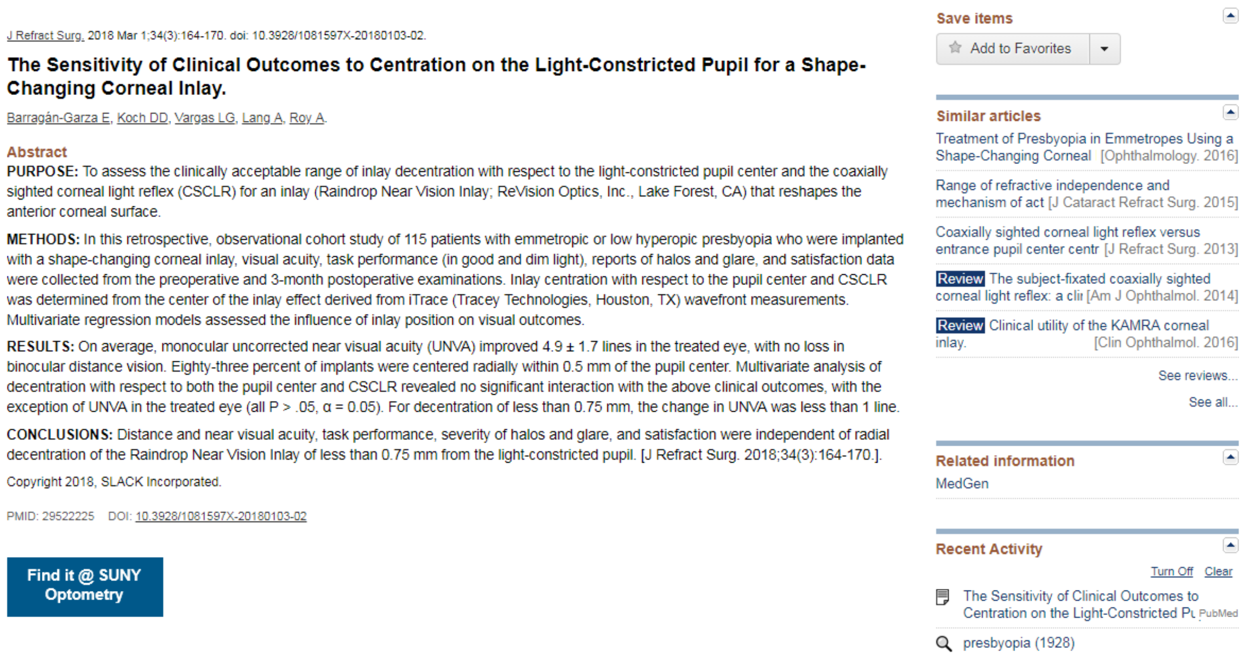

Figure 29. Full record view modified by extension

Next Steps

Now that the extension is complete I need to prepare to promote it to the SUNY Optometry Community. As of this writing the extension lives locally on my computer. I will need to get it approved to be hosted by the Chrome Web Store. To do this I have to create a developer account, upload the extension, and provide a detailed description. Initially, I will prevent the listing for the extension from appearing to the public in the Chrome Web Store. This way I can restrict access to members of the SUNY Optometry community and which will allow me to better assess the adoption and deployment of the extension.

I plan to promote the extension through various means. I intend to send promotional emails, make presentations to the Faculty Development Committee, the Learning Resources Committee, and will also promote it during the annual information literacy presentations at the beginning of the fall semester. Chrome offers inline installation of extensions so users will be able to install the extension directly from the library's website as well as from the College's course management system. It is my hope that in having the browser extension visibly available from places our users already are they will be more inclined to install it than they would be if they had to go to the Chrome Web Store.

Once the extension has been made available to the SUNY Optometry community it is important that I keep up with its usage. I will be able to measure how often it is downloaded but more importantly I will need to measure whether the extension impacts user experience. I plan to do this in a couple of different ways. I will distribute surveys to early adopters of the extension. Additionally, I will conduct some small scale A/B testing among those who have not used the extension and observe how the experience of searching and retrieving full text articles from PubMed differs between those who are given the regular PubMed interface and those who are given the PubMed interface which is modified by the extension. This testing may lead to further research for publication.

Limitations

While the browser extension addresses the shortfalls in PubMed's LinkOut, there are certain limitations to this as a solution. To begin with, the extension is only available in Chrome. While that is a heavily used browser, not everyone uses it. Depending on how the extension is received I expect to make one for Firefox as well. While having the extension available for multiple browsers will allow more users to take advantage of it, there are many users who are completely unfamiliar with the concept of browser extensions entirely. Onboarding these users will be more of a challenge. Additionally, some users do their research from a variety of different devices and may need to download it on more than one device. It is also important to note that Chrome extensions are not able to be downloaded to mobile devices. Fortunately, our analytics indicate that most of our users do their research using desktop and laptop computers. I will also need to be vigilant of any changes to PubMed's interface as those changes could interfere with the code running in the extension. Despite some of these limitations I believe that this extension will substantially benefit our users.

CONCLUSION

This idea for this project came about when I realized that I had many users contacting me with citations from PubMed asking me if I could get the full text articles for them because they couldn't get them from PubMed. Often times we would have access to the article and had set up our holdings in LinkOut to indicate this on the PubMed interface. This signaled to me that the current set up of LinkOut in PubMed was not meeting user needs. By researching how users search and retrieve articles through the lens of information design theory I was able to take a critical look at PubMed's linking services and determined that by developing a browser extension which would apply best practices in information design to modify PubMed's interface, I developed a technological solution to many of the issues our users were having.

The finished PubMed browser extension product modifies PubMed's interface by removing the superfluous elements which add to the cognitive load of the user. The user is now able to directly connect from each bibliographic record, regardless of result view, to the full text article available from the library seamlessly. Users should not have to rely on library instruction to make sense of the interfaces on which they conduct their research. By considering the needs of the user, designers can begin to tailor their systems to align with the user's search and retrieval behaviors relieving the stress of having to discern the idiosyncrasies of those systems and freeing them up to engage with the research itself, providing a better user experience.

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