Individual differences in information-related behaviour: what do we know about information styles ?

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Abstract

This chapter reviews the study of individual differences in information behaviour; those differences which are not due to demographic factors such as age, gender, education or occupation, but rather to personality factors, and to learning and thinking styles. It examines studies of patterns in information behaviour, and of personality and similar factors in groups of information-focused occupations, as well as studies which have explicitly sought to relate information behaviour to such factors. The aim of the chapter is to assess how far we have come in being able to identify and measure 'information style', a quality different from any other categorisation of personality, or of intellectual styles. If this goal were achieved, it would be a valuable concept for the academic study of information-related behaviours, as well as being of practical usefulness for the design of information systems and services, the evaluation of the effectiveness of such systems, and the training of users. It could also allow a tailored provision of information, particularly for creative or innovative purposes.

1   Introduction

Information behaviour is, by definition, individual, and the idea that a person may have an 'information style' – a way of dealing with information, depending on individual personality and cognitive traits - has been discussed in the literature for at least four decades (Rubenstein 1970). Nonetheless, the great majority of studies of information practices and information-related behaviour, including studies of information seeking, retrieval, use, and everything else falling under the ambit of what used to be termed 'user studies', have focused on groups of people. Usually these groups have been defined by profession, occupation, educational level, or involvement in some hobby or other activity other than work or study; less commonly by factors such as age or ethnicity. Case (2007), for example, in his magisterial overview of this form of research, categorises the subjects of such studies into three groups:
- by occupation, e.g. scientists and engineers, humanities scholars, journalists
- by role, e.g. citizen or voter, patient, student
- by demographic group, e.g. age, gender, socioeconomic status

There have however been a smaller number of studies which have related aspects of people's interactions with information to what might be loosely called 'personality factors'. This simply reflects what is evident; that doctors, or graduate students in the humanities, or job-seekers, or any of the other groups whose information behaviours are studied, do not form homogenous groups. They may be very different sorts of people; and these individual differences – not necessarily related to immediately assessable factors such as age, ethnicity or educational level – may outweigh the similarities in information behaviour dictated by the common context and tasks of the group. Line (1998, page 223) expresses clearly the experience of many information providers:

> "… all people are individuals, and will seek and use information in different ways… [information gathering] is an integral part of our personalities, and we all do it differently. There is no such thing as a homogenous body of information users. A group of people with the same level of education may be working on the same subject at the same time, but they will use information in different ways. Some information will be obviously relevant to all of them, some to only one or two. Some of the group will scan and absorb vast quantities of material, others will read much less. Some will be content with abstracts of many articles, others will not. Some will prefer oral channels, some will prefer to see information in print, where they can pore over it; some always prefer to ask other people, some prefer to avoid people whenever they can. Some like browsing, some find it wasteful in time and effort. Some enjoy computer searching, some have technophobia…"

While many practitioners will recognise the truth of this from experience, studies to give hard evidence of such personality factors in what we will refer to as 'information styles' have been more limited, although it would be of obvious benefit for practitioners to have some reliable means of assessing such styles. This would allow, in principle, the 'tailored' provision of information, in ways most acceptable to the individual, with greater precision that current approaches, which are largely dictated by assumptions of the needs of particular professional or educational groups, or those needed to undertake certain tasks. Woolston (1999) put forward this idea at an early stage; Frias-Martinez, Chen and Liu (2007) illustrate it with the idea of a personalised interface to a digital library, based on cognitive style, while Chen, Magoulas, and Dimakopoulos (2005) make similar points for web directories. It would similarly allow training programmes, and other means of promoting information literacy, to be geared to individual styles, as noted particularly by Ford (2004B) in the context of 'meta-cognitive' or 'learning to learn' information skills. It should also be value in the design and evaluation of information systems generally, and of their evaluation.

We might also note that creativity and innovation is generally held to be highly personal and individual in its nature. Information systems and services aiming at stimulating creativity and supporting innovation could therefore be enhanced by a more detailed understanding of individual information styles (Bawden 1986, McGarry 1991, Ford 1999).

Academically, a generally accepted and validated ways of assessing individual information style would open the way to a deeper conceptual understanding of information-related behaviour, and facilitate research in these areas.

This chapter is intended to give a literature-based overview of how far we have come towards these goals. No comprehensive reviews of the area have been written: there is an early overview by Saracevic (1991), and shorter literature analyses from various perspectives by Ford (2000), Hannell (2001), Chen, Czerwinski and Macredie (2000), Ford, Wilson, Foster, Ellis, and Spink (2002), Heinström (2003), and Stokes and Urquhart (2010). The most detailed thorough coverage of any aspect of the topic is a recent book by Heinström (2010), discussing the relation between information behaviour and personality traits, the latter assessed largely in terms of the 'five-factor' personality model.

Several caveats should be mentioned at the start.

The literature of the area is very diverse in nature, ranging from carefully designed empirical studies, to largely anecdotal reportage; for an example of the latter, see Bawden (2010). This chapter emphasises more formal studies.

Identification of material has relied on searches of Web of Science and Library and Information Science Abstracts, with references in relevant material followed up, and citation searching used to identify more recent material. The analysis was completed in July 2010. The literature cited comes from a relatively long time period, covering over 30 years. During this time, the information environment in which the studies have been carried out has changed very greatly; most obviously because of the emergence of the World Wide Web as a virtually ubiquitous information environment, with user expectations of information systems and services being set by services such as Google, Amazon and Wikipedia, and latterly by social networking services (Bawden and Vilar 2006). It would therefore be surprising, to say the least, if the details of information behaviour had not changed over this period. This chapter, rather than dwelling on details now of only historical interest, focuses on general approaches, and on issues which may be expected to remain largely invariant over time.

Material has been regarded as relevant if it seemed to add significantly to understanding of the issues presented. The focus is on material directly relevant to library and information science, and largely taken from the literature of those subjects. However, information handling is a rather general concept, and links between information behaviour and personality are discussed in a much wider range of literature; see Wilson and Walsh (1996) for a review, from a library/information perspective, Dillon and Watson (1996) for an equivalent review from a human-computer interaction perspective, and Tidwell and Sias (2005) for an overview from a business communication perspective. Therefore, while the coverage of this chapter is intended to be thorough, particular for more recent work, this is neither a fully comprehensive nor a systematic review. Still less is it a meta-analysis; the difficulty of such a undertaking, given the typically unsystematically reporting in the library/information literature, has been noted (Urquhart 2010). Indeed, there are only two meta-analyses of any kind dealing with the topic of this chapter: Chen and Rada (1996) carried out a meta-analysis of empirical studies of usage of hypertext systems, including assessment of the effect of individual differences, while Ford, Miller and Moss (2005A) reported combined multivariate analysis of several data sets reported in a series of publications.

We should also note that whole area of assessment of personality, and of cognitive and learning styles, is a contested one, far beyond its use in examining information-related behaviour; see, for example Pervin and Cervone (2010) and Maltby, Day and Macaskill (2006). This chapter does not attempt to engage with these general issues, although some specific implications are noted. Indeed, what is meant by 'personality' is far from clear. Over 50 years ago, Hall and Lindzey (1957) suggested that there were as many definitions of personality as there were psychologists interested in the subject, and the situation has not necessarily improved since. A typical explanation, often cited by researchers into the relations between personality and information behaviour, is "a pattern of characteristic thoughts, feelings and attitudes that distinguishes one person from another and that persists over time and situation" (Phares 1991, p 4). There have been numerous studies dealing with personality traits of librarians and other information specialists, but these are too far removed from

the focus of this chapter to be discussed here; see Sabatier and Oppenheim (2001), Hallam and Partridge (2005) and Williamson, Pemberton and Lounsbury (2008) for reviews.

In the next section, we consider the kind of patterns found within information behaviour.

2   Patterns in information behaviour

Although this chapter focuses on studies of information-related behaviour which seek to investigate the association of this behaviour with individual factors of personality and style, we should note at the outset that aspects of behaviour which have relevance to this purpose have been described in the literature in rather different contexts. Most particularly, this has been done to draw attention to, and sometimes to recommend, strategies and tactics for finding information; see, for example, Bates (1979A, 1979B, 1989, 2005), Fidel (1991), Belkin, Marchetti and Cool (1993), Xie (2000), Huvila (2010), and Dobrowolsi, Huntington, Nicholas and Williams (2004), and an overview by Yuan and Belkin (2010). Reasons of space preclude discussion of these; they may, in any event, not be tied to any particular individual style.

An arguably more relevant indicator lies in the concept of 'information encountering', introduced by Erdelez (1997, 2004, 2005). This alludes to the finding of useful information by accident, also termed serendipitous information acquisition, and to means employed by information users to maximise the chance of this. On the basis of interview and questionnaire studies with university students, initially a set of 132 participants, and later smaller groups for more in-depth studies, Erdelez identified four categories of information user: non-encounterers; occasional encounterers; encounterers; and super-encounterers. For the last group, this was the preferred means of finding information, and they took active steps to promote it. There seems a strong likelihood that a preference for this form of information acquisition, which has been generally regarded as idiosyncratic and inefficient, is associated with individual personality and cognitive factors, but this seems not to have been specifically investigated. Pálsdóttir (2010), who – as noted below - identified four categories of information seeking behaviour, found encountering to occur in all of them, but in active or passive ways in different categories. Heinström (2006A) has related the similar tendency for 'incidental information acquisition' to personality factors, according to the 'five factor' model.

A similarly pervasive proposed form of information behaviour is 'information foraging', with its more specific behaviours, such as 'wait and see foraging' (Pirolli and Card 1999, Pirolli 2007). It reasonable to suppose that this might form the basis for a personality-associated information behaviour, but this does not appear to have been investigated.

In some studies, categorisations of behaviour have 'emerged' from analysis – quantitative or qualitative – of user behaviour data. An early example of this approach is that Kernan and Mojena (1973) who analysed how, and to what extent, university students made use of information. They identified three groups: Ritualist, who made most use of information, and were persistent in obtaining it; Venturesome, who used least information, with preference for social interaction rather then systematic information seeking, and Efficacious, who occupied an intermediate position.

Another early example is that of Bellardo (1985), who analysed the online searching performance of 61 library/information students, based on a series of tests of personality, creativity, intelligence and scholastic aptitude, which were then analysed by factor analysis. This gave four personality/study dimensions, described by the author as: Assertive Adventurer; Artistic Scholar; Analytical Individualist; and Sensitive Nurturer. However, relations between these dimensions and search behaviour were very limited, and largely eliminated as searching experience grew, so they do not seem to represent any definite information styles.

Pálsdóttir (2010) carried out a cluster analysis on the results of a postal survey of the behaviour of 976 members of the Icelandic public, with respect to finding health and lifestyle information. Four clusters were found, denoted, in information seeking terms, as passive, moderately passive, moderately active and active,

An example giving a more detailed set of categories is a study of the information behaviour of 67 scientists working at an agricultural research organisation, based on semi-structured interviews and questionnaires (Palmer 1991A). Cluster analysis of the results showed the participants falling into five groups, denoted as:

- 'non-seekers', for whom information access was not a priority
- 'lone, wide rangers', preferring to work alone, reading and scanning widely, and relying serendipituous information discovery
- 'unsettled, self-conscious seekers', concerned about missing important information
- 'confident collectors', amassing their own information collections, rather than routinely searching for information
- 'hunters', with regular information-gathering routines, and a focus on currently relevant information

Palmer then went on to derive an alternative and, by her description, subjective six-fold typology, based her appreciation of participants information habits, and including such factors as appearance, body language, and intonation in response to questions:
- 'information overlord', operating an extensive and controlled information environment
- 'information entrepreneur', creates an information-rich environment, using many sources and strategies
- 'information hunter', organised and predictable information gatherer, in narrowly focused areas
- 'information pragmatist', occasional gatherer of information, only when need arises
- 'information plodder', rarely seeking information, relying on own knowledge or personal contacts
- 'information derelict', seeming to neither need nor use information

This classification had some similarities with that produced by the cluster analysis, but each reflected different characteristics of the participants.

Another such study, again based on cluster analysis, had the aim of investigating the use of, and attitudes towards, desktop information systems and services among staff of a pharmaceutical research organisation (Bawden, Devon and Sinclair 2000). 30 scientists and managers, from different parts of the organisation were included in the study, carried out mainly by semi-structured interviews. Analysing the quantitative results by cluster analysis showed three distinct groupings (which remained stable when different clustering methods and standardisation techniques were applied), associated with attitudes to information and information systems, rather than specific behaviours. These were denoted as:
- 'perfectionists', concerned about their ability to find the right information, and likely to ask for help
- 'pragmatists', relatively unconcerned about information, and not enthusiastic about new systems
- 'positivists', enthusiastic information users, taking much time over finding information, and not likely to suffer from information overload

As the groupings cut across boundaries of job role, subject speciality, age, etc., they were deemed to relate to personality, though, as no standard test was used, this could not be verified.

Solomon (1997) made a qualitative analysis of a detailed ethnographic study of the annual work planning process of a public agency. He identified seven information-related 'sense-making' styles: holist; manager; analyst; organiser; processor; presenter; and transmitter. Each of these was associated with cognitive, affective (emotional) and conative (action preference) elements. Although the author claimed no generality for these styles, they do in fact seem to capture some broadly applicable traits: the analyst style, for example, focusing on the methodical compilation and analysis of as comprehensive set of relevant information as possible.

Another categorisation of information users was made by Steinerová and Susol (2005, 2007), based on a questionnaire survey of a sample of 793 Slovakian users of Slovakian academic libraries. Identified three information user personality types: type S (strategic/pragmatic) and type A (analytical). Type S used a broad range of resources, requiring rapid access to authoritative information, and happy to use interpersonal sources, while type A invested more time and effort in information seeking, sought different forms of resources, and took a more individually evaluative

position. However, these were extreme positions, with most users being categorised as mixed, M, type. There was also a gender influence, with type A/S being oriented towards male/female genders.

While such analyses are interesting, and enjoyable to carry out, it is difficult to see how they can be generalised, particularly if subjective judgements are made by the analyst. They are best regarded as indicators of interesting avenues for further investigations, particularly for attempts at direct correlation of information behaviour with personality and cognitive traits, as discussed in the following section.

3   Correlations with personality and cognitive dimensions

Here there is a deliberate attempt to correlate information behaviour with personality and cognitive factors, measured by an existing typology not created specifically for information behaviour. This will usually allow the findings to be related to wider aspects of individual behaviour and practices, not specifically information-related.

3.1 The nature of 'styles'

Although the literature typically speaks of 'cognitive style', 'thinking style' or 'learning style', it should be said at once that there is no sharp distinction between these; thinking and learning are, after all, hopefully not too far removed from one another. As Vilar and Zumer (2008, p. 1996) note "in essence, learning styles are an application of cognitive styles to a learning environment". The term 'intellectual style' is increasingly used as an umbrella term, covering cognitive, thinking, learning and teaching styles (Zhang and Sternberg 2009). Some tests may be described in any of these ways and, as we shall see, some authors believe that there is a common underlying rationale for all such constructs. For reviews of cognitive and learning styles, and issues raised, see Sternberg (1997), Riding and Rayner (1998), Zhang and Sternberg (2009) and Peterson, Rayner and Armstrong (2009).

Advocacy of this approach was given at an early stage by Borgman (1989) who examined the inter-relations of a variety of personal attributes relevant to use of retrieval systems; these included the Scholastic Aptitude Test, the Myers-Briggs Type Indicator and Kolb's Learning Styles Inventory. An early empirical study of searcher behaviour included assessment of cognitive style by a number of measures including Kolb's learning styles (Saracevic and Kantor 1988).

A second aspect of Palmer's study, referred to above, of agricultural research scientists, was an early example of application to the details of information behaviour (Palmer 1991B). The relation between information behaviour and personal 'style' was studied using two psychometric tests: the Kirton adaption-invention inventory, which assumes two opposite styles of problem solving, adaptive and innovative (Kirton 1989); and the Honey-Mumford learning styles questionnaire (N=Honey and Mumford 1986), based on assumption of four general styles of learning; activist, pragmatist, theorist and reflector. Those identified by the Kirton test as Innovators, and those with an Activist learning style sought information more enthusiastically, and from a wider range of diverse sources than others, while those identified as Adaptors, and those with a Reflector learning style, seemed more controlled and methodical. However the author notes that the extent of correlation with information behaviour, for learning styles in particular, was disappointing.

3.2   Cognitive styles

Much of the work on cognitive styles in information behaviour has drawn from the insights of Gordon Pask and his associates, who identified two basic cognitive styles in dealing with complex information: a 'serialist' style focusing on local and isolated elements of the problems, and subsequently linking them into an overall picture; and a 'holist' style, examining first a board conceptual picture, with the details fitted later (Pask 1976, Ford 2000, 2001, 2004A). Entwistle (1981) developed a simplified instrument for assessing these issues, the Short Inventory of Approaches to Studying, later developed into the Revised Inventory of Approaches to Studying (Tate and Entwistle 1995), while Ford (1985) developed a measure, the Study Processes Questionnaire, specifically to assess the holist or serialist bias of a person.

Somewhat similar in nature are Hermann Witkin's studies of field dependence/ independence. Those with a field independent style are able to impose structure on a complex environment; those with a dependent style do not do so, take a more passive role, and are more likely to 'get lost' in complex cognitive environments. It has been suggested that the similarities between Witkin's dimensions and Pask's learning styles are indicative of an underlying common ground, but this has never been established (Ford 2000). These factors have been studied in information behaviour contexts, using Embedded Figures Tests. A more recent formulation, Riding's Cognitive Styles Analysis, captures essentially the same distinction on a wholistic/analytic dimension (Riding 1991, Peterson, Deary and Austin 2003, Ford 2000).

Wang, Hawk and Tenopir (2000), in a detailed study of the way in which a group of 24 graduate students interacted with Web search systems, assessed cognitive style using the Embedded Figures Test. In this study, cognitive style was found to be significantly associated with the time spent for each search, and with the number of pages viewed; those with a field dependent style, taking longer and visiting more pages to achieve their ends. The authors noted that further studies were needed to amplify this finding.

The same measure of cognitive style was used by Palmquist and Kim (2000) in a study of the web searching behaviour of 48 college students, based on a recording of all aspects of their searching sessions. Again, it was found that field dependent individuals need a longer time, and visit more pages, to complete a task; however, the discrepancy between the styles largely vanished as the students gained experience in searching, suggesting that this was a phenomenon associated with early experience of a complex information environment, rather than a fixed information style. This echoes the findings of Bellardo (1985).

3.3 The Sheffield studies
The most substantial continuous body of work in this area has been carried out by Nigel Ford and colleagues at Sheffield University over a ten year period.

Two early studies examined the use of CD-ROM databases by university students. In the first, the behaviour of 67 postgraduate library/information students searching the Library and Information Science Abstracts database was analysed against their cognitive styles assessed by the Short Inventory of Approaches to Studying and by the Group Embedded Figures Test (Ford, Wood and Walsh 1994). Different cognitive styles were associated with different search strategies, 'global' individuals typically undertaking broader searches. In the second, the behaviour of 105 undergraduate students searching a variety of subject-specific databases were analysed against cognitive styles assessed by Short Inventory of Approaches to Studying and by the Cognitive Styles Analysis (Wood, Ford, Miller, Sobczyk and Duffin 1996). Different cognitive styles were associated with a variety of features of searching, including the extent to which searches were broadened or narrowed, the number of different terms used at various stages, and perception of success.

Following an early study, using the Short Inventory of Approaches to Studying and the Study Processes Questionnaire, which indicated that cognitive styles were a significant determinant of user behaviour in hypertext systems (Ellis, Ford and Wood 1993), the Cognitive Styles Analysis instrument was also used to study the behaviour of graduate students using a hypertext system, finding statistically significant relationships (Chen and Ford 1998, Ford and Chen 2000). Cognitive style were related to differences in strategies used for navigation, with, for example, those with a field dependent/analytic style relying more on the system main menu than did others; similar results were found by Korthauer and Koubek (1994), and by Dufresne and Turcotte (1997) using the Group Embedded Figures Test. These and similar studies are reviewed by Chen and Macredie (2002).

A later study (Ford, Miller, and Moss 2001), described by the authors as "a data exploration, rather than hypothesis testing approach" (p. 1052), used the multivariate techniques of regression and factors analysis to examine relationships among data for retrieval effectiveness and a variety of individual factors. The participants were 68 postgraduate library/information students, using one Internet search engine. A subset of the Revised Inventory of Approaches to Studying assessed study styles, the Cognitive Styles Analysis was used to categorise field-dependence and also preference for verbal or visual information analysis, while other questionnaires analysed perceptions of the Internet and extent of Internet searching experience. Significant relations were found between poor retrieval performance and a verbalizer cognitive style, though no relation – as was seen in earlier studies – was found with the field dependence dimension. Intriguingly, much of the variation correlated to gender, with females performing relatively poorly; the authors comment that this may be due to biased IT-related education of these students in pre-Internet days. This study is one of very few which attempted to contextualise individual differences in a standard model, which showing which aspects of Wilson's information behaviour model (Wilson 1999) are influenced by them.

In a subsequent and similar study, subsets of the Revised Inventory of Approaches to Studying were used to investigate the searching behaviour of 67 postgraduate library/information students with an internet search engines, with factor analysis used to investigate relationships. (Ford, Miller and Moss 2003, 2005B). Significant associations between cognitive style and searching behaviour (particularly the use of Boolean as against best-march searching), were found, similar to the previous studies. The results enabled a mapping of search behaviour against three dimensions of study style, inherent in the Entwistle approach:

- 'deep', aiming at the understanding of information
- 'surface', aiming at the reproduction (memorisation or copying) of information
- 'strategic / organised', aiming either understanding or reproduction, as necessary of success in the context

It seems clear that a strong preference for one of these study styles could be the basis of a formulation of an information style. These same patterns were used by Heinström (2006), as noted later, and also by Aharony (2009), who found them to be a major predictor of perceptions of Web 2.0 applications by library/information students.

Another pattern emerging from this work - a distinction in cognitive style between Wholist/Imagers and Analytic/Verbalizers, associated with preferences for Boolean and best-match searching respectively – may also be seen as the basis for a denotation of information style.

Finally, we may note a further study from these authors using the Cognitive Styles Analysis and the Study Processes Questionnaire to investigate the perceptions of 111 postdoctoral researchers of their problem-solving and information-seeking behaviour (Ford, Wilson, Foster, Ellis and Spink (2002). Again, relations between cognitive style and searching behaviour were found, similar to the previous studies, although the authors note that "the evidence is suggestive rather than in any sense conclusive" (p. 734).

A summary paper (Ford, Miller and Moss 2005A) reported a combined multivariate analysis of several of the data sets used in this series of papers, with results confirming a link between cognitive styles and cognitive complexity and retrieval styles and perceptions of success. However, the authors noted a number of contradictions in the results of the various analyses, and suggest that " we claim no more of the relationships found in this analysis than that they provide at least a *prima facie* case for more focussed systematic enquiry" (p. 762).

This series of studies gives an interesting cumulative picture of the relations between cognitive styles and information-related behaviour, although, as noted above, the authors made several caveats about the conclusiveness of relations identified, and about contradictions in emerging from complex multivariate analyses. We might also note that, although the studies were carried out by the same group of researchers, and focused on essentially the same issues of cognitive style, five different instruments, not including subsets of the same instrument, were used in the studies, and no two studies used exactly the same instruments. This exemplifies the difficulty, noted above, of carrying out any extensive meta-analysis, to combine the results of such studies. Moreover, since the great majority of the participants were library/information students, disciplinary differences are not likely to be detected.

3.4   Other studies of cognitive styles

There have been a number of studies by other researchers, using similar instruments, participants and tasks.

Kim and Allen (2002), using the Group Embedded Figures Test to study relation between cognitive style and web browsing behaviour, found no significant effects of cognitive style on search behaviour or outcomes; somewhat at variance with the results of similar studies.

Graff (2005) using the Cognitive Styles Analysis, found a distinction between the web browsing strategies of verbaliser and imager style, the former using more pages set up in a hierarchical arrangement, the latter using more relationally linked pages. However the same distinction was also

seen between older and younger participants respectively; perhaps an indication that the conventional assumption of a behavioural grouping by age is equally relevant.

One such study also used the Cognitive Style Analysis to investigate individual differences in the use of three Web directories by 57 computing students (Chen, Magoulas, and Dimakopoulos 2005). Some differences were found, field dependent individuals, with their more 'global' style, preferring to see a larger number of main categories, with resources arranged by relevance, while those of field independent style preferred a smaller number of categories with numerous sub-groups, and an alphabetical ordering. As often in studies in this area, the authors note that this was "only a small scale study" (p. 81), and recommend larger and more detailed studies.

Riding's CSA was also used with a group of 50 users of a university library catalogue, with the aim of developing library system interfaces which can be personalised to a particular user's style (Frias-Martinez, Chen and Liu 2007, 2008). Distinct differences were found between individuals with field dependent and field independent styles, the letter completing search tasks more rapidly with fewer interaction steps, and using advanced features more. Little difference was found between verbalizer and imager styles. These findings are somewhat at variance with those of earlier studies of these styles, noted above.

A more extensive study analysed the usage of interfaces to three e-journal systems by 61 postgraduate students at the University of Ljubljana, Slovenia, including individual difference factors (Vilar and Zumer 2008). In this case, choice of test instrument was constrained: firstly by the desire of the authors to use only tests whose reliability had been estimated, and second by the need to have a Slovene language version of the instrument. Cognitive styles were assessed by the Short Inventory of Approaches to Studying, by Sternberg's Short Questionnaire on Thinking Styles (Sternberg 1988, 1997, and by a test for 'hemispherical leanings' in thinking style (Reynolds, Kaltsounis and Torrance 1979, Torrance 1983).

Sternberg's theories propose 13 'thinking styles: legislative, executive, judicial, monarchic, hierarchic, oligarchic, anarchic, global, local, internal, external, liberal and conservative. Some of these seem clearly related to ways of dealing with information: the 'global' style, for example, which prefers to focus on the wider aspects of a situation, without focus on details, or the 'conservative', with a preference for solving problems in a clearly defined and systematic way, or the 'anarchic', able to focus on several goals simultaneously, but in a randomized and unsystematic manner.

The hemispherical model proposes three styles of thinking and learning, based on the concept of different brain hemispheres: a left-hemisphere style prefers information presented in a sequential, factual manner; a right-hemisphere style is more holistic, and accepts information in diverse ways; while the integrative style can operate equally well in either way.

Distinct differences were seen between disciplinary groups, both in their links to thinking styles (scientists, for example, showing a 'conservative' thinking style and a holistic approach, while social scientists lacked the conservative dimension and showed a stronger preference then other groups for an analytical approach) and their preferences for one interface rather than another (for example, scientists preferring those interfaces allowing access to several databases simultaneously, and more complex interfaces generally). Relations, independent of discipline to a degree, were found between interface preference and cognitive style; those with a more global dimension, for example preferred the Science Direct interface, those with a weak global tendency preferred the Ebsco Host interface. A cluster analysis of interface preference data showed two groups, perhaps pointing to two general information styles. However, the authors' conclusion was that "while we confirmed the relevance and importance of investigating the characteristics of individual users, we also showed the continuing relevance of studying well-defined users groups, such as by the user's discipline" (Vilar and Zumer 2008, p. 2006).

3.5   Personality assessments

Heinström (2003) compared information behaviour, assessed by questionnaire for 305 postgraduate students in varied disciplines, against personality, assessed by the NEO Five-Factor inventory (Costa and McCrae 1992). This test relies on the idea that personality can be understood on the basis of five dimensions: neuroticism; extraversion; openness to experience; agreeableness; and conscientiousness. The conclusion was that these personality traits do influence information behaviour, although the correlation is confounded by other factors. Information-related conclusions could be drawn for each of the dimensions. For example, a high rating for openness to experience was related to broad information seeking, openness to accidental discovery, and preference for material which was found 'thought provoking', while a low rating was associated with a preference for material confirming prior opinions, and a general concern about whether material was relevant. These ideas have since been presented more fully in book form (Heinström 2010).

Significant correlations between information behaviour, assessed by questionnaire, and these factors, using the same test, was found in a study of 600 university students, the largest single empirical study of this topic to date (Halder, Roy and Chakraborty 2010). Hylegårde (2009) used the full-version of the NEO personality instrument to investigate the relation between personality and information behaviour, assessed by questionnaire and detailed diary keeping, for 10 library/information students. The authors notes the advantages of using the 'long' version of the test, as opposed to a shorter version commonly used; a further example of the difficulties in making exact comparisons between studies. The complexity of the data produced by the instrument, and the limited number of participants, led the author to conclude that it was difficult to establish general patterns. Relations were identified, but the influence of personality factors seemed to vary according to the task and social context, for example between individual and collaborative work.

Heinström (2005) used the results in her 2003 paper to generate three broad categories of information behaviour, derived from the questionnaire: fast surfing, broad scanning and deep diving. These were related in detail and with statistical significance, to the personality dimensions, and to factors identified from the questionnaire assessment of study skills. . For example, the fast surfing behaviour – associated with a rapid search for a few highly relevant documents, ideally supporting already formed viewpoints - was related to neuroticism, to cautiousness (low openness to experience) and to carelessness (low conscientiousness), as well as to a typically superficial and non-strategic approach to study. These follow a rather similar pattern of categories of behaviour, identified as 'deep-enders', 'mid-poolers', 'shallow-enders' and 'consolidators', identified in an earlier study of retrieval behaviour (Ford and Ford 1993).

In a later study (Heinström 2006B), similar patterns were found in a set of 574 school students, using the a short version of the ASSIST (Approaches and Study Skills Inventory for Students) instrument (Entwistle and McCune 2004) to assess information seeking style. The 'surface', 'deep' and 'strategic' styles were found to be associated with information behaviours, those with a surface approach, for example, being unwilling to invest much time or effort in finding information. The styles were related to those identified in the author's 2005 study, which have in turn been analysed in terms of the five-factor personality model (Heinström 2010).

Finally, in a recent study, Stokes and Urquhart (2010) investigated the information behaviour, assessed by a questionnaire based on core processes in Foster's model of information seeking (Foster 2004, 2005), for a group of 261 nursing students. Learning style was assessed by a shortened form of Entwistle's ASSIST, and personality factors by the Mini-Markers instrument (Saucier 1994), which is claimed to assess the 'five factor' personality traits with more reliability than tests such as NEO. Relations were found between learning and information behaviour, with deep learners preferring browsing, the exploration of broad areas, and the sifting of volumes of information, strategic learners focusing on thorough problem definition and keyword searching, and surface learners rely on networking and on the reviewing of information to hand. Relations were also found between personality and information behaviour, with the Openness trait associated with a preference for browsing, and the Conscientious trait with the avoidance of serendipity. In general the results seemed "plausible' and roughly in accordance with previous studies. There were some discrepancies: links between personality and learning style differed from those found by Heinström (2003), while a link between strategic learning style and a preference for serendipitious behaviour did not have an

obvious explanation. These niggling discrepancies are typical of findings in this kind of study; they may relate to lack of rigour or clarity in the concepts being applied, or simply to variation in the groups studied..

4　　Self-efficacy and anxiety

Self-efficacy, or rather its lack, is the root cause of a number of 'pathologies of information' (Bawden and Robinson 2009), including technostress (Moreland 1993), information anxiety (Wurman 2001) computer anxiety (Fakun 2009) and library anxiety (Mizrachi 2010, Mellon 1986, Katopol 2005, Bostick, Jiao and Onwuegbuzie 2004, Cleveland 2004).

The last of these has been most extensively investigated, and has had specific test instruments designed. (Bostick, Jiao and Onwuegbuzie 2004, van Kampen 2004). It has been related to learning styles, some styles being more prone to the problem (Onwuegbuzie and Jiao 1998), and also to critical thinking scores, showing that anxiety can have a negative effect on cognitive processes (Kwon 2008). Studies have related high levels of anxiety to negative consequences, for example a high rate of errors in bibliographic citations (Jiao, Onwuegbuzie and Waytowich 2008).

Nov and Ye (2008) found a relation between a measure of 'resistance to change' (Oreg 2003) to perceptions of ease of use of a digital library. Aharony (2009) found that resistance to change with a significant negative factor for use of Web 2.0 applications by library/information students.

Finally in this section, we might note the behaviour of 'monitoring' and 'blunting' in stressful situations. 'Monitors' seek information about the situation, since gaining information reduces stress, while 'blunters', for whom receiving such information is itself an extra source of stress, try to avoid it. This may provide some additional rationale for individual differences in information behaviour (Baker 2005, Heinström 2010).

5   Caveats on tests generally

The studies reported above have generally chosen the test instruments on, reasonable enough, grounds of accessibility and wide use, as well as some apparent relevance to information issues. There have been relatively few comparative studies of the quality of such tests. One such is an extensive critical and systematic literature review of the value of such tests used for assessing learning styles for teaching purposes (Coffield, Mosleley, Hall and Ecclestone 2004).

This analyses the literature on learning styles generally, and then gives a detailed discussion of thirteen widely used tests, seven of which have been noted above used to analyse some aspect of information behaviour. The authors focus particularly on reliability, in essence the internal consistency of the results and their generalisability, and on their validity, essentially the extent to which the results reflect what is claimed for the test. On these basis, only Entwistle's Inventory emerges in a good light. The Myers-Briggs types (controversial validity), Honey Mumford styles (unassessed validity), Riding's Cognitive Styles (very poor reliability), Dunn's learning styles (major problems with reliability and criticisms of validity), Kolb's inventory (reliability and validity disputed), and Sternberg's thinking styles (limited evidence for both reliability and validity) are all disparaged to some extent.

A particularly interesting example is the Myers Briggs Type Indicator (MBTI), as it is one of the most widely-used tools for personality assessment, despite repeated criticisms of its validity (Gulliver and Ghinea 2010), and despite its having been described by a leading knowledge management practitioner as having "no scientific basis – it's just witchcraft" (Mezey 2010 p. 18). It has four personality dimensions: Introvert – Extrovert; Intuitive – Sensory; Feeling – Thinking; Judging-Perceiving. The Intutive-Sensory dimension is arguably the most immediately relevant to information behaviour, since it indicates the preferred way of gathering information (Hallam and Partridge 2005), though other dimensions may influence preference for use of interpersonal interactions for information seeking, and their nature (Heinström 2010). If individuals are assigned to one end of each dimension, this leads to sixteen possible personality types (Myers 1962, Quenk 2009). The original instrument is a proprietary, and – with 93 questions – rather lengthy, test; many investigators have used shorter versions, or publicly available equivalents, adding to the difficulty of comparing results in detail.

Of course, these analyses were done with learning styles and pedagogy in mind, rather then information behaviour, so that the results, for validity in particular, may not be directly applicable. It might also be noted that this study takes the form of a report which does not appear to have peer-reviewed, and the material has not subsequently been published in any other form. Nonetheless, this study is a reminder of the problems of relying on a test because it is widely used. As these authors point out, there is an intellectual, and sometimes financial, impetus behind widely used tests which may not be justified by their scientific validity. They also point out that the appeal of learning styles in pedagogy is partly due to their seeming to provide a simple solution to a complex problem; perhaps something of the same is true in the quest for a measure of information style.

Other authors have gone so far as to argue that, in the educational context, not only has the use of learning styles failed to improve teaching practice, but that it may be positively harmful, for example in perpetuating stereotyping; see, for example. Scott (2010). This possibility should also be borne in mind in considering information styles.

Finally, we should note that there may be strong correlations between the categorisations of individual differences produced by various tests. In one illustration of this, in the context of studying preferences for search engine interfaces, it was shown that there were "fundamental links' between the field independent and serialist cognitive styles on the one hand, and between field dependence and holist style on the other (Ford, 2000, Clewley, Chen and Liu 2010). This should caution us against focusing to enthusiastically on any one categorisation as a basis for information style.

6   Information styles

Studies aimed at identifying and assessing information styles *per se* have been very few in number.

In some cases, it seems that, where several dimensions of personality or cognitive style are considered, a strong preference for one such might amount to an 'information style'. An example is Gardner's 'five minds': five ways of thinking, based on a 'multiple intelligence' concept (Gardner 2006). A simpler example is the binary monitor/blunter categorisation, noted above.

An alternative pattern, linking these considerations with the results of studies discussed above, is also presented by Heinström (2010), with five 'information attitudes', linked to personality traits, and resulting in typical patterns of information behaviour. These attitudes, which might perhaps equally well be called information styles, are:
* invitational
* exploring
* purposeful
* passive
* avoiding

The Honey-Mumford learning styles have been used explicitly as a surrogate for information style, to plan training and personalised service delivery in a multinational company (Donnelly and Craddock 2002). An 'information activist', with a Honey-Mumford Activist style, might be expected to be an enthusiastic networker, keen to try out new tools, but unlikely to want to spend time planning thorough search strategies; while an 'information theorist' would be likely to always wish to do exhaustive background searches (Donnelly and Craddock 2007).

Characterised by its designers as exploring serious themes but presenting them in a fun way , a test of 'Web behaviour' of the general public was created by a team at University College London, for use by a large sample of the public on the BBC website, in connection with a TV broadcast. On the basis of tests for multi-tasking ability, and of how rapidly and internet search could be performed, together with questions about use of social networks, participants were categorised as one of eight 'web animals' (CIBER 2010). The 'web leopard', for example, is adept at finding internet information quickly, lies to work alone while finding information, and prefers to perform one task at a time, while the 'web elephant' browses the web at a stately, methodical pace, Is highly social and adaptable, and is well-suited to carrying out several tasks at once.

In a small-scale Masters' dissertation project, Hannell (2001) developed a short and unvalidated questionnaire for determining an information style, based on 18 Likert-scale (1-5) questions.

The questions, based on the available literature at that date, gave types based on the dimensions:
* Entrepreneurial – Cautious (reflecting liking, or dislike, for new sources and ill-defined problems)
* Fat – Thin (reflecting preference for obtaining as much information as possible, rather than getting the minimum necessary at the time)
* Browser – Hunter (reflecting the preference for focused searching aiming at getting exactly the information required, rather than liking general information background)

Eight styles were defined by strong preferences on all three dimensions, e.g. Cautious Thin Hunter or Entrepreneutrial Fat Browser. If simpler preferences on one or two dimensions are included, e.g. Entrepeneurs, Cautious Browsers, and Thin Hunters, then a total of twenty-six styles, at different levels of specificity can be determined.

To make a comparison with other individual difference factors, personality was assessed by a shortened version of the Myer-Briggs Type Indicator, and learning styles by the Honey Mumford test.

The questionnaire was initially used with 28 information professionals working in special libraries and information units, with a comparison group of 31 other professional workers with similar educational level. Subsequently, with small modifications of the terminology of 'organisations', it was used with 6 staff members and 58 students of library/information studies departments in London and in Ljubljana, Slovenia.

Some limited correlations between the information styles and personality types and learning styles were noted, but the information styles did seem to show different patterns. The most common types in all groups were EFB and ETH, with the library students showing something more of the Cautious dimension than the professional groups. The therefore seemed a promising approach, given the limits of sample size and the unvalidated test.

7   Conclusions

Progress has clearly been made in the study of information styles, as evidenced by the studies described above, However, the results has not been as striking or conclusive as might have been hoped when the systematic study of the topic began two decades ago. The summary of their own work by Ford, Wilson, Foster, Ellis and Spink (2002, p. 734) might well stand for it all: "the evidence is suggestive rather than in any sense conclusive".

It has been shown that differences in the individual behaviour of information seekers and users are not entirely explained by the conventional categories of discipline, task, educational level, age, gender, etc. In broad brush terms, consistent and plausible relationships have been found between some main personality traits, cognitive styles and learning styles. In terms of detail, there is less consistency among the findings.

Perhaps ironically, one fairly consistent finding is that there are links between information behaviour, and traits which may correlate with it, with age, gender and subject discipline. In addition to the examples noted above, Gorrell, Eaglestone, Ford, Holdridge and Madden (2009) found that a number of significant differences in reported metacognitive behaviours in information retrieval - such as planning, monitoring and evaluating - related to age, gender and discipline.

Gender influences on information behaviour have been noted by numerous authors; see Steinerová and Susol (2007) and references therein, while a relation between age and learning style, and by implication information behaviour, was noted by Stokes and Urquhart (2010).

A more definite categorisation by age is often used, in terms of 'generations' - the baby boomers, Gen X, the Google Generation, and so on – with the assumption that the generational label summarises a good deal of the behaviour of the group. It has been suggested that there may be information behaviour characteristic of a generation; see, for example. Lancaster (2003), Weller (2005), Rowlands, Nicholas, Wlliams, Huntington, Fieldhouse, Gunter, Withey, Jamali, Dobrowolski and Tenopir (2008), and Anderson and Rainie (2010). This is an extreme form of attributing an information style to an age group.

We should also remember that times change, and that the results of early studies may no longer be applicable. Many of Palmer's participants in 1991 did not need to use a computer for information handling; to what extent would their information style have changed by now, simply due to the changed environment? Gender effects may also change with time, due to educational and societal changes. And perhaps the concerns about issues such as continuous partial attention (Bawden and Robinson 2009), and an increasing disinclination on the part of many people to pay sustained attention to complex information (Rowlands, Nicholas, Wlliams, Huntington, Fieldhouse, Gunter, Withey, Jamali, Dobrowolski and Tenopir 2008, Carr 2010), may indicate a new context-dependent information style.

When put together with the interactions of subject discipline and information style and behaviour noted above, these gender and age relations should caution us again raising too many hopes for a description of individual information style which would dramatically cut across these traditional ways of categorising information users. It may be that consideration of information style within such groups, particular within domains, may be the best way forward. As Heinström (2005, p 244) reminds us "personality does not determine information-seeking behaviour, but it creates boundaries and possibilities for the way information seeking is executed".

What we can say about the studied described above is that many of them show a pattern of two rather general information styles: an open exploratory style and a more closed and focused style. However, it is difficult to ascertain how 'real' this distinction is, how it may be related to demographic factors, and whether any more subtle distinctions are discernable, without a proper meta-analysis. However, many of the studies have been small in scale, and many have limited to studying library/information students or practitioners; an understandable pragmatic choice, but not perhaps

the most informative group for investigation. As we have noted, there have few attempts at meta-analysis, or overall synthesis, of the results of the various studies, and it would be difficult to attempt such in view of the variety of methods used. Such seemingly minor issues as the use of the short or full version of a test, or the substitution of an open access of a proprietary test, can cause problems in the consolidation of results. Here we find a difficult balance, between the desire of the researcher to choose the 'best', or perhaps the most accessible version of a test, and the desirability of using consistent instruments, so that results may be more directly comparable. And a balance also between a desire to use the most appropriate test and the necessity of using a short and simple one; as Palmer (1991A) and Stokes (2008) have pointed out, if test are not short and simple, they are not likely to be completed accurately, if they are completed at all.   Pre-validation of test instruments would seem desirable, yet few of the studies reported above took this step; we have also seen that there is dispute about the validity and reliability of some of even the most widely used tests.

Relatively little has been done, with some exceptions noted above, to link ideas of information style to models of information seeking, and information practices generally. Nor is it clear how much direct influence these studies have had on the design and evaluation of systems and interfaces, nor on training programmes, though it is not unreasonable to think that there has been some indirect impact.

We should not perhaps expect too much, and certainly not to be able to dictate a 'good' information style; as Heinström (2003 p 1) puts it, "There is certainly not one single personality type which would form the 'ideal' information literate citizen". Nonetheless, some better understanding of how to investigate and denote information style seems highly desirable, for the reasons outlined in the introduction.

It may also be that typologies from other areas may be worth re-investigating. An example is the 'multiple intelligences' approach of Howard Gardner (related to that of Sternberg discussed above), who proposed that each individual possesses eight forms of intelligence: verbal/linguistic, logical/mathematical, bodily/kinaesthetic, visual/spatial, musical, intrapersonal, interpersonal, and naturalist (Gardner 1983, 1993, Chen, Moran and Gardner 2009). Spink (2010) has suggested that an additional form – information intelligence – might be added, underlying the understanding of information problems and the carrying out of information behaviours. These 'intelligences' will be present, and may be developed, to varying extents, and the dominant form/s of intelligence will impose a cognitive style. Knowledge of this may be valuable for teaching and learning, for example in the teaching of information literacy (Powis and Webb 2005). Mokhtar, Majid and Foo (2008) showed, in this context, that students organised in homogenous groups of the same dominant intelligence, and taught in an appropriate way, did better than those in heterogeneous groups. Chau (2006) based the design on an interactive information literacy tutorial on Gardner's theory, together with Dunn's learning styles. The latter involves a model of 21 elements categorised under 5 stimuli; for example, the 'emotional' stimulus include the elements of motivation, persistence, responsibility and structure (Dunn and Dunn 1978, Dunn, Dunn and Price 1984, Dunn, Denig and Lovelace 2001). Smith (2006) has also suggested that Gardner's theory may be a useful framework for design of digital libraries with user groups crossing cultural boundaries.

In a recent, semi-popular book, Gardner (2006) has defined five ways of thinking, based on his basic multiple intelligence concept. These are:
- the disciplinary mind, with a mastery of traditional academic subjects and professional crafts
- the synthesizing mind, able to integrate information from many sources and domains
- the creating mind, able to uncover and clarify new ideas
- the respectful mind, appreciating different cultural perspectives
- the ethical mind, enabling responsible behaviour

Given the close links between these 'five minds' and the handling of information and knowledge, this categorisation seems appropriate as a basis for an information style typology. It does not, however, seem to have been applied, as yet, within the information sciences.

We must conclude, that we still do not have adequate answers to these fundamental questions:

- can an information styles test be devised with sufficient reliability and validity, and at the same time be sufficiently short and simple to complete?
- to what extent can such styles be independent of age, gender and discipline?
- to what extent can such styles be independent of personality, and thinking and learning styles?
- is an understanding of such styles really useful, and can it be integrated with other models of information-related behaviour?

These questions need to be addressed systematically, if a full understanding of information-related behaviour is to be achieved. It seems to me that a crucial step would be to try to determine whether or not an information styles test could be devised that would be both distinctly different from the commonly used surrogates, and also offer genuinely new insights into information behaviour. It is also highly desirable to attempt to fit any insights gained from such studies within existing models of information-related behaviour, rather than to seek to create new models to accommodate them.

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