Article

Psychologists' research activities and professional information-seeking behaviour: Empirical analyses with reference to the theory of the Intellectual and Social Organization of the Sciences

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Abstract
Five facets of professional information-seeking behaviour were analysed in a sample of 298 psychology researchers from the German-speaking countries. In an online survey data were gathered on (1) information-processing behaviour during research project development, research implementation, results publication, use of citation databases, and preferred publication language, (2) scientists' functional dependence, strategic dependence, technical uncertainty, and strategic uncertainty with reference to the theory of the Intellectual and Social Organization of the Sciences, (3) scientists' engagement in Big vs Little Science and (4) in psychological subdisciplines, and (5) scientists' personal characteristics (age, job position, sex, information competence, cognitive style). Empirical results refer to (1) the construction of economical psychometric Scales on Perceived Mutual Dependence and Task Uncertainty in the Sciences (S-DUS) and (2) the prediction of information behaviour by the DUS-scales, research engagement in Big vs Little Sciences and in subdisciplines, as well as age in hierarchical regression analyses. The paper discusses the broad usability of the S-DUS and the result that different facets of scientists' information behaviour require differential predictors.

Keywords
information-seeking behaviour; computer searching; scale development; research activities; science studies; science research; information services; scientists; psychology; information systems

1 Introduction

Information reception is a key aspect of all scientific work. Only those researchers who remain up to date professionally are able to provide excellent research and teaching. Adequate information resources are a necessity for scientists in their quest for applicable information.

In addition, information suppliers have to know the special needs of their users. This requirement is notably valid where differences in information-seeking behaviour between scientific users have often been explored – first and foremost in the face of the digital transition of scientific information and communication by the internet, which appears to affect the typical daily activities of scientists more profoundly than anything since the invention of the printing press (see, e.g. [1–8]; for overviews see e. g., [2, 8–10]). One must keep in mind that altering the scientific communication system changes the social structure of science in such a way as would not destroy the distinctive feature of scientific communication which is the essence of scientific progress and integrity (e.g. [11]).

However, most of the empirical studies on the changed and changing information-seeking behaviour of scientists are not beyond dispute. In addition to the absent or poor theoretical frameworks which would allow the explanation and forecasting of information-seeking behaviour, frequent criticisms include (see, e. g. [9]): (1) studies' limitation to analysis of

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information-seeking behaviour without taking the institutional context and social organization into account, (2) in-depth analysis of a single discipline and generalization of results across all disciplines, (3) comparison of very broad groups of scientific disciplines, and (4) focus on use of selected, particular information resources.

In fact, no research paradigm compares avant-garde information (mostly high energy physics) with other research fields. According to Kling and McKim here one often assumes that 'we are in the early stages of an electronic revolution, that it is only a matter of time before other fields catch up with the early adopters, and that all fields converge on a stable set of electronic forums' [12, p. 1306].

However, Kling and McKim [12] give rise to scepticism and discuss heterogeneous communication practices owing to stable differences between scientific disciplines. We concur with Fry and Talja in their conclusion that explaining scientists' information-seeking behaviour needs a deeper exploration of their 'epistemic and social home of knowledge producing communities' [9, p. 9].

We also concur with Fry and Talja [2, 9] and Talja, Vakkari, Fry and Wouters [8] in assuming that Whitley's model of the *Intellectual and Social Organization of the Sciences (ISOS)* [13] allows exactly that because of its simultaneous integration of epistemic and social assumptions in two widely independent dimensions: mutual dependence of scientists and task uncertainty in research with two subdimensions each. This is in agreement with Weingart, who considers Whitley's ISOS-theory [13] to be 'the largest and most cogent attempt to integrate the different observations of disciplines' development and the social organization of science in a single theoretical framework' ([14, p. 50, translated].

2. Theory

The ISOS, the epistemic and as well as social assumptions integrating model of Whitley [13], seems to be very promising for clarifying idiosyncrasies of and differences in scientists' information-seeking behaviour. The starting point of Whitley's considerations is the fact that scientific fields are reputational organizations and the scientists themselves seek to augment their reputation through their contribution to their community's goals. Whitley's idea comes from the possibility of classifying scientific fields like other working organizations on two dimensions which in turn comprise two subdimensions each:

- *Mutual Dependence* refers to the social organization/assumptions of science, i.e. to scientists' dependence upon particular groups of colleagues to make competent to collective intellectual goals and acquire prestigious reputations which lead to material rewards [13, p. 87].
- *Functional Dependence* means the necessity of using results, ideas, and procedures of notable colleagues.
- *Strategic Dependence* means the need to argue such colleagues into significance and importance of problems and approaches.
- *Task Uncertainty* refers to the epistemic foundations/assumptions of science, i.e. to the extent to which work procedures, problem definitions, and theoretical goals are shared between practitioners, and are clearly articulated [13, p. 120].
- *Technical Uncertainty* means the extent to which working techniques are well-understood and produce reliable results [13, p. 121].
- *Strategic Uncertainty* comprises the ambiguity about intellectual priorities, the significance of research topics and preferred ways of tackling them, the likely reputational pay-off of different research strategies, and the relevance of task outcomes for collective intellectual goals [13, p. 123].

Although Whitley's [13] theory concerns the relationship between the cultural identity of a scientific field and its characteristics of communication, he does not explicitly discuss its implications for the use of information and communication technologies [9]. However, this option seems obvious. We explicitly want to point out that we are in alignment with previous works of Fry and Talja [2, 9] as well as Talja, Vakkari, Fry and Wouters [8] and that our work would not have been feasible without their foundation and initial theoretical as well as methodical steps. Yet in many ways the present study goes a step further.

In our investigation of psychology researchers in the German-speaking countries (i.e. Austria, Germany as well as parts of Switzerland and Luxembourg) we suppose that Whitley's [13] model allows the explanation of idiosyncrasies of scientific subdisciplines as well as differences between them in today's information-seeking behaviour of scientists. In addition to determining the explanatory power of the model, an objective of the present study is to check its advantages in explaining above and beyond conventional frameworks and/or differential person characteristics.

Fry and Talja [2] correctly point out that Whitely's model [13] is only applicable to comparison of different scientific fields, and not to making statements about one particular field. Therefore, it must be pointed out that the investigation of

German-speaking psychology researchers is possible since psychology is composed of different scientific subfields. It has often been shown that psychological subdisciplines differ from each other in many different ways with respect to how research is conducted (see, e.g. [15]). Extending this, we ask, why not in the way scientific information is sought after? This argument increases with the epistemological and methodological differences between psychological subdisciplines since their research topics (i.e. behaviour and experience or – more contemporary – action and cognition) must be analysed from both a natural science and an arts and humanities perspective. For instance, the psychobiological and neuropsychological determinants and correlates of behaviour and experience fall within psychological study as well as the social, cultural and psychodynamic aspects of action and cognition. Thus, psychological research can incorporate the natural science methodology as well as the (often more qualitative) methodology of the arts and humanities which includes the social sciences methodology.

A conventionally fundamental differentiation of scientific fields is that of Big vs Little Science. It was first introduced by Weinberg [16] but when used nowadays it is used most often in reference to Price [17]. In the Pricean sense we concur with Shearer and Moravscik in distinguishing:

> Science is considered little when research is done individually or in small groups, and the resources (money and equipment) of the scientists are small. (…) Science is big when projects involve large sums of money and lots of people [18, p. 463–464].

To simplify one can say that natural science research tends to be Big science and the arts and humanities research tends to be Little science – both areas are significant and present in psychology research. For example, neuropsychology, biopsychology, and experimental psychology are much more Big sciences than research on the history of psychology, media psychology, legal psychology, and traffic psychology, which are examples of Little sciences. Owing to the personal and laboratory resources needed, some other subdisciplines (e.g. work and organization psychology, psychological diagnostics, and social psychology) sit between the Big and Little ones.

In fact, it has already been shown that patterns of information-seeking behaviour differ between the poles of Big vs Little Science [18, 19]. In addition to these more or less research inherent factors – i.e. environmental and social role in Wilson's [20] model of information-seeking behaviour – there are some relevant differential person characteristics too. According to Wilson's [20] model this is the person him- or herself, whose influence should also be controlled (see, e.g. [21] [22]). Besides age, sex, and job position, we concur particularly with Heinström [22] in the supposition of the crucial role of cognitive styles and that of Covi [21] in regard to material mastery, i.e. information competence, experience, and interest in professional information-seeking training.

The following study and analyses were performed with certain goals in mind. First, an attempt was made to develop short psychometric scales for the objective, reliable, and valid measurement of the four constructs (i.e. functional dependence, strategic dependence, technical uncertainty, and strategic uncertainty) postulated by the theory of the Intellectual and Social Organization of the Sciences [13] to be significant for differences between the (Big vs Little) sciences and scientific subdisciplines. The construction of the broadly usable S-DUS is the product of this goal.

Second, we attempted to predict the information-seeking behaviour of scientists in five different typical research activity domains (i.e. project development, research implementation, publication of results, use of citation databases, and publication language). In stepwise hierarchical regression procedures, the four variables of the perceived social organization of the sciences are included in the first step. The second step additionally includes indicators of Big vs Little science, the third includes psychological subdisciplines, and the fourth step includes scientists' characteristics (i.e. age, job position, sex, experience, and interest in training about internet information resources and intuitive vs analytical cognitive style).

3. Method

3.1. Participants

In total, 1755 members of the German Psychological Society (Deutsche Gesellschaft für Psychologie, or DGPs), the association of psychology researchers in the German-speaking countries, were invited to participate in an online survey about professional information behaviour. In other words, we invited every member of the following professional sections of the DGPs (comparable to the divisions of the American Psychological Association, APA): Work and Organizational Psychology; Biological and Neuropsychology; Differential Psychology, Personality Psychology and Psychological Diagnostics; History of Psychology; Media Psychology; Educational Psychology; Legal Psychology; Social Psychology; Environmental Psychology; Traffic Psychology. Due to multiple memberships participants represent all of the 15 DGPs sections.

A total of 298 (16.98%) scientists followed the invitation and completed the survey immediately (n = 272) or completed the survey after a break (n = 26). In our main analyses 64 participants had to be excluded due to only partial completion of the survey.

The sample consists of 175 men (59%), 113 women (38%), and 10 participants (3%) who did not provide their gender. Mean age of participants is 42.9 years (SD = 11.16, Min = 26, Max = 73). The academic structure of the sample, deeply rooted in the DGPs charter [23], is as follows: PhD students as associated members (*n* = 35/12%) and postdoctoral researchers (*n* = 76/26%), assistant professors (*n* = 52/17%) as well as professors (*n* = 114/38%) with full DGPs membership. Twenty-one (7%) participants did not reveal their current position.

3.2. Representativeness of the sample

To better control whether the group of participants (responders) differed systematically from those who did not participate (nonresponders), we decided to conduct an open (i.e. not anonymous) online survey. This gave us the opportunity to control for crucial objective scientometric variables which shed light on possible selection biases. Our bibliometric *indicators of scientific productivity* refer to (1) the total number of scientific publications and (2) the number of English-language scientific publications documented in PSYNDEX, the only comprehensive psychology literature database in the German-speaking countries. The scientometric *indicators of scientific reception and impact* refer to (1) the total number of citations by others (Social Science Citation Index, SSCI, journal subject type: psychology) excluding self-citations and (2) the number of citations by others in English articles (SSCI).

Eleven responders did not state their name. Thus it was impossible for us to determine their bibliometric and scientometric scores. This resulted in the comparisons of 287 responders (16.4%) vs 1468 nonresponders (83.6%), all of them being DGPs members. The four aforementioned bibliometric and scientometric scores were gathered objectively for all these DGPs members using the PSYNDEX and SSCI databases, respectively.

Responders and nonresponders were compared on the four indicators of scientific productivity and scientific reception using two-tailed independent sample *t*-tests. The results in Table 1 point neither at statistically significant mean differences (*t*-tests) nor at significant variance heterogeneities (Levene's *F*-test) between our sample of responders and the nonresponders. This confirms the representativeness of our sample with reference to publication output and to the frequency of its citations by others.

It should be noted that the standard deviations of all scientometric variables are rather large, pointing at the heterogeneity of the population (and the sample of the study as well) in scientific productivity and impact. This is due to the heterogeneity of the DGPs membership with reference to job experience and age, i.e. including junior scientists as well as senior scientists. In connection with the recent debate on the (re-)internationalization and anglicization of psychological research in the German-speaking countries (see, e.g. [24, 25]), it should be noted that more than one third of the scientific output refers to English-language publications and more than three quarters of the citations by others are citations in English-language articles (see Table 1).

3.3. Measures

The four subdimensions of the theory of the Intellectual and Social Organization of the Sciences (ISOS) [13] were measured by 15 items which were constructed with reference to the definitions given by Whitley [13]. Item development and formulation was done deductively with face validity to the constructs described and defined by Whitley (see Table 2). Participants indicated their agreement with each statement on a five-point rating scale (1 = *not applicable at all* to 5 = *totally applicable*). Wordings of all 15 items and their scoring on the scales measuring Functional Dependence, Strategic Dependence, Technical Uncertainty and Strategic Uncertainty are presented in Table 2.

Subjective perceptions of being personally engaged in Big vs Little Science were measured by two items: first, participants were asked to indicate to what extent they would agree (five-point rating scale; 1 = *not applicable at all* to 5 = *totally applicable*) with the statement that very costly infrastructures are necessary for a typical research project (technical resources) and second, how many collaborators participate in such a typical research project (personnel resources).

In addition, the psychological sub-disciplines were gathered by the participants' memberships in professional DGPs sections. This resulted in 15 dichotomous predictors which are, although dependent, applicable because of their satisfactory tolerance scores (*M* = 0.74; SD = 0.12; Mdn = 0.77).

Person characteristics refer to age, sex, and job position, experience with electronic information resources training (no: 253/85%; yes: 34/11%; missing: 11/4%), and interest in electronic information resources training (no: 164/55%; yes: 121/41%; missing: 13/4%). The last two indicator variables were included to check individual experiences in systematic information-seeking competence training (i.e. positive indicator of mastery) and to check the motivation to engage in such training in the future indicating at least some subjective deficit perceptions (i.e. inversed indicator of mastery). Furthermore, cognitive style was measured by participants' position on the analytical-intuitive dimension measured by the 12-item version (*M* = 53.8, SD = 7.70, α = 0.58) of the *Cognitive Style Index* (CSI; [26, 27]). With regard to the interpretation of scores, Allinson and Hayes explicate,' the nearer the total CSI score to the theoretical maximum of 76, the more analytical the respondent, and the nearer the total score to the theoretical minimum of zero, the more intuitive the respondent' [27, p. 124].

Thus, the present sample of psychology researchers shows, on average, a high analytical cognitive style (observed mean M_o = 53.8 which is more than two standard deviations above the theoretically expected mean: M_e = 35; i.e. $M_o = M_e + 2.4$ SD).

Professional information-seeking behaviour, the dependent variables or criteria in our analyses, is measured by five indicators referring to the use of professional information resources during (1) research project development/preparation, (2) research project implementation, and (3) result dissemination as well as (4) the use of citation databases, and (5) the preferred publication language in result dissemination. Statistical characteristics of these five indicators of professional information-seeking behaviour as well as their items and their statistical parameters are presented in full detail in Table 3.

Table 1. Mean comparisons in scientometric variables between responders to the online survey (n = 287) and nonresponders (n = 1468)

Scientometric variable	Responder (n = 287)		Nonresponder (n = 1468)		Levene's test		t-Test (df = 1753)	
	M	SD	M	SD	F	p	t	p
Indicators of scientific productivity								
PSYNDEX: total number of scientific publications	25.8	35.9	26.9	38.2	0.27	0.61	0.43	0.66
PSYNDEX: number of English-language publications	9.2	15.3	9.3	17.4	0.23	0.63	0.05	0.96
Indicators of scientific reception and impact								
SSCI: number of citations by others	55.2	115.3	73.6	243.2	3.17	0.08	1.25	0.21
SSCI: number of citations by others in English articles	42.3	90.1	57.6	217.2	3.37	0.07	1.17	0.24

Table 2. Psychometric characteristics of the scales Functional Dependence, Strategic Dependence, Technical Uncertainty, and Strategic Uncertainty and of their items[a]

Scales and items	M	SD	a_{ij}	r_{it}
Functional Dependence (α = 0.66, N = 282)	8.99	2.26		
My research will be appreciated even when it is not oriented to the mainstream.[b]	2.73	0.98	0.63	0.42
Theoretically or methodologically unusual research contributions have very little chance of being published in my research area.	2.87	1.01	0.76	0.49
My research contributions have to suit to the current research landscape; otherwise they will not be funded or recognized.	3.40	0.93	0.66	0.50
Strategic Dependence (α = 0.64, N = 279)	14.91	2.64		
Networked research projects receive funding first and foremost in my research area.	3.23	1.04	0.67	0.41
In my research area it is an advantage to be oriented to the current research trends.	3.98	0.80	0.67	0.45
There is a lot of competition for personnel and financial resources in my research area.	3.63	1.06	0.63	0.44
You need connections in my research area in order to climb the scientific ladder.	4.04	0.91	0.62	0.38
Technical Uncertainty (α = 0.66, N = 280)	11.20	2.67		
The methods appropriate for use in my research area are clearly defined for each individual case.[b]	2.64	0.96	0.55	0.38
What is considered methodologically good work is clear to everyone in my research area.[b]	2.72	0.98	0.78	0.62
In my research area there is a lot of consensus about the value of a research paper.[b]	2.87	0.88	0.69	0.45
In my research section, the methods used depend more on the researcher him- or herself than on the object of investigation.	2.99	0.99	0.54	0.32
Strategic Uncertainty (α = 0.52, N = 277)	11.46	2.38		
In my research area there is consensus about the most important research goals.[b]	2.80	0.90	0.57	0.30
The relevance of many objects of investigation is vague for potential target groups.	3.10	0.95	0.54	0.33
The direction my research area will take is hardly foreseeable.	2.83	0.93	0.45	0.28
The topics that receive funding in my research area seem quite arbitrary to me.	2.73	0.95	0.40	0.32

Note: N varies owing to item missing values.

[a]α = Cronbach's alpha, M = mean, SD = standard deviation, r_{it} = item-scale correlation, a_{ij} = factor loading.

[b]Item scores reversed for scoring.

4. Results

4.1. Professional information-seeking behaviour

A brief inspection of the means (*M*) of the 11 items and of the five indicators of professional information-seeking behaviour (see Table 3) result, with reference to their theoretical minimum vs maximum value and the empirically observed standard deviations (SD), in the following interpretations: most pronounced is information-seeking behaviour in the working phase of results publication with an observed mean (M_o = 12.1) located more than two standard deviations above the theoretically expected mean (M_e = 7.5; i.e. $M_o = M_e + 2.4$ SD). Slightly less, but also strongly pronounced is information-seeking behaviour in the phase of project development: the observed mean (M_o = 11.4) is more than 1.5 standard deviations above the theoretically expected mean (M_e = 7.5; i.e. $M_o = M_e + 1.7$ SD). Information-seeking behaviour concerning English as the preferred publication language (M_o = 3.8, M_e = 2.5; $M_o = M_e + 0.96$ SD) and information-seeking behaviour in the working phase of research project implementation (M_o = 6.6, M_e = 5.0; $M_o = M_e + 0.8$ SD) are somewhat less pronounced, however, both these means are almost one standard deviation above the expected means. Use of citation databases shows the lowest observed mean (M_o = 4.8) which is nearly in agreement with the theoretically expected mean (M_e = 5.0; i.e. $M_o = M_e + 0.1$ SD). It is worth noting that all standard deviations (SD) confirm that there is a lot of variance in the sample, i.e. there are clear interindividual differences in all variables of professional information-seeking behaviour among psychology researchers.

4.2. Psychometric scale construction

First, we attempted to develop psychometric scales for the objective, reliable, and valid measurement of the four constructs postulated by the theory of the ISOS (i.e. scientists' functional dependence, strategic dependence, technical uncertainty, and strategic uncertainty [13]). Scale construction followed the standard principles of classical test theory and factor analysis.

A review of the means (*M*) of the 15 items and of the four scales (see Table 2) result, with reference to their theoretical minimum vs maximum and to their standard deviations (SD) in the present sample, in interpretations of a (1) high

Table 3. Characteristics of the five indicator variables of professional information-seeking behaviour using information resources during scientific Project Development, Research Implementation, and Result Publication as well as Use of Citation Databases and Preferred Publication Language[a]

Items and indicators	*N*	*M*	SD	Min	Max
When and why do you look for professional information? (never … always)					
Development of ideas/project proposals, etc.	289	3.92	0.91	1.00	5.00
Specification of questions/hypotheses	286	3.88	0.94	1.00	5.00
Setting up of theories/models	287	3.62	1.04	1.00	5.00
Indicator Project Development/Preparation	**289**	**11.42**	**2.28**	**3.00**	**15.00**
When and why do you look for professional information? (never … always)					
Operationalization/laboratory work	284	3.23	1.12	1.00	5.00
Empirical testing/examination	281	3.32	1.08	1.00	5.00
Indicator Research Project Implementation	**288**	**6.55**	**1.92**	**2.00**	**10.00**
When and why do you look for professional information? (never … always)					
Preparation of manuscripts for publication	290	4.47	0.66	2.00	5.00
Preparation of lectures	288	3.87	0.93	1.00	5.00
Preparation of courses	282	3.86	0.97	1.00	5.00
Indicator Results Publication	**289**	**12.19**	**1.99**	**3.00**	**15.00**
Please indicate how often you use the following information resources for finding professional information (never … always)					
Scopus	271	1.92	1.21	1.00	5.00
Web of Science	276	2.82	1.44	1.00	5.00
Indicator Use of Citation Databases	**276**	**4.76**	**2.17**	**2.00**	**10.00**
Please indicate how often you use information resources when you prefer German- vs English-language publication					
1. 1 = German ….. 5 = English	276	3.80	1.35	5.00	5.00
Indicator Preferred Publication Language	**276**	**3.80**	**1.35**	**1.00**	**5.00**

Note: *N* varies due to item missing values.

[a]*M* = mean, SD = standard deviation, Min = minimum score, Max = maximum score in the sample.

score for Functional Dependence (M_o = 8.99, M_e = 7.5; $M_o = M_e + 0.7$ SD) and (2) a markedly high score for Strategic Dependence (M_o = 14.9, M_e = 10.0; $M_o = M_e + 1.9$ SD). (3) There are also high scores for Technical Uncertainty (M_o = 11.2, M_e = 10.0; $M_o = M_e + 0.5$ SD) and (4) Strategic Uncertainty (M_o = 11.46, M_e = 10.0; $M_o = M_e + 0.6$ SD) in the present sample of psychology researchers. However, all standard deviations confirm that there is a lot of variance in the sample, i.e. there are clear interindividual differences in all variables among psychology researchers.

A standard exploratory factor analysis with varimax rotation was computed. Four factors were extracted. The resulting factor loadings (a_{ij}) are presented in Table 2. Three items are markers (with the highest factor loadings) of the scale Functional Dependence (proportion of total variance: 18.1%) and four different items each are markers of the scales Strategic Dependence (29.3%), Technical Uncertainty (38.6%), and Strategic Uncertainty (13.9%). These item-factor relationships are in total agreement with the expectations underlying item development.

The results of the reliability analyses and item analyses computed for the four scales are also presented in Table 2. Reliability coefficients, computed conservatively by Cronbach's alpha (α), of the four scales meet the psychometric requirements for their use in group comparisons (their intended use), but not the requirements for differential (individual) diagnosis. This is also the case for the corrected item-scale correlations (r_{it}) presented in Table 2.

In sum, objectivity of the scales on Perceived Mutual Dependence and Task Uncertainty in the Sciences (S-DUS) is guaranteed in this questionnaire approach without displaying any subjective biases in data gathering, data analysis, and data interpretation. Reliability of the scales is empirically confirmed in a first sample of psychology researchers. Besides the empirically confirmed factorial validity there are results on the scales' intercorrelations and correlates which provide some first hints about their discriminative and convergent validity (see Table 4).

The two subdimensions of mutual dependency (i.e. Functional and Strategic Dependence) as well as the two subdimensions of task uncertainty (i.e. Technical and Strategic Uncertainty) are significantly intercorrelated, although the numerical value is rather low (less than 11% common variance; see Table 4). These results confirm, in connection with the scales' reliabilities, the convergent validity of the subdimensions on mutual dependence and task uncertainty of the ISOS-theory [13] as well as their sufficient discriminative validity. The significant, albeit numerically rather low, correlation of Functional Dependence and Strategic Uncertainty (common variance: 9%) points at a covariation of stronger social orientations toward important colleagues and ambiguity about the significance of research topics. Discriminative validity of the S-DUS is confirmed by the insignificant relations of all four subdimensions with scientific productivity as indicated by the amount of research funding, total number of scientific publications, and total number of citations by others (see Table 4). Age is not significantly correlated with Functional Dependence and Technical Uncertainty, but a significantly negative correlation is found with Strategic Dependence and a significantly positive one with Strategic Uncertainty. There seems to be a cluster of psychology researchers whose longer job experience converges with a decreased subjective dependence from colleagues and an increased ambiguity

> about intellectual priorities, the significance of research topics and preferred ways of tackling them, the likely reputational pay-off of different research strategies, and the relevance of task outcomes for collective intellectual goals [13, p. 123].

Thus, awareness of the existence of competing theories and multiparadigmatics of science as well as some scepticism about research and personal independence increase with age and duration of job experience.

Table 4. Intercorrelations and correlates of the scales Functional Dependence, Strategic Dependence, Technical Uncertainty, and Strategic Uncertainty (n = 287)

Scales S-DUS	Functional Dependence	Strategic Dependence	Technical Uncertainty	Strategic Uncertainty
Functional Dependence	1.00	0.33**	0.00	0.30**
Strategic Dependence		1.00	– 0.09	0.11
Technical Uncertainty			1.00	0.29**
Strategic Uncertainty				1.00
Correlates				
Age	0.05	– 0.16*	0.06	0.20**
Research Funding	0.12	0.10	0.05	– 0.06
Total number of publication (PSYNDEX)	0.02	– 0.05	– 0.07	0.11
Total number of citations by others (WoS)	0.00	– 0.02	– 0.04	0.07

Note. *$p < 0.05$; **$p < 0.01$.

4.3. Prediction of professional information-seeking behaviour

Hierarchical regression analyses were computed to determine relevant influences of the four predictor sets on the five aspects of professional information-seeking behaviour (see Table 5). The four subdimensions of the ISOS-theory [13], operationalized by the S-DUS, were entered in Step 1 as the first predictor set. In Step 2, we entered the two measures of subjective involvement in Big vs Little Science research. In Step 3, we entered the psychological subdisciplines of the researchers mentioned above. In Step 4, differential person characteristics were additionally entered as a predictor set: Besides the variables of sex, age, and job position, experience, and interest in training on professional internet information resources (two aspects of information mastery), analytical vs intuitive cognitive style was included as well.

Dependent variables or criteria of the five hierarchical regression analyses are the five indicators of professional information-seeking behaviour: use of professional information resources during (1) project development/preparation, (2) project/research implementation, and (3) result publication, and (4) the use of citation databases and (5) the preferred publication language (see Table 5).

Results from the hierarchical regression analyses are shown in Table 5. With regard to project development (i.e. preparation of scientific research), variance cannot be explained by any predictor in a statistically significant way. Nevertheless, the complexity of necessary technical resources (i.e. Big Science) seems to have a promoting influence while membership of the DGPs Traffic Psychology section and age have, in contrast, a somehow reducing influence on professional information-seeking behaviour in project development.

The use of professional information resources during research project implementation can exclusively be explained by the extent of technical resources. The more extensive resources are necessary for research (i.e. Big Science), the more the researcher depends on professional information during this working phase. No other predictor contributes anything else here.

Use of professional information during the result publication working phase is mainly influenced by the two uncertainty dimensions. If working techniques are well understood (low technical uncertainty), professional information behaviour is less pronounced. If, instead, intellectual priorities are highly ambiguous (high strategic uncertainty), professional information behaviour is more pronounced. No other predictor can additionally explain variance to a significant extent. However, job position is of some importance, too. Membership of the DGPs Developmental Psychology section loses its significance when personal characteristics are added into the equation.

Associated with the publication of scientific results are references to others and citations. Again, use of citation databases is high if technical uncertainty is low, if costly technical infrastructure is necessary (i.e. Big Science), and among members of the DGPs Experimental Psychology section. Technical resources, however, lose their significance when psychological subdisciplines are entered into the equation. This change of significance over predictor blocks of variables inserted is a statistical advantage of hierarchical regression, which takes into account the intercorrelations of variables and variable blocks. Thus, if a newly inserted variable block is more effective in prediction and includes statistically a variable block inserted in an earlier step, the block inserted earlier loses its significance in favour of the new block. Even though the beta weights of no subdiscipline reaches significance, except for Experimental Psychology, entering the DGPs section memberships adds the largest portion of explained variance. However, owing to the large number of predictors, this equation fails to reach significance.

With regard to the dissemination of one's own scientific contributions, preferred publication language is crucial. Publications aspiring to international visibility, reception, and appreciation have to be published in English. In the present analysis, 38% of the variance of the preferred publication language can be explained. Each single multiple correlation coefficient (R^2) and each increase (ΔR^2) attain statistical significance (see Table 5). Of the predictors entered in the first step, technical uncertainty has a significant negative influence on the preference of English as the publication language. Indeed, most technical resources (i.e. Big Science) mandate publishing in English, but technical resources lose significance after entering membership in different psychological subdisciplines into the equation. In fact, DGPs section membership explains the major amount of variance here ($\Delta R^2_3 = 0.21$). Membership of the following DGPs sections, and research engagement in these subdisciplines, make English as the publication language more likely: Biological and Neuropsychology; Differential Psychology, Personality Psychology, and Psychological Diagnostics; Psychological Methods and Evaluation; Social Psychology. The fact that the beta coefficients of DGPs section membership show any loss in their amount after entering personal characteristics argues for their immense importance for this aspect of professional information behaviour. The opposite influences of age and job position is another result worth noting because it was expected that both variables would coincide with each other in the prediction of information-seeking behaviour. Albeit age and job position are significantly intercorrelated ($r = 0.69$; $p < 0.01$), their inverse predictive value for information-seeking behaviour when English is the preferred publication language may be due to the fact that younger German-speaking psychologists are more likely to prefer English as publication language while the effect of job position is inverse.

Table 5. Results[a] of hierarchical regression analyses for professional information-seeking behaviour by social organization of the sciences, Big vs Little Science, psychological subdiscipline, and personal characteristics

Variables entered	Project development				Research implementation				Result publication				Use of citation databases				Publication language			
Steps of hierarchical regression:	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1. Social organization of the sciences																				
Functional Dependence	0.05	0.06	0.07	0.07	−0.03	−0.01	−0.02	−0.02	0.09	0.09	0.08	0.05	−0.11	−0.10	−0.06	−0.08	−0.13	−0.12	−0.03	−0.03
Strategic Dependence	0.12	0.11	0.08	0.04	0.13	0.11	0.09	0.06	0.11	0.10	0.08	0.1	0.05	0.03	0.02	0.04	0.04	0.02	−0.01	−0.05
Technical Uncertainty	0.02	0.02	0.05	0.05	0.01	0.02	0.02	0.02	−0.16*	−0.16*	−0.17*	−0.14*	−0.19**	−0.18**	−0.19**	−0.18**	−0.17*	−0.15*	−0.14*	−0.15*
Strategic Uncertainty	−0.09	−0.10	−0.11	−0.06	0.03	0.01	0.00	0.04	0.18**	0.18**	0.18*	0.19*	0.07	0.06	0.07	0.06	−0.07	−0.10	−0.12	−0.09
2. Big vs Little science																				
Personnel resources		0.03	0.02	0.04		−0.08	−0.08	−0.07		0.04	0.04	0.07		0.04	0.06	0.06		−0.05	−0.03	−0.02
Technical resources		0.13*	0.15	0.16*		0.23**	0.30**	0.32**		0.10	0.14	0.13		0.22**	0.13	0.13		0.27***	0.10	0.12
3. Psychological subdiscipline																				
Experimental psychology			0.05	0.05			0.01	0.03			−0.10	−0.12			0.17*	0.16*			0.09	0.09
Work and organizational psychology			0.05	0.08			−0.01	0.02			−0.02	−0.04			0.08	0.06			−0.10	−0.08
Biological and neuropsychology			−0.07	−0.05			−0.12	−0.10			−0.05	−0.05			0.14	0.14			0.32**	0.34**
Differential & personality psychology, & psychological diagnostics			−0.04	−0.05			−0.08	−0.07			−0.07	−0.08			0.12	0.12			0.14*	0.13*
Developmental psychology			0.01	0.00			0.07	0.08			0.16*	0.12			0.05	0.03			0.00	0.00
History of psychology			0.00	0.02			−0.04	−0.02			0.00	−0.01			0.02	0.02			−0.11	−0.09
Health psychology			0.05	0.05			−0.04	−0.05			−0.03	−0.06			0.02	0.00			0.06	0.06
Clinical psychology and psychotherapy			0.03	0.05			0.08	0.09			−0.02	−0.01			0.10	0.09			−0.05	−0.04
Media psychology			0.12	0.09			0.01	0.00			−0.02	−0.03			−0.05	−0.06			0.04	0.01
Psychological methods and evaluation			0.04	0.02			0.07	0.06			−0.10	−0.09			0.06	0.07			0.15*	0.15*
Educational psychology			−0.12	−0.12			−0.03	−0.03			−0.12	−0.12			−0.07	−0.08			−0.08	−0.07
Legal psychology			0.07	0.09			0.05	0.07			−0.03	−0.03			−0.02	−0.02			−0.05	−0.03
Social psychology			−0.06	−0.07			0.05	0.04			−0.05	−0.05			0.05	0.05			0.24**	0.24**
Environmental psychology			0.08	0.10			0.05	0.06			0.06	0.06			0.02	0.01			0.06	0.08
Traffic psychology			−0.20**	−0.18**			0.00	0.02			0.05	0.06			−0.02	−0.03			−0.05	−0.04
4. Personal characteristics																				
Sex				0.05				0.07				0.14				0.04				0.05
Age				−0.29**				−0.17				0.01				−0.01				−0.30**
Job position				0.18				0.09				0.19*				0.13				0.19*
Training experience				0.00				0.10				−0.01				0.04				0.03
Interest in participating in training				0.02				−0.05				0.03				0.02				−0.01
Intuitive/analytical				0.03				0.02				0.06				−0.06				−0.06
R^2	0.02	0.04	0.11	0.15	0.02	0.06*	0.10	0.12	0.08**	0.10**	0.15*	0.19**	0.04*	0.10**	0.20**	0.22**	0.06**	0.13**	0.33**	0.38**
ΔR^2	0.02	0.02	0.07	0.04	0.02	0.05**	0.03	0.03	0.08**	0.01	0.06	0.04	0.04*	0.05**	0.10*	0.02	0.06**	0.07**	0.21**	0.05*

Note: $N = 234$.

[a]Standardized beta weights in the cells (β), R^2 = multiple correlation coefficient, ΔR^2 = increase of R^2 per step. *$p < 0.05$; **$p < 0.0$.

5. Discussion and conclusions

First of all, we succeeded in the construction of psychometric scales for assessing the four subdimensions of Whitley's theory of the ISOS [13] which can be used in similar and other research contexts. The Scales on Perceived Mutual Dependence and Task Uncertainty in the Sciences are brief and succinct; the 15 items are clearly formulated and can be answered quickly. In addition, the scales meet the crucial psychometric criteria of objectivity and reliability of measurement.

Content validity (i.e. face validity) of the S-DUS and their items is ensured by their *a priori* construction which was done closely following the definitions of the subdimensions Functional Dependence, Strategic Dependence, Technical Uncertainty, and Strategic Uncertainty given by Whitley [13]. Construct validity of the S-DUS is confirmed by the empirical results on their factorial, discriminative, and convergent validity. However, our psychometric results on the S-DUS are based on a sample of researchers working in different psychological subdisciplines and, thus, replication studies for researchers in other areas of science are required. This can be easily carried out since all items are *not* domain-specifically formulated for psychology; rather, they are generic and suitable for all sciences. Thus, the S-DUS are an economic tool for further research on professional information behaviour in all sciences as well as for a broad scope of topics in science research and science studies.

Worth noting are the modal characteristics of science-related mutual dependence and task uncertainty in the representative sample of psychology researchers from the German-speaking countries. Most distinctive is that subjective perceptions of Strategic Dependence (i.e. the necessity of using results, ideas, and procedures of influential colleagues) are, on average, markedly increased, while the perceptions of Functional Dependence (i.e. the need to argue such colleagues into significance and importance of problems and approaches) are less so although a visible increase is still apparent. Both subdimensions of task uncertainty in research show slightly increased mean scores as well: on average, mean scores exceed 0.5 standard deviations in Technical Uncertainty (i.e. the extent to which working techniques are not well-understood and do not produce reliable results) and Strategic Uncertainty (i.e. the ambiguity 'about intellectual priorities, the significance of research topics and preferred ways of tackling them, the likely reputational pay-off of different research strategies, and the relevance of task outcomes for collective intellectual goals' [13, p. 123].

The results obtained here shed light on the social pragmatics (i.e. mutual dependence perceptions) and on the methodological and epistemological scepticism as well as the awareness of multiparadigmatics in the science of psychology researchers in the German-speaking countries. This may be interpreted in the sense of taking a critical position toward modern psychology and toward the scientific community one personally belongs to. These results are all the more interesting because all the present online survey questions on subjective perceptions about mutual dependencies and research task uncertainties are very transparent and intelligible (i.e. direct formulation, open questions on the topics with face validity) thus making misunderstandings and response biases unlikely.

Although Whitley [13] does not discuss the implications of his model for the use of information and communication technologies at all, the present study not only determines the model's de facto existing explanatory power, it also demonstrates its advantages above and beyond conventional frameworks or differential person characteristics. In our empirical attempt to predict the information-seeking behaviour of scientists in five different typical research activity domains (i.e. project development, research implementation, results publication, use of citation databases, and publication language) using stepwise hierarchical regression procedures, the four variables of the perceived social organization of the sciences succeeded at least partly. Especially valuable for these analyses was the inclusion of the indicators of Big vs Little Science, the psychological subdisciplines researchers are actively engaged in, and some personal characteristics (i.e. age and job position, but *not* gender, experience and interest in training about professional internet information resources, and intuitive vs analytical cognitive style). A scientist's age has some predictive value for information-seeking in project development and during English publication of research results. Younger scientists may be more engaged in information-seeking in this work phase because of their reduced job experience. However, in the phases of research implementation, result publication and use of citation databases, age is not a significant predictive variable of information practices which agrees with the results of others (e.g. [28, 29]). It should be noted as well that there is no gender effect on professional information-seeking behaviour – at least in German psychology researchers.

Whereas there seems to be no significant associations between mutual dependence and any of the analysed facets of information-seeking behaviour in our sample, both subdimensions of task uncertainty are influential in a meaningful and significant way. In scientific fields with high agreement on working techniques (i.e. low technical uncertainty), professional information-seeking behaviour is less pronounced during the working phase of dissemination of results and citation database use. Additionally, German psychologists more often prefer German-language publishing. On the other hand ambiguous intellectual priorities make sure that scientists adopt the advantages of looking into applicable information as their own during writing manuscripts for publication, preparation of lectures, or preparation of courses.

Thus, our initial comprehensive attempt to operationalize Whitley's [13] model *The Intellectual and Social Organization of the Sciences* shows that this theory is an important component for explaining scientists' information-seeking and -processing behaviour. Especially, it is worth noting that the ISOS subdimension Technical Uncertainty is the only significant predictor at all for professional information-seeking behaviour in the working phase of result dissemination.

In addition, there are more significant predictors of professional information-seeking behaviour in psychologists. These refer to the subjective perceptions of being personally engaged in Big vs Little Science research and to the subdiscipline of psychology to which one's own research belongs to. Age of researchers has some (negative) influences on information-seeking behaviour during project development and with reference to German as the preferred publication language. The latter is not in accordance with (higher) job position, which positively influences English as the preferred publication language. This may be due to the special situation of psychology researchers in the German-speaking countries and the recent debate on (re-)internalization and anglicization of their psychological research (see, e.g. [25, 26]). Individual characteristics of researchers which refer to material mastery (as supposed by Covi [21]) and cognitive style (as supposed by Heinström [22]) failed to be significant predictors of professional information-seeking behaviour, at least in our sample of psychology researchers. This latter finding may be due to the fact that the psychology researchers in the present study are aware of the personality traits of intuitive vs analytical cognitive style and thus understand the meaning of the items measuring analytical cognitive style. Thus, their answers to the items of the scale for the measurement of intuitive vs analytical cognitive style may be biased. Further research should test this in samples of researchers in other sciences. This is in line with the open question about the generalizability of our results to other disciplines than psychology. Nearly 20 years ago, Ellis, Cox and Hall [30] could not determine fundamental differences in information-seeking behaviour between researchers in the physical and social sciences. However, this qualitative and grounded theory based research was done at the start of the digitalization of scientific information and communication for which Ellis et al. noted 'the relatively minor impact which developments in information technology have had on information seeking and communication acticities of the three groups (under study)' [30, p. 366].

As expected, the professional information-seeking behaviour of psychology researchers is mostly pronounced in the working phases of Results Publication and Research Project Development. One may be surprised by the finding that scientists are somewhat more engaged in information seeking during their work on results publication than on research project development. It may be hypothesized that research project development is frequently more or less experience-based (hic and nunc) and refers mainly to previous research done by the researcher himself or herself. The necessity of information-seeking (for brand new publications) increases in result publication activities and cannot be ignored any longer. Information-seeking behaviour is somewhat less pronounced during research implementation (as was expected) and concerning the preferred publication language of English (which is supposed to be relevant only in samples of non-Anglo-American scientists). More surprising, however, is the rather poor use of citation databases like Scopus and the Web of Science by psychology researchers from the German-speaking countries. One may speculate that there is a connection to the rather poor experiences with professional information resources training (85% of the sample has no experience) and to the rather low interest in information behaviour training (55% indicate no interest). Perhaps many psychology researchers in the German-speaking countries, as autodidacts, rely more on self-help and self-teaching, without informing themselves about the advantages of professional information-seeking behaviour supported by scientific databases in contrast to non-science based, popular search engines. This may be due to the fact that neither systematic domain-specific nor systematic generic information-seeking competences training are part of the curriculum. In times of markedly changing information and communication technologies this is an urgent demand as well as a great and interesting challenge which must be fulfilled as soon as possible in science education.

Our results give rise to the hypothesis that *the* (one and only) professional information-seeking behaviour, and its general predictors, does not exist at all. Instead, the facet of information-seeking and -processing behaviour under study must be specifically defined. In the present study this was done for three phases of typical research activities of scientists (i.e. project development, research implementation, and dissemination of results), their use of citation databases, and their preferred publication language (an indicator which is relevant in non-Anglo-American contexts only). In the present analyses, we were able show that different predictor sets are empirically significant. We conclude that this double differentiation of predictors and criteria of professional information-seeking behaviour should be taken account in further research on information behaviour in sciences as well as in attempts to model information competence and information competence development. This will optimize the knowledge of information suppliers about the special needs of their users in different phases of their work in research and teaching.

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