On the Pitfalls of Bibliographic Database Searching: Comparing Successful and Less Successful Users

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Abstract

The present article investigates individual factors that determine success and failure in bibliographic database searching. In line with previous research, we hypothesised that the low usability of advanced bibliographic database interfaces (e. g., OvidSP™) would hinder students in implementing their information-seeking knowledge. Furthermore, we assumed high conscientiousness and need for cognitive closure to drive students towards rigidly using such advanced interfaces, even if they overtax them. In a study with 116 psychology undergraduates, three types of searchers were identified by means of a cluster analysis: Successful database users, unsuccessful database users, and no-database users (e. g., Google Scholar™ searchers). Multiple regression revealed the relationship between information-seeking knowledge and search success to be positive for no-database users and negative for unsuccessful database users: Unsuccessful database users do not only have trouble putting their information-seeking knowledge into practice; high information-seeking knowledge even impairs their search success, presumably because it makes them use advanced functions that they are not yet able to master. T-tests revealed that unsuccessful users differ from successful users in terms of higher conscientiousness and need for cognitive closure. In conclusion, our results highlight the importance of enhancing database interface usability and underline the crucial role of practical database instruction.

Keywords: information-seeking behaviour; bibliographic database; usability; personality; need for cognitive closure

1 Introduction

Bibliographic databases are still deemed to be the “gold standard” for information searching (Callicott and Vaughn 2005; Boeker, Vach, and Motschall 2013; Bramer et al. 2013). Even though Google Scholar™ is constantly working on the improvement of its search algorithms, discipline-specific bibliographic databases (e. g., PsycINFO™) have important advantages in terms of search precision, quality of results, and customisability of search queries (Boeker et al. 2013; Hjørland 2014). Nevertheless, many bibliographic database interfaces have been criticised for their low usability (e. g., Imler and Eichelberger 2014). Moreover, formal instruction is still a crucial factor for search success (Brophy and Bawden 2005), and research shows that a significant proportion of students have severe troubles when searching in advanced database interfaces like OvidSP™ (e. g., Sutcliffe, Ennis, and Watkinson 2000; Currie et al. 2010). Interestingly, there is a subgroup of students which actually possesses some declarative and procedural knowledge on information searching, but is unable to put this knowledge into practice (Leichner 2015).

To explain these findings, one may refer to research on knowledge and skill acquisition, as ACT theory posits that at the beginning of a skill acquisition process, difficulties in implementing one’s knowledge are common (Anderson 1982). Nevertheless, one may also ask about specific psychological mechanisms that lie behind database search failure: Even though an abundance of user experience studies on various database interfaces exists (e. g., Haya, Nygren, and Widmark 2007; Currie et al. 2010), empirical research on interindividual differences in personality underlying failure in bibliographic databases is scarce. Investigating the causes of such failures might nevertheless allow database providers to adapt their products to specific users’ requirements, and help lecturers and librarians determine which students need what kind of instruction. By connecting psychological findings with research on search interface usability, the present research thus provides insights into individual causes for success and failure in bibliographic database searching and relates success and failure to specific preferences and personality factors.

2 Background

2.1 Advantages and Disadvantages of advanced Bibliographic Database Interfaces

A vast body of research exists on the numerous advantages and disadvantages of bibliographic databases. First, the mean quality of results is arguably higher in bibliographic databases than in popular academic search engines (e. g., Google Scholar™), because databases index only certain types of publications (e. g., scholarly articles). Moreover, they possess an abundance of advanced functions that allow users to customise their search queries and boost the efficiency of searching (Hjørland 2014). For example, PsycINFO™ and PSYNDEX™ users have a great number of limit options at their disposal, allowing them to narrow down their searches if they yield too many results (e. g., by subject category or by methodology). Functions like thesauri allow them to rely on controlled vocabulary, and searches can be connected with Boolean Operators to ensure maximum search efficiency (Shiri and Revie 2005; Boeker et al. 2013; Hjørland 2014).

These functions are especially important in light of the exponentially growing amount of scholarly articles available (Hjørland 2014). Nevertheless, along with that multitude of features comes a downside: Bibliographic databases possess rather complex (sometimes even confusing) search interfaces (Cordes 2014); their usability and accessibility are moderate at best (Mead et al. 2000; Adams, Blandford, and Lunt 2005; Imler and Eichelberger 2014). Moreover, they require knowledge about the structure of metadata stored (data fields) and skills to access these fields (e. g., to specify searches for publications with a certain type of methodology or population). Additionally, most interfaces rely on specific “library terminology”, often conceived as confusing by end users (Cockrell and Jayne 2002; Imler and

Eichelberger 2014). Not surprisingly, Stewart, Narendra, and Schmetzke (2005, 280) note, with regard to the popular OvidSP™ interface, that the "complex site structure will require extensive user instruction, [the] site construction and button placement are counterintuitive, [and that] poor element labeling makes navigation cumbersome".

In contrast, popular search engines (e. g., Google Scholar) generally have easy-to-use interfaces that do not require much instruction, if any at all (Griffiths and Brophy 2005). Moreover, freely accessible bibliographic databases that put strong emphasis on interface usability are currently on the rise in the social sciences. For example, PubPsych™, officially online since mid-2013, is an open access psychology information retrieval system with a European focus which adopts a "Google-like" interface but nevertheless strictly indexes content from European and American scientific-information producers (among others, the PSYNDEX™ database, and segments of ERIC™).

2.2 Individual Requirements for successfully searching Bibliographic Databases

With regard to their rather complex interfaces, searching for information in bibliographic databases does not only require basic information-seeking knowledge (e. g., knowledge about Boolean operators, search keyword generation, or publication types; often denominated as "information literacy"). Skills and abilities necessary to deal with the search interface might play an even more important role. In fact, we find it hard to deny that the complex interfaces of many bibliographic databases affect information-seeking, up to the point where they confuse unexperienced users and severely impede their search performance (see also Shiri and Revie 2005). Considering this, individual differences in dealing with database interfaces might explain the findings by Leichner (2015) who applied cluster analytic techniques to categorise searchers with regard to (1) their performance in information search tasks and (2) their declarative information-seeking knowledge ("information literacy"). Even though he did not differentiate between database and Google Scholar™ users (the majority of his searchers nevertheless used bibliographic databases), he identified three clusters in his data. Results regarding the first two groups are not surprising: One group scored high on all variables involved; one group exhibited low scores on all variables. The third group, however, consisted of students with high information-seeking knowledge but poor search outcomes. Leichner (2015) concludes that these students were, even though they possessed a significant amount of declarative information-seeking knowledge, unable to put their knowledge into practice. We assume two particular aspects to be responsible for this: First, students might have insufficient practical experience with database searching, and second, as a consequence thereof, the complexity and low usability of the database interfaces they used might have hindered them to adequately search for what they were looking for. In sum, the third group in Leichner's (2015) study might thus have lacked specific interface-related knowledge that is nevertheless required for adequate information searching in bibliographic databases.

Popular academic search engines, even though they lack many of the advantages of databases, exhibit high "speed, simplicity, ease of use, and convenience" (Chen 2006, 413). We therefore assume that their use does require information-seeking knowledge ("information literacy"), but little to no specific interface-related knowledge (e. g., Haya et al. 2007; Badke 2011; Herrera 2011). Up to a certain extent, the same might be the case for bibliographic databases with simpler interfaces that specifically focus ease of use and usability (e. g., PubPsych^{TM}). In addition, as search tool selection is an important aspect of information literacy, we assume that only subjects with a certain amount of information-seeking knowledge will search in databases voluntarily; students with lower information-seeking knowledge will likely just use a web search engine or the library catalogue.

With regard to individual differences, we argue that database failure may result from a lack of practical database search experience which interacts with certain personality variables:

Their personality might drive students towards using databases that overtax them (i. e., for which they lack the necessary practical experience), which in turn impairs search efficacy.

2.3 The present Study

Based on these assumptions, the present study examines individual reasons for search success and failure in students using bibliographic databases voluntarily. In a first step, we extend the assumptions of Leichner (2015) by hypothesising that a significant proportion of students searching bibliographic databases voluntarily will yield unsatisfactory search outcomes, even though they possess the necessary information-seeking knowledge. This group should thus have difficulties in putting their information-seeking knowledge ("information literacy") into practice, presumably because of the low usability of advanced bibliographic database interfaces. In contrast, we do not expect usability to be an issue in less complex search environments (e. g., in popular academic search engines or the online library catalogue). We therefore assume information-seeking knowledge to be the only individual factor affecting outcomes of searches carried out in these environments, whereas both information-seeking knowledge and interface experience might influence bibliographic database search outcomes. This should especially apply to searches in databases with rather complex search interfaces (e. g., PsycINFO™ over OvidSP™).

With regard to the group of students with low results in bibliographic databases, we thus expect information-seeking knowledge not to relate to search outcomes, because these students may not be able to put their information-seeking knowledge into practice (Leichner 2015). On the other hand, we expect a positive relation between information-seeking knowledge and search outcomes in a group of students with moderate to high search outcomes, because they probably (1) have sufficient experience in coping with more complex database interfaces, or (2) use databases with less complex interfaces likely not to overtax them. With regard to search tools exhibiting lowest interface complexity (e. g., popular academic search engines), we also expect information-seeking knowledge to positively relate to search success for all users, because these will not hinder students to implement their knowledge.

Hypothesis 1: The relationship between information-seeking knowledge and information search outcomes is moderated by group membership: A positive relationship exists for students not searching in bibliographic databases (and relying, for example, on Google Scholar™; group 1) or successfully searching bibliographic databases (group 2), whereas this relationship does not exist in a group of students less successfully searching bibliographic databases (group 3).

In addition to these skill- and knowledge-related effects on search outcomes, we were interested in individual characteristics of database users who are unable to implement their knowledge. We therefore contrasted the personality and need for cognitive closure of successful and unsuccessful database users. As theorised above, we expected that especially students with little experience in database searching might encounter issues with the complex search interfaces of many bibliographic databases (especially commercial databases frequently used in library contexts). To investigate this, we examined which personality factors might drive students to search in databases that will likely overtax them.

With regard to the Big Five Personality Inventory (e. g., Costa and McCrae 1992), one might suppose that either openness for experience or conscientiousness plays a role: Openness for experience might incline students to try out databases with complex interfaces earlier, which increases the risks for issues with their structures. As openness for experience in terms of the Big Five mainly focuses art, beauty, and aesthetics (Costa and McCrae 1992), we were nevertheless unsure on its influence on information behaviour. After careful consideration, we therefore decided not to hypothesise a corresponding relationship. With regard to conscientiousness, on the other hand, such a relationship is more likely. In fact, high levels of conscientiousness might incline students to undifferentiatedly act like lecturers and librarians expect them to. For example, introductions on library use often stress the importance of bibliographic databases and library catalogues (e. g., Zhang, Watson, and Banfield 2007; Sult et al. 2013). Moreover, especially psychology lecturers might convey that library databases produce more reliable (in terms of scientifically sound) results and should therefore be seen as the “gold standard” in scholarly information searching (see also Hjørland 2014). As a result, more conscientious students might want to search for information the way they are expected to in psychology and disregard whether they are ready for it skill- and experience-wise. In fact, high conscientiousness also implies a certain amount of rigidity (Meyer 2002), and studies demonstrating an inverse U-shaped relationship between conscientiousness and academic achievement further substantiate this assumption (Cucina and Vasilopoulos 2005). In that sense, over-conscientiousness might impair skill acquisition because it inclines students to adopt a less flexible and adaptive approach towards learning (which manifests itself, with regard to our study, in a tendency to rigidly search in bibliographic databases). On the other hand, students with low conscientiousness might be more open for rather new and / or easy-to-use database interfaces that are freely available on the web (e. g., PubPsych™ or PubMed™).

Hypothesis 2: Students searching bibliographic databases less successfully have higher scores in conscientiousness than students who succeed in their database searches.

Moreover, we expect need for cognitive closure to differ between database users who put their knowledge into practice and those who fail to do so. In fact, need for cognitive closure theory posits that individuals with a higher need for closure have a strong desire to arrive at quick solutions to problems (“seizing”), and maintain these solutions over time (“freezing”; Kruglanski and Webster 1996; DeBacker and Crowson 2009). One might thus expect that once students high in need for closure learn (e. g., from their lecturers; see above) that library database searches are the method of choice in their field, they will adopt this view and "freeze" on it. As a consequence, they will rigidly adopt database searches as their method of choice, regardless if they are ready to handle the corresponding interfaces adequately or not. Students with low need for closure, on the other hand, might flexibly adjust their search strategies (i. e., by using databases with less challenging interfaces) when they recognise that the complex interfaces of library databases (e. g., OvidSP^{TM}) overtax them.

Hypothesis 3: Students searching bibliographic databases less successfully have higher scores in need for cognitive closure than students who succeed in their database searches.

Finally, we aimed to investigate whether there were differences in information-seeking knowledge and information literacy self-efficacy between successful and less successful bibliographic database users. We argued earlier that unsuccessful database users primarily have difficulties in putting their information-seeking knowledge into practice (and not that they lack knowledge per se). Moreover, students with a low amount of information literacy self-efficacy would presumably not search in bibliographic databases at all. We therefore tend to assume that neither differences in information-seeking knowledge nor in information literacy self-efficacy exist between the groups.

3 Method

3.1 Participants and Procedure

Data from the second (t2) and third (t3) wave of a longitudinal field study on knowledge development with N = 116 psychology Bachelor students (third semester) from a large German university was used to verify our assumptions. Due to technical difficulties, data of two subjects were eliminated from all further calculations. For the remaining N = 114 subjects, mean age at t3 was M = 21.30 (SD = 2.27) and ranged from 19 to 32 years. Subjects were 91 females and 23 males, an uneven distribution nevertheless typical for German psychology students (Wentura et al. 2013). Self-report data (e. g., Big Five, need for cognitive closure, and information literacy self-efficacy) were collected in at-home modules. Some of that data (Big Five and need for cognitive closure) were collected at the second wave of the study. Six months later, performance data (information-seeking knowledge and search task success) were collected during a laboratory session in a computer lab at the University of Trier, Germany. Data from this session was collected in groups of 4 to 23 participants and took approximately two hours. All participants were paid for their participation.

3.2 Measures

Demographic data and some additional data on the usage of library instruction (e. g., questions about the attendance to library tours or database training) were collected at the beginning of the laboratory session.

The *information search tasks* consisted of three increasingly difficult search assignments (e. g., medium level: ‘Find two longitudinal studies on risk factors for generalised anxiety disorder published after 2005.’; Leichner et al. 2014). Information searches were carried out on a computer with access to the internet, bibliographic databases, and other library services. Subjects could choose freely where they would search, and no cues regarding specific search tools were given (i. e., subjects were told that they could search where they wanted to). Search time was limited to 4 to 10 minutes, depending on task difficulty. Upon completion of each task, subjects were required to enter the title and the first author of two corresponding publications on a separate page. Moreover, they were required to answer some questions about the search process (e. g., which search tool they had used). Based on a standardised scoring rubric by Leichner et al. (2014), search outcomes were evaluated regarding their fit to the task requirements. Subsequently, a mean outcome score was calculated based on the outcome scores of all three tasks. To investigate the objectivity of scoring, search outcomes of one third of our sample were scored by two independent raters and a Pearson correlation between the two respective outcome scores was calculated (Stemler 2004). Both scores correlated by $r = .97$ ($p < .001$), thus indicating an inter-rater reliability well above the generally accepted criterion of .70.

Information-seeking knowledge (“information literacy”) was measured by the PIKE-P test (Procedural Information-seeking Knowledge Test – Psychology Version; Rosman, Mayer, and Krampen 2015; Rosman and Birke 2015). The test uses a situational judgment test format and claims to measure both procedural and declarative knowledge about various aspects of information-seeking (e. g., knowledge about publication types, generation of search keywords, use of limiters and Boolean operators, etc.). The PIKE-P is particularly suited to investigate our hypotheses because it was designed to measure information-seeking knowledge *independently* of the respective search interface. It thus measures “pure” knowledge about information-seeking, and does not assess proficiency in dealing with specific databases and their interfaces (Rosman et al. 2015). All 22 items begin with the description of a situation that requires an information search (e. g., ‘You are looking for a 1964 article of Heinz Heckhausen in a reference database. Unfortunately, you forgot the name of the article. How do you proceed in order to find it out swiftly?’). Subsequently, four response options (e. g., ‘I conduct an author search for “Heckhausen” and limit my search to the publication year of 1964.’) are presented. Subjects are required to rate these on a 5-point Likert-Scale (*not useful at all* to *very useful*) with respect to their appropriateness of resolving the situation. Scores are obtained through a standardised scoring key based on expert rankings of the appropriateness of the response options.

Personality was assessed with a German 30-item version of the Big Five Personality Inventory (NEO-FFI-30; Körner et al. 2008). Responses were indicated on a 5-point Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). A sample item from the

Conscientiousness sub scale is: “I work hard to accomplish my goals.”. Reverse-coded items were transformed so that low scores indicate low and high scores high conscientiousness.

Need for cognitive closure was measured with the German need for cognitive closure scale by Schlink and Walther (2007). The scale is based on a short version of the English questionnaire by Webster and Kruglanski (1994). 16 Items (e. g., “I don’t like unpredictable situations.”) were to be rated on a 6-point Likert scale (*not agree at all* to *strongly agree*). Again, reverse-coded items were transformed so that low scores indicate low and high scores indicate high need for closure.

Information literacy self-efficacy was measured with the Self-Efficacy Scale for Information Searching Behaviour (SES-IB-16; Behm 2015). The scale consists of 16 items such as ‘When searching for information on a specific subject, I am able to use different sources of information in a way to obtain a maximum of relevant information.’, which are to be rated on a 5-point Likert-Scale.

3.3 Cluster Analysis

To separate successful from unsuccessful database users, we employed cluster analytic techniques. The reasoning for this is as follows: First, we expected cluster analysis to be more distinctive in splitting our database users into two homogeneous groups than simple median-splits (Meece and Holt 1993). Second, while scoring the information search tasks, we observed a specific pattern in our data: The majority of students searching bibliographic databases achieved rather low scores, whereas another (smaller) group scored quite high using these databases. In contrast to Google Scholar™ searchers, relatively few database users achieved scores in the medium range of the distribution. With regard to this apparent violation of the normal distribution in database search outcomes, median split seemed not to be the method of choice (e. g., as it splits the data into two equally sized groups).

Prior to cluster analysis, a categorical variable indicating whether subjects had searched in bibliographic databases (i. e., PsycINFO^{TM}, PSYNDEX^{TM}, PubPsych^{TM}, or PubMed^{TM}) in at least in one of the information search tasks, was created. This rather liberal criterion for identifying database users was chosen on pragmatic grounds. In fact, as the first (and easiest) of the three information search tasks did not necessarily require the use of bibliographic databases (Leichner et al. 2014), the proportion of users solely relying on databases was rather small. To nevertheless obtain sufficient cluster sizes, we liberated the criterion for identifying database users, and accepted that subsequent procedures might underestimate the magnitude of potential effects.

Subsequently, this variable and the search outcome variable were entered into a cluster analysis. Given the mix of categorical and continuous predictors, two-step clustering (distance measure: log-likelihood) was chosen (Tabachnick and Fidell 2007). To determine the amount of clusters that best fits our data, analyses were performed with two, three, and four clusters, respectively. For the three cluster solution, the average silhouette was highest with 0.71 (two cluster solution: 0.68; four cluster solution: 0.69), indicating that a three cluster solution best fits our data. We therefore retained this solution. As expected, the procedure had separated bibliographic database users into two clusters, whereas no-database users were classified into one cluster. Table 1 shows the results of the cluster analysis and provides short descriptions of the respective clusters. A one-way analysis of variance revealed that the between-group differences in outcome scores were significant ($F[2,111] = 44.55$; $p < .001$). Tukey's HSD post hoc tests revealed that all groups significantly differed from each other ($p < .001$): Successful database users have higher outcome scores than no-database users, who, in turn, have higher outcome scores than unsuccessful bibliographic database users.

Table 1. Results of a cluster analysis with search task scores and database use as predictors.

	Cluster 1	**Cluster 2**	**Cluster 3**
Size	*n* = 34	*n* = 24	*n* = 56
Bibliographic databases	Yes	Yes	No
Search tasks outcome scores	*M* = 1.25 ; *SD* = 0.50; range: 0.00 – 2.00	*M* = 2.60; *SD* = 0.33; range: 2.17 – 3.33	*M* = 2.00; *SD* = 0.64; range: 0.67 – 3.17
Description	Unsuccessful database users	Successful database users	No-database users
Search tools used (percentage of total searches over all three information search tasks)	Library catalogue: 15.7 % Google Scholar™: 20.6 % PSYNDEX™: 24.5 % PsycINFO™: 31.4 % PubMed™: 1.0 % Google™: 1.0 % PubPsych™: 2.9 % Other: 3.1 %	Library catalogue: 5.6 % Google Scholar™: 22.2 % PSYNDEX™: 9.7 % PsycINFO™: 19.4 % PubMed™: 8.3 % Google™: 4.2 % PubPsych™: 29.2 % Other: 1.4 %	Library catalogue: 20.8 % Google Scholar™: 69.6 % Google™: 3.6 % Bing™: 1.2 % Other: 4.8 %

Note: N_{total} = 114; *M* = arithmetic mean; *SD* = standard deviation.

4 Results

4.1 Hypothesis 1

The aforementioned cluster analysis (see Table 1) served as a basis for all subsequent calculations. Descriptive inspections of search tool usage revealed that unsuccessful database users primarily rely on the databases PSYNDEX™ and PsycINFO™ using the OvidSP™ interface, whereas successful database users use the simpler PubPsych™ interface far more frequently (see Table 1). This indicates that database choice strongly influences search outcomes, and furthermore suggests that undergraduates struggle with the complexity of the OvidSP™ interface.

An analysis of variance showed that between-group differences in PIKE-P scores were significant ($F[2,111] = 5.51$; $p < .01$) across the three clusters (successful database users: M = 55.88; SD = 6.29; unsuccessful database users: M = 53.79; SD = 6.54; no-database users: M = 51.11; SD = 5.88). Linear contrasts revealed no differences between successful and unsuccessful database users (CI: -1.18 – 5.34; $p = .21$), but showed that unsuccessful database users still have higher PIKE-P scores than no-database users (CI: 0.03 – 5.34; $p < .05$). This supports our assumption that only subjects with a certain amount of information-seeking knowledge will search in bibliographic databases voluntarily.

Subsequently, cluster membership (unsuccessful database users vs. successful database users vs. no-database users) was dummy coded (Aiken and West 1991). Hypothesis 1 posits that successful database users and Google Scholar™ users differ from unsuccessful database users, which is why the latter cluster was taken as a reference group (0/0 coding). As three clusters (or groups) were involved in the hypothesis, two dummy variables were created. The first dummy variable (D1) tested the unsuccessful database users group against the successful database users group, and the second dummy variable (D2) tested the unsuccessful database users group against the no-database users group.

Hypothesis 1 was then tested by multiple regression procedures. As we were interested in an interaction between continuous and dummy coded categorical variables, we adopted the respective procedure suggested by Aiken and West (1991). First, a blockwise multiple regression predicting the outcome score of the information search tasks from (z-standardised) PIKE-P scores and the dummy variables (Block 1), as well as their interaction terms (Block 2), was conducted. With all variables in the regression equation, a significant effect of PIKE-P scores indicates that in the reference group (i. e., the unsuccessful database users cluster), the dependent variable (search task outcome scores) is influenced by information-seeking knowledge (Aiken and West 1991). Significant interactions, on the other hand, indicate that this relationship varies over different clusters.

Table 2. Multiple regression predicting search task outcomes from dummy coded cluster membership, PIKE-P scores, and their interactions.

	Information search task outcomes		
	β	R^2	ΔR^2
Block 1		$.45^{***}$	
PIKE-P (Information-seeking knowledge, z-standardised)	.03		
D1 (unsuccessful database users vs. successful database users)	$.76^{***}$		
D2 (unsuccessful database users vs. no-database users)	$.52^{***}$		
Block 2		$.51^{***}$	$.06^{**}$
PIKE-P (Information-seeking knowledge, z-standardised)	$-.27^{*}$		
D1 (unsuccessful database users vs. successful database users)	$.77^{***}$		
D2 (unsuccessful database users vs. no-database users)	$.54^{***}$		
D1*PIKE-P (interaction term)	.08		
D2*PIKE-P (interaction term)	$.38^{***}$		

Note: N = 114; Method: Enter; PIKE-P, D1, and D2 were entered first (Block 1); Interaction terms (D1*PIKE-P and D2*PIKE-P) were entered subsequently (Block 2); β = standardised regression weight; R^2 = total variance explained; ΔR^2 = change in R^2 from block 1 to block 2.
$^{*}p < .05$.
$^{**}p < .01$.
$^{***}p < .001$.

As shown in Table 2, a negative and significant effect of the PIKE-P scores on information search task outcomes (β = -.27; p < .05) was found for the reference group (unsuccessful database users): High information-seeking knowledge seems to impair search outcomes in unsuccessful database users. Moreover, the product term of D2 (unsuccessful database users vs. no-database users) and PIKE-P scores was significant. This suggests that the relationship between information-seeking knowledge and information search outcomes indeed varies between unsuccessful database users and no-database users. On the other hand, the product term of D1 (unsuccessful database users vs. successful database users) and PIKE-P scores was not significant.

To evaluate the effects of information-seeking knowledge on search outcomes in the other two groups, simple slope tests were conducted by changing the reference group in the dummy coding to the no-database users cluster (and later on, to the successful database users cluster) and running the aforementioned multiple regression procedure again (Aiken and West 1991). A significant and positive effect of PIKE-P scores on search task outcomes ($\beta = .32$; $p < .01$) indicates that high information-seeking knowledge indeed promotes search success in the no-database users group. On the other hand, no significant effect of PIKE-P scores on search outcomes was found in the successful database users group ($\beta = -.10$; $p = .53$). In sum, Hypothesis 1 is partially supported: The relationship between information-seeking knowledge and information search outcomes varies between unsuccessful database users (negative relationship) and no-database users (positive relationship), whereas no corresponding effect was found for the successful database users group.

4.2 Hypotheses 2 and 3

Table 3. Descriptive statistics of personality dimensions, need for cognitive closure, and information literacy self-efficacy in the successful and unsuccessful users cluster.

	Big5-E	Big5-N	Big5-C	Big5-O	Big5-A	NCC	SE-I
Unsuccessful database users	3.44 (0.57)	2.78 (0.66)	3.94 (0.61)	3.78 (0.80)	3.98 (0.67)	3.28 (0.68)	3.20 (0.47)
Successful database users	3.27 (0.52)	2.78 (0.82)	3.38 (0.76)	3.92 (0.64)	3.92 (0.54)	2.93 (0.50)	3.20 (0.46)

Note: $N_{\text{successful database users}} = 34$; $N_{\text{unsuccessful database users}} = 24$; Big5-E = Extraversion; Big5-N = Neuroticism; Big5-C = Conscientiousness; Big5-O = Openness to experience; Big5-A = Agreeableness; NCC = Need for cognitive closure; SE-I = Information literacy self-efficacy; Values in parentheses = standard deviations.

Table 3 shows means and standard deviations of conscientiousness, need for cognitive closure, and information literacy self-efficacy in the successful and unsuccessful users cluster. To test Hypotheses 2 and 3, t-tests for independent samples were calculated. These showed that unsuccessful students indeed have higher scores in conscientiousness ($t[56] = 3.08$; $p < .01$) and need for cognitive closure ($t[56] = 2.15$; $p < .05$) compared to students who succeed in their database searches. As expected, no significant effects were found for extraversion, neuroticism, openness to experience, and agreeableness (all *p*-values > .10). Both hypotheses are thus confirmed. Furthermore, unsuccessful database users used considerably more library-associated search tools (with thus more complex interfaces; e. g., PsycINFO™, PSYNDEX™, or the library catalogue), whereas successful database users used PubPsych™ as their most frequent search tool (see Table 1). This supports our argument that unsuccessful database users fail because they rigidly rely on interfaces that overtax them. Interestingly, we also found that in contrast to successful database users, a higher percentage of unsuccessful database users had taken part in a library tour (63 % vs. 50 %). Though not statistically significant, this might explain why unsuccessful database users rely more heavily on library tools. Finally, no significant differences between the groups with regard to their PIKE-P ($t[56] = 1.21$; $p = .23$) and information literacy self-efficacy scores ($t[56] = 0.01$; $p = .99$) were found.

5 Discussion

The present study investigated psychological factors for success and failure while searching for information in bibliographic databases. In line with previous research, we assumed that a significant proportion of database users might struggle with the complex user interfaces of common bibliographic databases, and might therefore not be able to put their information-seeking knowledge into practice. Furthermore, we contrasted the personality and information-seeking knowledge of unsuccessful with successful database users, and assumed that students high in conscientiousness and need for cognitive closure might more rigidly choose database interfaces that overtax them.

5.1 Information-seeking Knowledge and Search success

A group of $n = 34$ unsuccessful database users was identified through cluster analytic procedures; $n = 24$ database users were more successful in their searches, and $n = 56$ subjects did not use bibliographic databases at all (they relied, for example, on Google Scholar™). Consistent with Hypothesis 1, cluster membership was shown to moderate the relationship between information-seeking knowledge and search success: A negative relationship between information-seeking knowledge and search success was found for unsuccessful database users, whereas this relationship was positive for participants not searching bibliographic databases.

This finding is particularly important for librarians, faculty staff, and database vendors: Not only are unsuccessful database searchers unable to put their knowledge into practice; high information-seeking knowledge may even *impede* their search success. We explain this (at first sight somewhat counterintuitive) finding as follows: Students with a high information-seeking knowledge are motivated to search like one should (see also Hypothesis 2), and they *know* how one should search in an ideal setting. This might incline them to use advanced features (e. g., thesaurus and field limiters) while searching bibliographic databases. Nevertheless, because they lack practical experience, they are likely unable to cope with how these features are realised in the corresponding interfaces, which eventually leads to very poor search outcomes. For example, an unexperienced student trying to use advanced limit options in databases might not know that only very specific terms may be used in the respective fields (e. g., for PsycINFO™: “meta analysis” in the “methodology” field is fine, but “metaanalysis” or “meta-analysis” will yield zero results). On the other hand, using the (few) limit options in PubPsych™ (or Google Scholar™) is not challenging at all: All fields are arranged and labeled intuitively; and both interfaces provide examples of typical search queries in the respective fields. This explains, for example, why students who know which limit options are useful to narrow down a search effectively (high information-seeking knowledge) indeed have higher search success (search task outcome scores).

Unexpectedly, however, no significant relationship between information-seeking knowledge and search outcomes was found for successful database users. Even though this is a post hoc interpretation of our data and further studies are required to straighten out whether our tests just missed significance by chance, one might conclude that in bibliographic databases, practical experience and interface usability play a much greater role than "theoretical" information-seeking knowledge. In that sense, some aspects of information-seeking knowledge might even become redundant when using bibliographic databases correctly: Using a thesaurus might (up to a certain extent) replace "intellectual" keyword-generation and therefore make some aspects of keyword-generation related knowledge dispensable. On the other hand, our data shows that successful database users have significantly higher information-seeking knowledge than users who did not use databases. One may therefore conclude that a certain amount of information-seeking knowledge is well necessary when searching in databases. As soon as a certain threshold is crossed (and we assume that our successful searchers have crossed it), further increases in information-seeking knowledge might nevertheless no longer influence search outcomes. Notwithstanding this, it is intriguing to realise that even students who apparently deal well with bibliographic databases do not seem to benefit much from their information-seeking knowledge. Further research is clearly needed to investigate the issue.

5.2 Differences between successful and less successful Searchers

To further examine differences between more and less successful database users, we investigated the personality and need for cognitive closure of unsuccessful database users. Our results show that unsuccessful, in contrast to successful database users, have significantly higher scores in conscientiousness. As students were allowed to freely choose their search tool, this finding is easily explained: High conscientiousness might drive psychology students to search like one "should do" in psychology (i. e., use more complex bibliographic databases), even in case they still lack the necessary practical experience. Moreover, we found that unsuccessful students have a higher need for cognitive closure. Considering that individuals with a higher need for closure have a strong desire to arrive at quick solutions ("seizing"), and to maintain these solutions over time ("freezing"; Kruglanski and Webster 1996), this is again not surprising. In fact, advanced bibliographic database interfaces (e. g. OvidSP™) are often considered the "gold standard" for carrying out information searches in psychology (e. g., by librarians and lecturers), which inclines students with a high need for closure to "seize" this view and consequently "freeze" on it.

Both our findings on conscientiousness and on need for cognitive closure have important implications: One might assume that students with high conscientiousness and need for cognitive closure are especially sensitive to claims that reliance on library tools is the one "true" approach to information-seeking (see above). We expect this to be the main reason that these students use interfaces not meeting their individual needs. This, in turn, likely hinders them to put their information-seeking knowledge into practice, thus entailing unsatisfactory search outcomes. In sum, our data thus supports our conception of database search outcomes being influenced by an interaction between both personality and practical skills.

Additionally, we investigated whether there were differences in information-seeking knowledge and information literacy self-efficacy between successful and unsuccessful database users. As we would have expected, no corresponding differences were found. However, due to the rather small number of database users (n = 58), statistical power was too low to make strong conclusions on this. We nevertheless find it intriguing that the arithmetic means of information literacy self-efficacy did not differ *at all* ($z < 0.01$) between successful and unsuccessful database users. Unsuccessful database users thus do not seem to recognise that they are not yet ready to use advanced database interfaces. As information-literacy self-efficacy was measured prior to the information search tasks, one may argue that at least some unsuccessful database users had never actually searched in bibliographic databases, and were thus not able to take actual experiences as a basis for their judgments. It would therefore have been interesting to re-assess information literacy self-efficacy after the information search tasks, as previous research has shown that the implicit feedback associated with information searching leads to more realistic self-assessments (Rosman, Mayer, and Krampen 2014).

5.3 Limitations and future Directions

An obvious strength of our study is that searchers could freely choose their search tool. Along with this nevertheless comes a downside, namely that our sample of database users was rather small. Moreover, we had a very pragmatic criterion for identifying database users, as we viewed all students that had at least once searched in databases (i. e., in one of the three information search tasks) to be “database users”. This decision may only be justified on pragmatic grounds, as our sample size in the database users group would have been too small otherwise.

Additionally, we only investigated third semester psychology students. Although third semester students are particularly well-suited to investigate our hypotheses (e. g., because most of them will already have acquired some theoretical, but not much practical information-seeking experience), our focus on psychology students impairs the generalizability of our findings to other disciplines. Especially in disciplines where bibliographic databases constitute the "gold standard" for information searching, one might estimate to find very similar results, but future research should straighten out whether this assumption withstands thorough empirical testing.

A third limitation is that at the University of Trier, both PSYNDEX™ and PsycINFO™ can only be accessed through the OvidSP™-interface. Even though usability concerns are widespread among different database interfaces (e. g., Stewart et al. 2005), generalisations of our conclusions to other interfaces might thus be problematic.

Finally, the time limits on the information search tasks might have been problematic, because bibliographic databases are more complex and thus require more search time (even though going through an extensive list of Google Scholar™ results is time-consuming as well). We therefore cannot tell for sure whether unsuccessful database users really lacked interface-specific skills or whether they were just inefficient in using the specific interfaces (i. e., not able to put their skills into practice in the time given to work on each search task).

In sum, we concede that our conclusions might be less robust than expected, and that changes in conditions (e. g., different samples, domains or user interfaces and less restrictive time limits) might result in different findings. We therefore see our study as exploratory in nature, and future research should strive to replicate our findings.

Apart from these more methodological constraints, one might question the long-term consequences of unsuccessful database searches. In our opinion, two scenarios are possible: On the one hand, one might suppose that as a consequence of our study, our unsuccessful database users will act on their weaknesses (for example by taking part in database instruction). Deliberately having chosen bibliographic databases as a search tool may even indicate their desire to master these complex search systems. Envisioning the positive long-term consequences of proficient database skills, they simply might have taken failure into account. This is in line with ACT theory positing that errors and impaired efficiency are common at the beginning of a skill acquisition process (at the so-called *declarative stage*; Anderson 1982). With increasing practice, error rates will gradually decline and efficiency will increase (DeKeyser 2007), up to the so-called *procedural stage* in which the respective task is carried out almost automatically. Our unsuccessful students' choice of search tools might thus have been the first step of a (hopefully successful) learning process. On the other hand, one might estimate that "failed" searches discourage students and undermine their expectations regarding the benefit of bibliographic databases, which would ultimately incline them to revert back to easier search tools (e. g., Google Scholar™). Choosing a bibliographic database as search tool would thus not have been the beginning, but the end of a learning process. The former position is supported by our findings on the personality of unsuccessful database users: Their high conscientiousness might not only have inclined them to follow their lecturers' and librarians' recommendations on how to search for information. In fact, it might also have created an "intrinsic" desire to master more complex information retrieval methods. Nevertheless, future research (i. e., longitudinal studies) should straighten out which of these two scenarios is more likely.

5.4 Conclusions and practical Implications

In sum, an intriguing picture emerges from our results. A considerable number of Psychology undergraduates seem to have severe troubles to put their information-seeking knowledge into practice when searching in bibliographic databases. Even worse: For students with high conscientiousness, information-seeking knowledge does more harm than good, as it seemingly drives students towards using advanced database functions that overtax them. Despite unclear long-term consequences, this is an alarming conclusion that emphasises the significance of further improvements on library instruction programs and database interface usability.

Nevertheless, our research gives reason for hope, as it suggests that not deficiencies in a complex skill set like information literacy, but sheer unfamiliarity with the respective search interfaces accounts for the unsatisfying results of our unsuccessful database users. Especially since we found no differences in information-seeking knowledge between successful and unsuccessful database users, one might therefore conclude that it does not take much to turn unsuccessful database users into successful ones. One particular finding from our study illustrates this: The 9 users (M = 2.67; SD = 0.41) who relied on PubPsych™ had nearly twice the information search task scores than the 15 PsycINFO™ users who used the much more complex OvidSP™ interface (M = 1.36; SD = 0.77; see also Table 1). Their information-seeking knowledge, however, was almost identical (PubPsych™ users: M = 56.89; SD = 2.09; PsycINFO™ users: M = 56.40; SD = 7.34). Even though we acknowledge the small sample size, we think that this shows impressively what impact usability can have on search success. We therefore see database interface suppliers in the obligation to dedicate their full attention to improving the usability of their systems. They might, for example, strive to enhance navigability (Green and Pearson, 2011), reduce library terminology (e. g., Kupersmith 2012), develop comprehensible and readily accessible tutorials (e. g., Silver and Nickel 2005), provide query previews (e. g., Tanin et al. 2000; Kim 2005), and implement error prevention features (e. g., prevent users to enter unsupported characters instead of returning cryptic error messages; Manzari and Trinidad-Christensen 2013). Communication and collaboration between database vendors, librarians, and faculty are vital to achieve this (Imler and Eichelberger 2014). In sum, we thus agree with Imler and Eichelberger's (2014) position that database interfaces should be tailored to the individual user's needs and not the other way around.

Moreover, our findings highlight the crucial role of library instruction. Nowadays, most libraries provide specific instructional modules to teach students how to use bibliographic databases (Brophy and Bawden 2005; Wang 2013). Our findings show that instruction should focus on the *practical* use of the user interfaces of the databases; conveying declarative knowledge about certain database features or library services is not enough. Moreover, we think that it is especially important to embed library instruction into courses (i. e., embedded librarian programs; Dewey 2004). This may not only teach students in the practical use of library services, but also convey that even though advanced bibliographic database interfaces are still the "gold standard" in information searching, they are rather complicated to use, and that alternative tools are well-suited for (1) less complex searches, (2) searches on interdisciplinary topics (especially Google Scholar™), and (3) may serve as a starting point for less experienced searchers.

Finally, we wish to point out the benefits of realistic self-assessments. Students who estimate their strengths and weaknesses realistically will likely not use database functions that overtax them. Rosman et al. (2014) showed that conducting a few information searches already enhances self-assessment accuracy. This again highlights the value of *practical* instruction, and gives reason for hope that in future searches, our unsuccessful database users will not stumble into the same pitfalls again.

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