Amanda Spink

Information Behavior

An Evolutionary Instinct

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Dedicated to Peter for his love and support

Foreword

This book is a synthesis of the information dimension of human behavior from an evolutionary perspective. It is based on a premise that information behavior is a crucial everyday human activity for all humans since the early days of human evolution. It addresses a number of fundamental questions not only scientific but also philosophical and hypothetical. In that sense, the book is an invitation for further research in a number of fields.

Of course, any discourse about human information behavior raises the obvious question: *But what is information to start with?* It is a basic question on the same level as: *What is energy? What is matter? What is life?* As such, the question is very hard to answer, although it was addressed in numerous fields from physics, biology, neuroscience, cognitive science, electrical engineering and psychology to philosophy, economics, and humanities. Each field brought its own context and orientation to sought answers. Dictionary definitions, such as "Information: Knowledge communicated concerning some particular fact, subject, or event; that of which one is apprised or told; intelligence, news. *spec*. contrasted with *data*" (or even "Divine instruction, inspiration") provide a lexical description of the meaning of the word, but not answers to the basic question (Oxford English Dictionary, 2nd edition).

Thus, the question about *what is information* in those different fields was not answered directly – dictionary-like – but with investigation of information behavior, manifestations, and effects. This is exactly the same way the questions about energy, matter, and life were and are investigated in numerous fields. This is also the way the question about information is addressed here as well: through investigation of information behavior. It is the broader context for matters dealt with in this book.

The notion of information is of fundamental interest to information science, a field of professional practice and scientific inquiry dealing with effective communication of information and information objects, particularly knowledge records, among humans in the context of social, organizational, and individual need for and use of information. The interpretation by Jean Tague-Sutcliff fits well the context and orientation of information science:

> "Information is an intangible that depends on the conceptualization and the understanding of a human being. Records contain words or pictures (tangibles) absolutely, but they contain information relative only to a user. . . Information is associated with a transaction between text and reader, between a record and user." (Tague-Sutcliffe , 1995, pp. 11–12)

Historically, information science emerged in the aftermath of the Second World War, as did a number of other fields, addressing the problem of information explosion and using technology as a solution. By 1950s investigations of human information behavior became an integral and important part of information science. Of course, information behavior was investigated in many other fields, as demonstrated in the book, but the evolution of the area of study, including major concepts and theories, are closely connected with information science. Thus, the rest of the foreword provides a brief historical perspective of the study of human information behavior in information science as reviewed in Saracevic (2009). In general, social and individual question were addressed: *How do people relate to, seek and use information?*

As can be seen in this book, human information behavior refers to a wide range of processes which people employ when engaged with information and to related cognitive and social states and effects. In his work that comprehensively covers research on information behavior (with over 1,100 documents cited, most since 1980), Case defines that information behavior:

> "encompasses information seeking as well as the totality of other *unintentional* or *passive* behaviors (such as glimpsing or encountering information), as well as purposive behaviors that do not involve seeking, such as actively *avoiding* information. (Case, 2007, p. 5) (emphasis in the original).

As can be imagined, human information behavior, as many other human behaviors, is complex, not fully understood and of interest in a number of fields. As with the notion of information, a great many studies and a number of theories address various aspects related to human information behavior in psychology, cognitive science, brain sciences, communication, sociology, philosophy and related fields, at times using different terminology and classifications. Under various names, scholarly curiosity about human information behavior is longstanding, going back to antiquity.

Of particular interest in information science are processes, states and effects that involve *information needs and use* and *information seeking and searching*. The order in which these two major areas of human information behavior studies are listed represents their historic emergence and emphasis over time.

Historically, the study of information needs and use preceded information science. Many relevant studies were done during the 1930s and 1940s in librarianship, communication and specific fields, such as chemistry, concentrating on use of sources, media, systems, and channels. Already by the 1950s this area of study was well-developed in information science – for instance, the classic *Proceedings of the International Conference on Scientific Information* (1959) had a whole area with a number of papers devoted to the topic. The *Annual Review of Information Science and Technology* had regular annual chapters on "information needs and use" starting with the first volume in 1966 and ongoing through 1978. Thereafter, chapters covering this area were broadened to cover in addition various aspects or contexts of information behavior, including information seeking. This change illustrates how

the emphasis in topics studied significantly changed over time. Studies in human information behavior are evolving and slowly maturing.

In information need and use studies questions are asked: *Who are the users of a given information system or resource? What information objects do they use? What information channels are used to gather information?* Or in other words: *Who uses what? How? For what purpose?*

In information seeking and searching studies questions are asked: *What do people actually do when they are in a quest for and pursuit of information? How are they going about and how are they changing paths as they go about? What are they going through on a personal level? What information channels are used to gather information? How?*

Information seeking, as is the case with most human information behavior, is highly dependent on context. While context may be everything, the very concept of context is ill defined, or taken as primitive and not defined. The contexts may involve various motivations for information seeking, various cognitive and affective states, various social, cultural or organizational environments, various demographic characteristics, values, ways of life, and so on. A number of information-seeking studies were indeed directed toward various contexts. Thus, there is a wide range of such studies regarding context, accompanied by difficulties toward generalization.

The book provides a broader framework than that offered by studies of human information behavior in information science. The context is much wider and covers numerous other fields. The fundamental questions about behavior and effects of the notion of information have indeed a wider context. So does the question: *How do people relate to, seek and use information?*

Newark, NJ Tefko Saracevic

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Preface – Information Behavior Challenge

From childhood through our senior years, humans engage in information behavior or the ability to find, gather, organize and use information. Humans enjoy the benefits of their information behavior on a daily basis but also face the challenges that this presents, including many of the difficulties inherent in how to find information, where to find it amongst a plethora of sources, how to organize the information they do find and what information to use for different purposes. The daily challenges and struggles of information behavior are common to everyone. For example, let's look at some typical examples of people confronting the daily challenge of information behavior:

A stressed Wall Street business analyst uses his information finding abilities to gather information quickly about a competitor company to complete an industry report for a client company – which information system does he use to find the information;

A mother with a sick child uses a Web search engine to look for treatments for her child's cold – she wants to understand how accurate the information is that she finds on medical Websites;

A chef has thousands of recipes to organize – what classification system should she use;

A schoolchild works on a class paper on the ancient Egyptian pyramids, scans the school library and uses a Web search engines to find a relevant Website;

And an early human, to learn more about hunting techniques and herd locations, scans paleoart in a local cave.

Each person in the examples above is using their information behavior abilities for different purposes, tasks and goals, but all are going through some challenging processes. As we learn throughout this book, all humans do have a capacity for engaging their instinctive socio-cognitive abilities, including their information behavior abilities, on a daily basis. These human abilities have been shaped over the centuries by social and cognitive forces. However, in their daily lives the people in the examples above may not realize that they are using their information behavior abilities.

They are also using their information behavior instinct and intelligence. Humans have an information behavior instinct and intelligence that guide them in their

information finding, organizing and using abilities. Like many other behaviors, such as food foraging, language, etc, our information behavior abilities are critical to our human survival. But like many human instincts and innate abilities, we don't often realize how instinctive these abilities are and don't often analyze our own cognitive abilities, such as information behavior – we just use them.

To learn more about our instinctive information behavior abilities, we can ask the questions.

Where does our information behavior ability come from and how does it develop within us as an instinctive socio-cognitive ability? How did our information behavior originate, evolve and develop in early humans?

This book addresses these very basic and fundamental questions. Information behavior is a crucial everyday human activity for all humans. Imagine a world where humans had no information behavior ability – no ability to engage in information gathering, organizing and using. This would be quite a strange world to comprehend. But we currently have quite a limited understanding of our own information behavior, where it comes from and how it develops during our lifetime. Thus, we need to know more about these important fundamental issues that affect us everyday.

Information behavior is a core human capacity that provides a basic structure for humans to learn and control aspects of their environment. To be without information behavior for a human being would be similar to a form of cognitive disability such as Autism or Alzheimer's which restricts our cognitive abilities. Without information behavior abilities it's unlikely humans' would have evolved to become the dominant species on the planet Earth. Understanding more about this key instinct is critical.

We also often take our information behavior for granted. Humans are portrayed everyday in the media as "information beings" living in "information societies", and therefore our information behavior is a key driver of our humanness and our society.

Yet, behind the media hype we know so little about our information behavior. Despite the important universality of information behavior, people have little understanding of many aspects of this important ability. People may say they seek information, or they forage for information, or even gather information, but most people are not clear about these behaviors or understand how they can be more effective.

The nature and vocabulary of our information behavior is also not clear or immediate to most of us. The psychologist Sigmund Freud and others, through their writings, made the language of human psychology more available to people so we can now discuss their emotions and psychological traits. People understand that they have emotions, personalities, psychological traits and can analyze the psychology of others. In the same vein, a major goal for the field of information behavior is to develop a vocabulary that people can use to understand and talk about their own information behavior.

To reach a greater understanding of our information behavior, its instinctive nature and use a vocabulary to describe our information behavior, we first need to build a stronger understanding of the origins and nature of information behavior by first going back to human beginnings to explore the development of information

behavior over the history of human evolution. We need to ask the following key question.

How did information behavior emerge in early humans as an instinctive socio-cognitive predisposition for information finding, gathering, organizing and using?

Then building on a greater understanding of information behavior as an evolved behavior over the centuries of the millennium, we can also explore how information behavior develops over a human lifetime. We can ask the question.

How does information behavior develop in children and over a human lifetime?

To begin the process of building a theoretical framework for information behavior, we begin to explore what is currently known about information behavior from a broad range of evolutionary and behavioral scientific fields. Drawing on the recent research in developmental psychology we also explore how humans develop information behavior over their lifetime. We examine the complex intellectual issues related to information behavior by drawing on research and thinking from the broad cognitive, evolutionary and behavioral sciences. By building such a theoretical framework the book provides a broad exploration of the information dimension of human behavior from an evolutionary perspective.

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The author thanks the many people who contributed to the development of this book. My goal was to write an original research monograph and engage in fundamental thinking about information behavior. However, bringing an original research monograph to fruition is a long and intellectually complex process. So the author first thanks her husband Peter Spink for his love and support in commenting on the book and editing later versions during the long book gestation period.

Secondly, the author thanks the faculty from the School of Communication and Information at Rutgers, The State University of New Jersey for my intellectual training. My years as a Rutgers PhD student from 1990 to 1993, and my subsequent research career, was fundamentally influenced by the Rutgers world class scholars, including Tefko Saracevic, Nick Belkin, Carol Kuhlthau, Ron Rice, Brent Rubin and others.

Thirdly, the author thanks her many collaborators and PhD students who over the years have engaged in stimulating and challenging conversations that inspired our research. In particular the author thanks her doctoral students Bhuva Narayan and Jia T. Du for their helpful comments on the book.

Many readings and conferences contributed to my framework for the book. My thinking was influenced by many scholars from various scientific fields including information behavior, evolutionary psychology, cognitive archaeology, cognitive psychology, social psychology and developmental psychology. The published works and conference presentations by many scholars from the evolutionary and cognitive scholarly fields strongly influenced my work, including papers by Richard Alexander, Mark Blumberg, David Buss, Fred Coolidge, Leda Cosmides, David Geary, Stephen Mithen, Stephen Pinker, John Tooby and Thomas Wynn.

Over the years my information behavior research has been supported by many organizations including the United States National Science Foundation, American Library Association, University of Pittsburgh, The Pennsylvania State University, Queensland University of Technology and University of North Texas.

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Leicestershire, UK Amanda Spink

Contents

Author Biography

Amanda Spink

Amanda Spink is a leading Professor of Information Science. She has a B.A. (Australian National University); Graduate Diploma of Librarianship (University of New South Wales); M.B.A. in Information Technology Management (Fordham University), and a Ph.D. in Information Science (Rutgers University). Amanda's research focuses on theoretical and empirical studies of information behavior. The National Science Foundation, the American Library Association, Andrew R. Mellon Foundation, Amazon.com, Vivisimo.com, Infospace.com, NEC, IBM, Excite.com, AlltheWeb.com, AltaVista.com, FAST, and Lockheed Martin have sponsored her research.

Amanda has published over 330 scholarly journal articles, refereed conference papers and book chapters, and 6 books. Many of her journal articles are published in the *Journal of the American Society for Information Science and Technology, Information Processing and Management,* and the *Journal of Documentation*. Amanda's research has been published at many conferences including *ASIST, IEEE ITCC, CAIS, Internet Computing, ACM SIGIR, and ISIC Conferences.*

Her other books are *Web Search: Multidisciplinary Perspectives, New Directions in Cognitive Information Retrieval, New Directions in Human Information Behavior* and *Web Search: Public Searching of the Web*, also published by Springer, and the *Handbook of Research in Web Log Analysis*, published by the Idea Group.

Professor Spink was ranked as the 8th Most Highly Cited Author in the Field of Information Retrieval (Ding, Y., Yan, E., Frazho, A., & Caverlee, J. (2009). PageRank for ranking authors in co-citation networks. *Journal of the American Society for Information Science and Technology, 60*(11), 2229–2243) and in 2008 had the second highest H-index citation score in her field from 1998 to 2008 (Norris, M. (2008). *Ranking Fellow Scholars and Their H-Index: Preliminary Survey Results*. Loughborough University, Department of Information Science Report).

Chapter 1
Introduction

This book takes the reader on a long journey. We travel into the world of information behavior where humans seek, forage, organize and use information. We also journey from the beginnings of human existence on planet Earth to the twenty-first century of today. On this journey the reader will gradually appreciate that the scope of this book is broad and the tone of the book is quite theoretical in nature.

As we move through the book we explore many fundamental issues, including how information behavior originated in early humans and evolved as a uniquely human capability. We also examine how information behavior is shaped by both instinct and environment, and explore more deeply the notions of information instinct and information intelligence that emerges during childhood and developing through adulthood. This long journey both embraces human evolution over many millennia and goes deep into the fundamentals of human behavior and cognition.

The reader will appreciate that the book is fairly theoretical and addresses fundamental issues. When dealing with fundamental issues, books often raise more questions than they answer. This book is no exception. But the time is ripe and there is a critical need for a more fundamental, critical and basic approach to understanding information behavior. Information behavior is an important daily activity for all humans. Because of the importance of information behavior to how humans construct their lives and society, we need a stronger theoretical, evolutionary and more holistic framework for information behavior that is broader than the current limited cognitively-based models. This book provides such a framework that is developed as we work through the various chapters presented.

The major challenge is clear for information behaviorists – develop a stronger theoretical framework for information behavior, or other behavioral and evolutionary sciences will do the task. Over more than 100 years, information behaviorists have sought to understand information as a concept (Belkin & Robertson, 1976; Buckland, 1991; Burke, 2007; Cole, 1994; Rayward, 2008) and model the role of information in human behavior (Case, 2007). They hoped that by understanding information and modeling contemporary information behavior they could help to solve the information overload problem that humans face in the wake of the development of computers, electronic information and the Web (Saracevic, 1992, 1999). This vision has been driving research, theories and models of information behavior. However, the major scientific focus has always been more on artifact development

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to support information behavior and less on building good information behavior theories and models.

In the ongoing quest by information behaviorists to solve the information overload problem, many aspects of information behavior over the centuries from an evolutionary or developmental perspective have been overlooked. The focus has been on models depicting some aspects of contemporary information behavior to underpin the development of new Web technologies (Case, 2007; Courtright, 2007; Fisher & Julien, 2009; Pettigrew, Fidel, & Bruce, 2001). The field has largely ignored the bigger picture from the social, behavioral and evolutionary sciences, and issues such as how information behavior evolved in humans and how information behavior develops over a human lifetime.

In addition, information scientists and others have devoted many pages to discussing the pragmatic aspects of information behavior, including how we can improve people's information skills, literacy and competency (Case, 2007). However, in the plethora of applied and pragmatic studies there is a profound lack of fundamental knowledge and understanding about information behavior, limited research underpinned by evolutionary concepts (Bates, 2005; Madden, 2004) and no fundamental theoretical framework for understanding information behavior.

The important and fundamental challenge for information behaviorists is to build a holistic understanding of information behavior beyond the limited contemporary models. From a pragmatic perspective a good model of information behavior has great value in building artifacts and information services to support information behavior (Rayward, 2008).

Information behavior is one dimension of human behavior. The broad cognitive and behavioral sciences provide a framework for exploring how human behaviors' evolved and how they develop over a human lifetime. The approaches and findings of the cognitive, evolutionary and behavior sciences need to be applied to bring our understanding of information behavior into the general framework of those sciences.

To address this lack of broad and fundamental focus, this book extends our understanding of information behavior at a more theoretical level. We explore the origins of information behavior in early humans as an evolved cognitive mechanism and socio-cognitive ability affected by social factors. We also examine how information is shaped by instinct and environment, and manifests in humans as an information intelligence. We see how information behavior emerges in young children even without instruction and is visible in all human cultures and develops throughout a human lifetime.

In addition, we are now beginning to understand that information behavior is not just a uniquely modern phenomenon of the twentieth and twenty-first centuries that only occurs when people interact with computing technologies, libraries or the Web. Based on findings from evolutionary psychology we see how information behavior has developed across human existence. Like language, information behavior abilities emerge in every human across people in all cultures as a cognitive adaptation that developed over many thousands of years.

Overall, this book shows that information behavior cannot be seen in isolation from the holistic nature of human evolution, cognition and behavior. Our understanding of information behavior can be more strongly grounded in the broad

cognitive, evolutionary, social and behavioral sciences. More pragmatically, we understand that as a key human behavior, a greater understanding of information behavior will enhance general models of human behavior, evolution and development, and most importantly help people understand their own information behavior. These are the key issues addressed in more detail in this book.

The next section outlines the framework of the book.

Book Framework

The key contribution of this book is the development of a broad theoretical framework for understanding information behavior. The theoretical framework is developed throughout the various chapters of the book. To build this theoretical framework, we begin by exploring the origins and development of information behavior in early humans. Understanding more about the origins of information behavior in early humans is crucial for developing a stronger theoretical framework for understanding information behavior.

To achieve this, the book situates our knowledge of information behavior within the origins of early humans and their cognitive development. We look far back into the beginnings of human life on planet earth to see how early humans evolved into modern *Homo sapiens* with instinctive socio-cognitive abilities – including an information intelligence for information behavior. Evolutionary developments such as brain volume expansion in early humans helped shape the genetic and experiential foundation of information behavior.

We explore how instincts and cognitive abilities originated and developed in early humans, and how information behavior evolved to enable *Homo sapiens* to have the cognitive ability to construct information based on their motivation to control motivation to control their environment. Information behavior and other socio-cognitive abilities, such as language, abstract thinking, and strategic thinking, are underpinned by a human motivation to control and dominate the environment (Alexander, 1989, 1990c; Geary, 2004).

The theoretical framework for information behavior is also underpinned by the work of Blumberg (2005), Buss (2008), Geary (2004), and Pinker (1994, 1997, 2003). They show that human behavior and cognition abilities are basically instinctive and affected over time in humans by social, experiential and cultural factors. The framework depicts information behavior as related to the human ability to coordinate instinctive behaviors such as language, abstract thinking, decision making, sense making, foraging, systematic planning and the abstract representation of objects. The human ability to coordinate these instinctive abilities simultaneously enables the information ability to emerge. Without the ability to coordinate these other cognitive abilities, humans would not be able to engage in information behavior and the human species would not have evolved to ecologically dominate their environment (Alexander, 1989, 1990a, 1990b; Geary, 2004).

The theoretical framework also depicts humans as born with an instinctive capacity for information behavior that is underpinned by an information intelligence that

evolves over a lifetime. We learn how to use our information behaviors within the structures and artifacts that are created by other humans, such as libraries, catalogs, information systems, Web etc, to facilitate and support our information behaviors. But for many reasons our information behaviors may not be successful – we may not locate the right book or find the most valuable Websites on the topic.

Overall, the theoretical framework for information behavior presented in the book is complex and multifaceted. The book is a first attempt to discuss the framework, and much further research and thinking needs to be done to develop the framework's full potential.

The next section outlines the scope of the book.

Book Scope

The goal of this book is to outline a theoretical framework for further research and not to provide a comprehensive survey of contemporary information behavior research. The monograph by Donald Case (2007) is currently the most comprehensive discussion of information seeking research in particular. The book you are reading is more in the vein of a basic treatise on the instinctive and evolutionary nature of information behavior that explores many new exciting, fundamental theoretical issues to underpin the proposed theoretical framework.

An important aspect of scientific research is to understand and extend the latest thinking on a particular topic and produce changes in scientific fields over time. Therefore, the book focuses on presenting the latest thinking related to information behavior across a number of scientific fields and incorporates this latest thinking into a theoretical framework for understanding information behavior. A broad reading of the scholarly literature from various behavioral fields and thinking about information behavior from an instinctive perspective builds a solid theoretical framework for beginning to understand the evolution of information behavior in humans. My thinking on these issues over more than 6 years bore fruit in the reality of this book.

The scope of the book is intellectually and theoretically broad. The theoretical framework is also multidisciplinary in scope. The theoretical framework proposed situates information behavior directly within the research and intellectual frame of many other scientific fields. When dealing with evolved behaviors and instinctive, socio-cognitive abilities which is manifest in the coordination of other instincts such as language, information behavior is not only an important human behavior but is broad in impact.

The scope of the book is also chronologically long. Information behavior is a behavior that evolved in humans through adaptation over the long millennium into a human ability, while also developing over a human lifetime. This book is a first attempt to deal intellectually with these issues at a fundamental level. However, many long years of further research are needed to fully address these fundamental issues beyond my initial contribution.

Of course, such a broad sweep at fundamental information behavior issues is an exciting intellectual challenge. The scientific thinking on information behavior

and the evolutionary fields such as evolutionary psychology are so extensive and complex (Buss, 2008) that this book is but the first major attempt to develop an evolution-based information behavior model. But more fundamentally, as we move our thinking on information behavior beyond the current non-evolutionary and contemporary focus we can forge a deeper theoretical and evolutionary grounding for the field. We have a long and exciting road to travel.

Extending our understanding of information behavior within the broader evolutionary and developmental behavioral sciences is crucial and has strong implications for the intellectual development of the research field. More practically, we can also enhance people's understanding of their own personal information behaviors. As Freud and others enhanced people's understanding of their own behaviors through the development of the field of psychology, the field of information science needs to assist people by giving them a vocabulary, models and theories to help them in understanding their own information behaviors.

The next section outlines the contents of the nine chapters in the book.

Chapter Outlines

The book includes a Preface, nine chapters and an extensive multidisciplinary list of references.

Chapter 1: Introduction

Chapter 1 gives a brief overview of the book's theoretical framework for understanding the origins, evolutionary and developmental nature of information behavior. This introductory chapter summarizes the key propositions in the book and discusses why the issues are significant not only to information behaviorists, but for every human being. Later chapters provide more detailed background on the instinctive, socio-cognitive development of information behavior in early humans.

Chapter 2: Information Behavior Framework

Chapter 2 draws on extensive research from anthropology, evolutionary psychology, cognitive archaeology, and many other evolution oriented scientific fields. The chapter examines the latest thinking in the ongoing debate about how humans evolved cognitively and developed behaviors that are instinctive while also being affected by social and cultural factors. This chapter moves from the beginnings of human life on planet Earth to the neuro-evolution in early humans when the human brain expanded in volume and many cognitive abilities first emerged in the human species such as *Homo sapiens*.

Chapter 3: Evolutionary Foundation

Chapter 3 explores how information behavior originated and emerged in early humans and in particular how enhanced cognitive abilities emerged in the *Homo sapiens* species. We see how information behavior emerged in early humans because they were motivated to control their environment by gathering, organizing and using information. Paleoart is one of the earliest examples of the information behavior ability when early humans created and stored knowledge in the form of cave art by drawing red ochre images of large animal herds.

Chapter 4: Instinct Versus Environment

To more fully understand information behavior as shaped by instinctive and environmental factors, Chap. 4 teases out the past and current thinking across the sciences on what constitutes behavior within the context of the instinct versus environment debate. The key issue of ongoing debate is determining the role of instinct versus experience in shaping behavior. In this chapter we also examine the role of instinct and experience in shaping information behavior. Based on the latest understandings of human behavior by the cognitive psychologist Blumberg (2005), and the cognitive and behavioral sciences, we understand more about the instinctive basis of information behavior that is also shaped by environmental factors.

Chapter 5: Human Cognition and Social Behavior

Building on the work by Richard Alexander (1989, 1990c), David Geary (1995) and information behaviorists Spink and Cole (2005, 2006, 2007), Chap. 5 provides a more detailed discussion of the broad attributes of information behavior. Information behavior is not only instinctive with social/cultural and cognitive dimensions, but is also a type of intelligence and what Geary (1995) calls a biologically primary ability which is universal to all humans. In addition, information behavior also has the attributes of what Geary (1995) calls a biologically secondary ability that is affected by cultural differences.

Chapter 6: Lifetime Development

In Chap. 6 human development, developmental psychology and human lifetime history studies provide a framework for understanding how information behavior develops over a human lifetime. Information behavior emerges in infants and children, and further develops in adolescent and adulthood. In addition, based on work of information behaviorists Currier (2007), and Spink and Currier (2006a, 2006b), we explore some lifetime histories by people who discuss their information behavior abilities.

Chapter 7: Information Behavior Sub-processes

Extending work by the information behaviorists Spink and Cole (2005, 2006, 2007), and Fisher and Naumer (2006), Chap. 7 provides a theoretical framework for understanding the sub-processes that make up information behavior. Not only is information behavior an evolved behavior with instinctive, social/cultural and lifetime developmental attributes, but also includes sub-processes such as information grounds, seeking, foraging, sense-making, information organizinginformation organising and use.

Chapter 8: Information Behavior over the Ages

With the emergence of information behavior in early humans, over the centuries humans began to develop various artifacts to support their information behaviors. In Chap. 8 we briefly examine artifacts created by humans over the centuries to support their information behaviors. For example humans progressed from creating parchment scrolls to allow the storage of knowledge, through the first libraries and the eventual development of computer storage, search and retrieval devices, and most recently the Internet and the Web.

Chapter 9: Key Propositions and Future Directions

Finally, Chap. 9 synthesizes and elaborates the key propositions that emerged over the various chapters of the book. Some future directions are discussed for further exploration into information behavior and some exciting directions for further research.

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Chapter 2
Information Behavior Framework

> *As the whole of the African archaeological record shows that the transition to fully modern human behavior was not the result of a biological or cultural revolution, but the fitful expansion of a shared body of knowledge, and the application of novel solutions on an "as needed" basis (Ambrose and Lorenz, 1990;Vishnyatsky, 1994; Belfer-Cohen,* 1998; *Bar-Yosef, 1998). The complex content of human cultures has been built incrementally, with cognitive equipment present since at least 250 ka, in a process that continues today.*
>
> (McBrearty & Brooks, 2000)

As McBrearty and Brooks (2000) argue above, knowledge sharing and human information behaviors originated in early humans and are not just a twentieth century phenomenon. However in our twenty-first century information society when we think about our behavior we do not generally think about our information-related behavior. When using our information behavior abilities such as information finding, organizing and using, with all the benefits they entail, we often think more about the technologies such as the Internet or Web that are designed to support our information behaviors.

Of course, technologies are important. The mid 1990s saw the emergence and explosive development of the Internet and the Web. Today, most people in industrialized countries and increasingly in less-developed countries are expected to support their information behavior abilities by using some form of Web technology, such as a Web search engines including Yahoo and Google.

In our daily life if we do think about our information gathering, organizing or using behaviors, our frame of reference is often Web technology, Websites and Web search engines – not the instinctive, socio-cognitive abilities that enable us to engage in information behavior. It's often hard to self-analyze our own behaviors, and this is even more difficult if we have few words or models to help us understand our own behaviors.

To help people understand their information behaviors this book provides a theoretical framework for understanding how information behavior, including how information behavior evolved and emerged as a human instinct and intelligence. Figures 2.1 and 2.2 below provide a basis for our theoretical framework for

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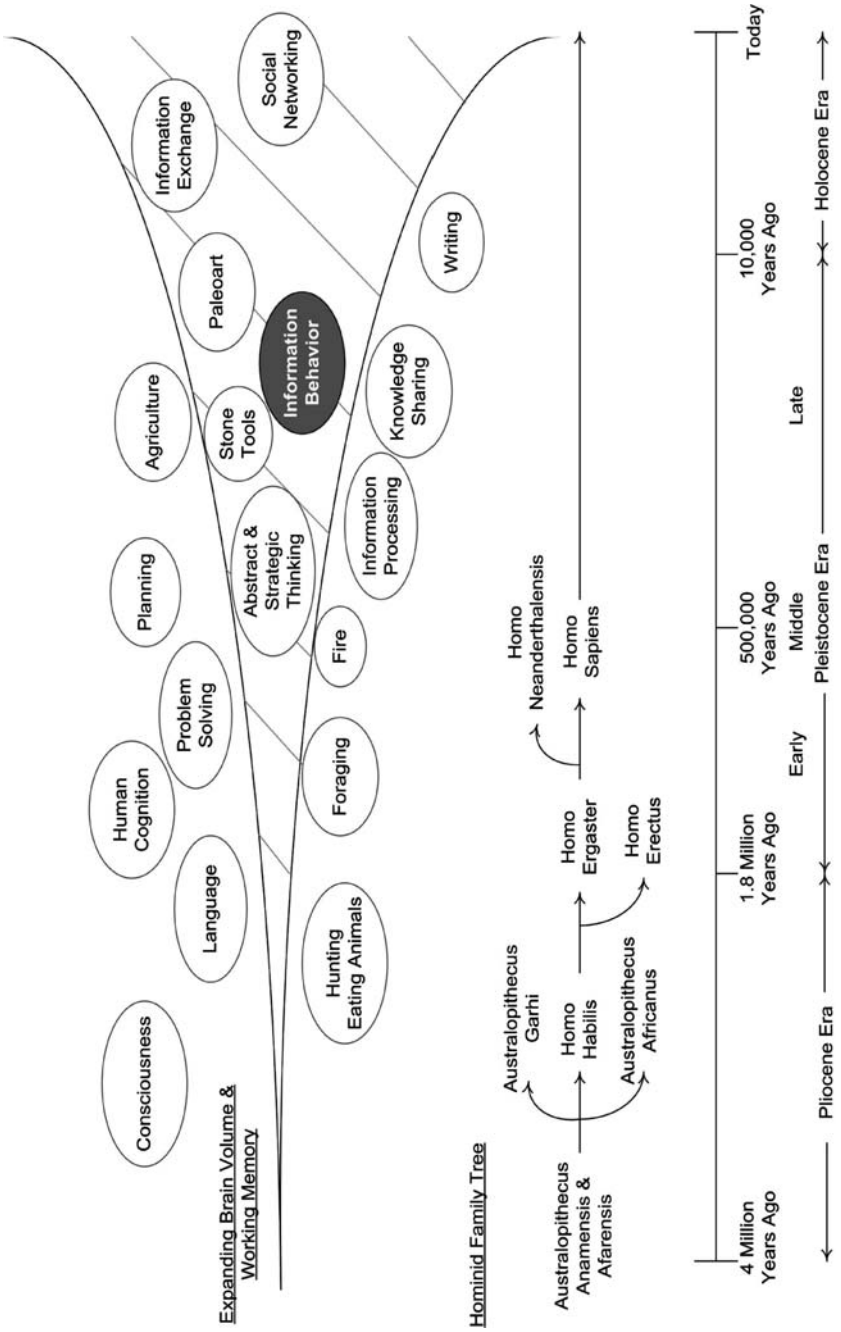

Fig. 2.1 Human evolution timeline

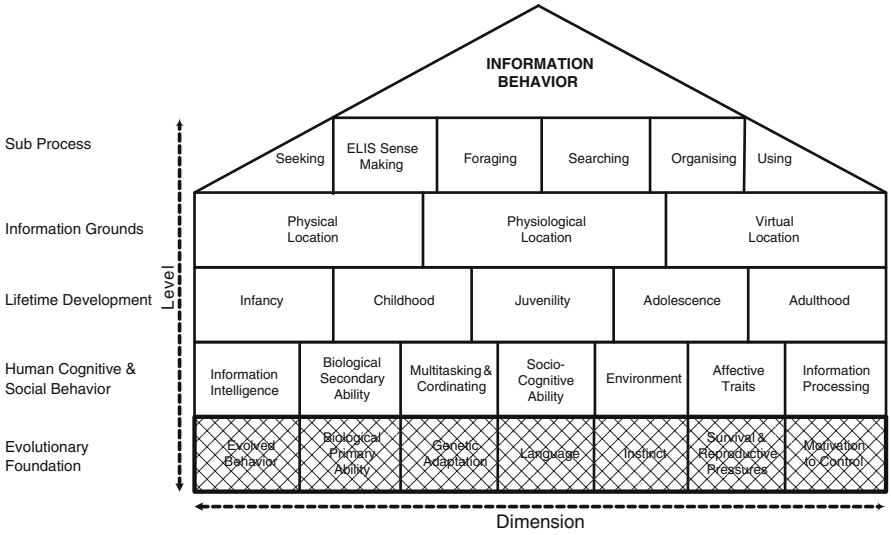

Fig. 2.2 A theoretical framework for information behavior

information behavior which is elaborated in more detail throughout the different chapters of the book.

- *Figure 2.1* provides a broad theoretical framework and timeline showing the eras of human evolution, the major human species and their cognitive developments, including when information emerged in *Homo sapiens*.
- *Figure 2.2* shows that information behavior is underpinned by five levels of dimensions. This model provides the basic underpinning for our conceptualization of information behavior. Each different dimension in Fig. 2.2 is discussed in more detail as the book unfolds.
- The *lowest level of Fig. 2.1* depicts the different eras and timeframes over human existence from the Pliocene Era some 4 million years ago to the modern era today.
- The *middle level of Fig. 2.1* depicts the evolution of the major human species in the hominid family tree from *Australopithecus anamensis* to *Homo sapiens*.
- The *top level of Fig. 2.1* shows the evolved human attributes at different stages of evolution and in particular the socio-cognitive abilities that emerged following the expansion of brain volume and working memory. Human cognition began with consciousness more than 1.8 million years ago. This was followed by a long period of time when various cognitive abilities, such as abstract and strategic thinking, emerged in *Homo sapiens* some 500,000 years ago. Information behavior emerged in early humans during the Late Pleistocene Era building on previously evolved cognitive abilities.

In general, Figs. 2.1 and 2.2 show that information behavior is an evolved behavior with biological and cultural aspects, and is also an instinctive and

socio-cognitive ability that evolves over a human lifetime enabled by human cognitive and social behaviors with affective, individual/collaborative, multitasking and coordinating dimensions, an information ground dimensions, and made-up of sub-processes including information seeking, foraging, sense-making, organizing and using. We now examine each figure in more detail.

Figure 2.1 begins our thinking about how information behavior originated and evolved as we first explore the origins of behavior in early humans. Human behavior originated in early humans and over time their cognitive abilities were enhanced with brain volume expansion that enabled enhanced cognitive abilities (Coolidge & Wynn, 2007).

Many neuroscientists, evolutionary psychologists and cognitive archaeologists are researching human evolution and the neuro-evolution in early humans that enhanced their cognition abilities (Chase & Dibble, 1990; Dennett, 1995; Geary, 2004). Over various early human species, humans' cognitive abilities expanded to include language, abstract thinking and strategic thinking. As part of their brain neuro-evolution early humans gradually developed an instinctive socio-cognitive ability to engage in information behavior.

This chapter provides a general overview of human evolution and shows the cognitive skills that emerged in early humans. In Chap. 3 we explore in more detail the evolution of information behavior. We now discuss the models in more detail, beginning with an overview of the major human species depicted in the lower level of Fig. 2.1.

Human Species

To explore the fundamental question – *What species of early humans first displayed information behaviors?*, we need to understand more about the various human species that emerged over the millennium. We first briefly explore the origins of humans on planet earth to lay the ground work for our discussion in Chap. 3 of how information behavior developed in early humans.

Early Human Species

The earliest microscopic life on earth has been dated to between 3.9 and 4.4 billion years ago (Abramov & Mojzsis, 2009). Based on the paleontological evidence that early humans emerged from the African Pliocene Era more than 4 million years ago, the earliest human species were genes Australopithecus (Aiello, 1993; Allworth-Jones, 1993; Brauer, Yokohama, Falgueres, & Mbua, 1997; Finlayson, 2004; Mithen, 2007; Rightmire, 2008).

This book does not provide a detailed overview of human history, including human origins and cross-species comparison. However, we can point to the thinking in comparative neurobiology about the origins and uniqueness of early

humans compared to other species such as chimpanzees in cross-species comparison (Boesch, 2007; Geary, 2004).

Figure 2.1 is not an exhaustive overview of all human species, Geary (2004) and McBrearty and Brooks (2000) provide more detailed overviews of the transitions between previous human species. The number and nature of all past human species is still unknown. However, it is generally believed the earliest human species *Australopithecus ananmensise* merged some 4 million years ago and other human species evolved over time including *Homo erectus* about 1.8 million years ago (Andrews, 1984; Finlayson, 2004; McHenry, 1994; Wood & Collard, 1999).

Homo sapiens

The first human species we currently have with evidence of information behavior abilities are *Homo sapiens*. We are yet to have evidence of an information behavior ability in earlier human species. A reason for this may be that early human species before *Homo sapiens* had not yet experienced what the evolutionary researchers call the "neuro-evolution" or brain volume expansion that lead to the development of more enhanced cognitive abilities, such as language, abstract thinking and information behavior.

Scholarly arguments rage about the European versus African origins of early humans and the development of the human species from the species pre-*Homo erectus* to the modern species *Homo sapiens* (or modern humans) (McBrearty & Brooks, 2000; Stringer, 2002). Research does show how *Homo* species exhibited major changes over time in facial structure and brain size compared to earlier human species (Geary, 2004). But little evidence has yet revealed that these earliest human species had the cognitive abilities of later *Homo sapiens* or that they displayed information behavior abilities.

Four major *Homo* human species evolved during the Pleistocene era (1.8 million to 10,000 years ago) including *Homo erectus*, *Homo heidelbergensis*, *Homo neanderthalensis* and to finally *Homo sapiens* (Stringer, 2002). Many interesting books and papers by paleontologists, archeologists and others identify the current known characteristics of these various human species, including:

- *Homo erectus* (Bettis et al., 2009; Coqueugniot, Hublin, Veillon, Houet, & Jacob, 2004; Geary, 2004; Krantz, 1995; Parker, 2000),
- *Homo habilis* (Miller, 1991; Tobias, 1987),
- *Homo heidelbergensis* (Rightmire, 1998), and then
- *Homo sapiens* (Collard, 2002; Donald, 1991).

It's at the point in human evolution with the emergence of *Homo sapiens* and their enhanced socio-cognitive abilities that we begin to see the emergence of information behavior. Although the evidence is not yet extensive, it seems that this is the time period for further exploration for evidence of information behavior. We need

to explore if information behavior was limited only to *Homo sapiens* or was also present in *Homo neanderthalensis*.

Scholars also continue to argue about the cognitive capabilities and reasons for the extinction of many human species, including *Homo neanderthalensis* (Adler et al., 2008; Delson & Harvati, 2006; Holloway, 1985; Klein, 2000; Stringer, 1992, 2001a, 2001b, 2002; Weiss et al., 2004). The reasons for extinction include not surviving environmental changes between ice and non-ice ages, lack of adaptability to competitive changes and competition from other human species such as *Homo sapiens*.

In particular, the characteristics of *Homo neanderthalensis* and how they differed, from or were similar to, *Homo sapiens* is being extensively debated (Asfaw et al., 1999; Bocquet-Appel & Demars, 2000; Cole, 2008; Eren, Greenspan, & Sampson, 2008; Finlayson, 2004; Harvati & Harrison, 2006; Hayden, 1993; Mellars, 1996, 1998, 1999; Mithen, 2007; Rightmire, 2008; Wynn & Coolidge, 2004, 2007).

The latest papers in the debate argue that *Homo neanderthalensis* engaged in conceptual thinking not indistinguishable for modern humans (Wynn, Coolidge, & Bright 2009). Whether *Homo neanderthalensis* exhibited information behavior is still an open question. We may need to wait for further fossils and artifacts to emerge from the *Homo neanderthalensis* era before making any further conclusions.

How and why human species differed and when an information behavior ability first emerged is major ongoing research issue. At this point, information behaviorists must deal with the fact that currently scholars can't even agree on the number and variety of human species that may have existed. Arguments are also raging about the validity of early human remains that may be new species from the Lower Pleistocene (1.8 million years ago) found in Atapuerca Spain as a possible ancestor for *Homo neanderthalensis* and modern *Homo sapiens* (Bermundez de Castro et al., 1997).

New Human Species

In addition, the recently found remains of an early human, known as *Homo floresiensis*, were discovered in Indonesia (Argue, Donlon, Groves, & Wright, 2006; Brown et al., 2004; Richards, 2006). This discovery has generated heated debate about what constitutes a new human species. Archaeological and anthropological research is constantly updating what we know about early humans, and providing new insights into the various human species that existed during the Pleistocene Era (1.8 million to 10,000 years ago).

We also have differing time scales for the origin and dispersal over time of different human species (Crow, 2004; Geary, 2004; Kimbel, 1991; McBrearty, 1990; Stringer, 2002). For example, *Homo erectus* may have lived till 26,000 years ago and *Homo neanderthalensis* till 30,000 years ago (Geary, 2004). However, scholars still disagree on these issues.

The latest thinking on the cognitive differences between the various human species are well summarized by Mithen (2007). He compares artifacts created by different human species and concluded that "the minds of *Homo habilis*, *Homo*

heidelbergensis, and *Homo neanderthalensis* appear to have been very different from each other as well as from that of modern humans" (p. 289).

Expanded Cognitive Abilities

This book does not provide a complete overview of the human species debate. However, because our focus is on information behavior we now explore the latest research on the "neuro-evolution" or the brain volume expansion in humans that occurred when various later human species such as *Homo sapiens* gradually cognitively evolved an assembled package of instinctive, socio-cognitive abilities (Kennedy, 1984; McBrearty & Brooks, 2000; Mithen, 2007; Tobias, 1987). This seems to be the time in human development when we start to see evidence of information behavior emerging in early humans along with other cognitive abilities.

The next section focuses on looking more closely at the latest thinking on the expansion of cognitive abilities in early humans that emerged in *Homo sapiens*. Information behavior was one attribute in a package of cognitive abilities that gradually emerged in *Homo sapiens* due to brain volume expansion as depicted in Figs. 2.1 and 2.2.

Brain Volume Expansion

Brain volume expansion Figs. 2.1 and 2.2 highlight the importance of brain volume expansion and enhanced working memory in early humans. They form the basis of the Fig. 2.1 timeline and part of the evolved foundation in Fig. 2.2.

Based on many studies measuring various early human brains from different species, the effect of an increase in brain volume is being researched by scholars in anthropology. Hodgson and Helvenston (2006) argue that "the organisation and evolution of the brain is beginning to provide clues as to how, why and when certain crucial behaviors may have arisen in hominins" (p. 3).

The latest research suggests that an increase in brain volume with an accompanying gradual accumulation of various cognitive abilities was a major factor in the neuro-evolution from early humans to *Homo sapiens* (Hodgson & Helvenston, 2006; Wynn & Coolidge, 2005).

The latest findings of enhanced socio-cognitive abilities in early humans are based on fossil studies that show brain volume expansion led to the development of consciousness and enhanced socio-cognitive abilities occurring over a long period of time:

- The first major human brain expansion occurred from about 2.5 to 1.8 million years ago in *A. africanus* to *Homo habilius* and is associated with a genetic mutation that resulted in masticatory muscle reduction in humans (Holloway, Broadfield, Yuan, Schwartz, & Tattersall, 2004);
- *Homo habilius*, about 1.8 million years ago, had rudimentary language and the ability to learn how to learn (Miller, 1991; Tobias, 1983a, 1983b);

- A small brain volume expansion occurred from 1.8 to 0.5 million years ago from *Homo habilius* to *Homo erectus*;
- Modest brain volume expansion from 0.5 to 0.1 million years ago occurred from *Homo erectus* to *Homo sapiens*, including facial structure changes that enabled a cranial, neocortex and frontal lobe size increase.

The final major expansion in brain volume emerged from the increased number of cortico-cortico association pathways that were created in the brain which enhanced (gradual or otherwise) cognitive capabilities. The impetus for brain volume expansion in early humans over time is still being debated by scholars. Animal eating is suggested as an important factor responsible for brain volume expansion and enhanced cognitive capabilities (Aiello, Bates, & Joffe, 2001; Aiello & Wells, 2002; Ardrey, 1976; Gamble, 1999; Lee & Devore, 1968; Martin, 1983; Robinson, 1963; Vasey & Walker, 2001). Those early humans who were able to perceive and identify animals most effectively stood more chance of survival and thus passed on the benefits accruing from eating animals (Armstrong, 1990). An increase in fatty acid consumption is also suggested as a factor in brain volume expansion (Crawford, 1992; Crawford et al., 1999) or an increased ability to extract food and enhanced ecological dominance (Kaplan & Robson, 2002) and social selection pressure (Geary, 2004).

Working Memory Expansion

Wynn and Coolidge (2001, 2008a, 2008b) propose that brain volume increase led to working memory expansion and enhanced cognitive abilities. Working memory capacity is the ability to hold various pieces of information simultaneously and use them for further processing (Coolidge & Wynn, 2001, 2004, 2005, 2006a, 2006b, 2007). Enhanced working memory is projected to have occurred between 150,000 years ago (thus creating modern *Homo sapiens*), or 100,000 years ago i.e., after *Homo sapiens* had evolved anatomically. Enhanced working memory underpinned the development of human cognition (Baddeley, 2001; Baddeley, Chincotta, & Adlam, 2001; Martin-Loeches, 2006).

Enhanced working memory (EWM) led to a mutation that distinguished *Homo sapiens* from *Homo neanderthalensis*, and enabled *Homo sapiens* to develop managed foraging systems and ultimately agriculture (Bearman, 2007; Wynn & Coolidge, 2001, 2003, 2004). The working memory expansion led to the emergence of various cognitive abilities in early humans. These evolved cognitive mechanisms included specializations based on the enhanced information processing capability of the human brain.

We now examine more closely the expanded cognitive abilities that are projected to have emerged in early humans. The latest research points to a gradual brain volume expansion due to various factors and an accompanying expansion of cognitive abilities evidenced in fossil remains. Brain volume expansion had consequences for the physiology and cognitive abilities in *Homo sapiens*, including the development

of a range of cognitive abilities based on a human motivation to control (Geary, 2004) and a drive for ecological dominance (Alexander, 1990c) using abilities for social complexity, competition, cooperation, and also information behavior.

The fossil record suggests that the increase in *Homo sapien* working memory capacity resulted in enhanced cognitive abilities through gradual increase in cognitive sophistication over a substantial period of time (McBrearty & Brooks, 2000). In addition to cognitive abilities, socio-cognitive abilities developed that supported human social dynamics and co-evolving traits (Geary, 2004).

The African archaeological record shows the transition to modern human behavior during the later Middle Pleistocene Era (500,000 years ago) was due to biological and cultural change, and increased knowledge sharing (Ambrose & Lorenz, 1990; Bar-Yosef, 1998). Scholars continue to argue about the degree to which this development resulted from genetic versus environmental factors and the degree to which the brain is modularized (Geary, 2004; Geary & Huffman, 2002).

Emerged Cognitive Abilities

As depicted in Fig. 2.1 enhanced cognition and language began to develop in early humans around 100,000 years ago (Early Pleistocene Era) after brain volume expansion and working memory development.

Figure 2.1 shows that before early humans such as *Homo sapiens* developed enhanced cognitive abilities, earlier human species developed consciousness, hunting and eating animals, and levels of human cognition (Donald, 1991). Consciousness takes many forms, but the latest thinking describes consciousness as the integration of local and global brain capabilities including subjectivity, sentience, primary consciousness and similar designations (Zelazo, Moscovitch, & Thompson, 2007).

Tension exists between scholars with different viewpoints on the relationship between the mind and body, and how the mind developed in early humans (Becker, 2008; Laureys & Tononi, 2008; Revonsuo, 2009). Scholars are still debating what consciousness is and how it developed in early humans.

Socio-Cognitive Abilities

McBrearty and Brooks (2000) claim that the cognitive expansion in early humans was a "fundamental behavioral shift … purported to signal a socio-cognitive advance, as possible reorganization of the brain, and the origin of language" (p. 453). Figure 2.1 shows that the expansion of cognitive abilities in early humans, included language, foraging and problem-solving skills, emerged after thousands of years of cultural, cognitive and biological transformation. Some scholars argue that cognitive evolution in early humans emerged abruptly (Wynn & Coolidge, 2005) and some argue for a more gradual development (Allworth-Jones, 1993).

The latest anthropological and evolution-based research points to a non-linear development of the enhanced cognitive abilities in early humans that was most fully developed in *Homo sapiens* (Benzon & Hays, 2006; McBrearty & Brooks, 2000).

Factors such as brain volume expansion and reorganization led to the cognitive enhancement in *Homo sapiens*. But this process is not yet well understood (Wynn & Coolidge, 2004).

Mithen (1996), and Locke and Bogin (2006) suggest that the development of language, as part of the cognitive development in early humans, also led to the elongation of childhood over about 2 million years. They argue that, in addition to brain volume expansion, the lengthening of childhood had an impact in the early human development of enhanced cognitive abilities.

Figure 2.1 shows that enhanced cognitive abilities that emerged in *Homo sapiens* are now key aspects of "modern" human behavior, including (Barrett, 2008; Bridgeman, 2003; Brooks, 1996; McBrearty & Brooks, 2000):

1. Abstract thinking – not limited in time and space
2. Planning – strategic thinking and increased geographic range
3. Behavioral, social, economic and technological innovation and organization
4. Symbolic behavior – use symbols in cultural settings

These cognitive abilities included an ability to integrate action across time and space, and holding a variety of information in active attention. *Homo sapiens'* larger brains allowed the development of: more complex social competencies and relationships, high levels of parental involvement, sexual selection and male-male competition, a long human development period and longer adult span of life. Selection pressures, such as climate, ecology and social changes also affected the development of *Homo sapiens* (Geary, 2004).

In particular, *Homo sapiens* developed cognitive abilities for ecological dominance over other species (Alexander, 1989, 1990c) or a motivation to control (Geary, 2004) through cooperation and competition. Humans possess many traits, but only a small group of traits, either physical (morphological) or cognitive, are adaptations or traits that evolved because they had effects favored by natural selection. Increased cognitive capabilities gave the *Homo sapiens* the advantage of innovative behavior, with the ability to see new ways of doing things, to recognize and react to novelty in their environment, and to concentrate on goals sets that were innovative and counter to the habitual way of reacting to stimuli.

Donald's (1991) also points to the role of brain enhancement in the "Mimetic Culture" of *Homo sapiens* with tools development and the integrative modeling of humans by humans. The evolution of consciousness (Bjorklund & Rosenberg, 2005; Butler, 2008; Donald, 2001), the physiological brain size expansion, and enhanced working memory contributed to *Homo sapiens'* enhanced cognitive abilities. Behavioral changes lead to a creative explosion, social networking, and the "great leap forward" (Mithen, 1996).

The advantages of enhanced socio-cognitive abilities included the development of new skills such as tool production, agriculture, paleoart (Appenzeller, 1998)

and information exchange with other humans (Hammerstein, 2003; Mellars, 2002). Learning involved in the skills of hunting and gathering provided some impetus for the development of abstract thinking, increased capacity to mimic their world; enhanced ability to sort by categories, evolving a sophisticated system of neural structures that facilitate perception, problem solving, decision making and language (Deacon, 1997; Holloway, 1983).

Information behavior also emerged as an advanced socio-cognitive ability related to other socio-cognitive abilities such as hunting and gathering, and later agriculture. Successful hunting and gathering requires information behavior abilities, including the ability to collect, store and use information about the animals hunted, the plants gathered, the timing of the seasons, changes in weather and temperature, and passing information to future generations.

With a base of knowledge about human cognitive origins provided by this chapter, in Chap. 3 we specifically explore the cognitive origins of information behavior in early humans.

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Chapter 3
Evolutionary Foundation

> *Thus, during our evolutionary history, hominins and finally Homo sapiens became biologically predisposed to certain kinds of learning that lead to particular brain systems specialising in the detection of natural categories, such as knowledge of animal behavior and assorted other biologically important information (Mahon* and *Caramazza, 2003).*
>
> *(*Hodgson *&* Helvenston, 2006, p. 6)

The quotation above provides some insight into the nature and importance of information behavior for early humans. Information behavior allowed them to learn about the behavior of animals and to create categories of information that were represented in different types of animals depicted in paleoart on cave walls.

To fully develop a theoretical framework for information behavior we need to have a greater understanding of information behavior origins in early humans. A greater understanding of information behavior origins has important implications for models of information behavior specifically and our understanding of human behavior in general. Information behaviors are an everyday activity for all humans when they engage in information gathering, using and organizing. But we know little about how information behavior cognitively emerged in early humans.

In this chapter we approach a very complex topic by building on the previous research into the origins and cognitive abilities in early humans. In the previous chapter we explored the origins and evolution of enhanced socio-cognition abilities in *Homo sapiens*. Building on those understandings we now focus on exploring the origins of information behavior in early humans and in particular we focus on the early human species known as *Homo sapiens*.

Major challenges for information behaviorists are to understand the origins of information behavior, and the role of instinct versus environment in shaping information behavior. In this chapter we explore the cognitive developments that underpinned the emergence of information behavior as an important behavior for early humans.

The key question driving our exploration in this chapter is: *What are the* origins *of information behavior in* early humans*?*

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We saw in Chap. 2 how human development in early humans included the expansion of socio-cognitive abilities that most fully emerged in the species *Homo sapiens*. Based on the previous research from the evolutionary sciences we propose that information behavior is an evolved biological adaptation and cognitive ability that probably first emerged in the human species *Homo sapiens*.

We now examine how and why information behavior, which is universally present in modern humans (Case, 2007; Spink & Cole, 2005, 2006, 2007), emerged in *Homo sapiens* during this period of cognitive ability enhancement. Building on the development of information processing abilities in early human species, information behavior emerged as a cognitive ability that allowed *Homo sapiens* to transform sense data into meaningful information.

As with human behaviors in general, information behavior probably developed gradually over many hundreds and thousands of years as early humans began to make sense of their environment and solve information problems through increased awareness and manipulation of their environment. Humans' evolved an information behavior instinct that included such sub-processes as information seeking, foraging, sense-making organizing and using. These information-related sub-processes became part of human nature, including information gathering and using mechanisms (Coe, 2003; Kaplan, 1992; Tooby & Cosmides, 1989).

Both Figs. 2.1 and 2.2 show a number of major contributing factors that underpinned the emergence of information behavior in early humans, including the presence of information processing capabilities, survival and reproduction pressures, motivation to control motivation to control the environment, and language capabilities. These contributing factors laid the socio-cognitive ground work for *Homo sapiens* to begin to develop and test their information behaviors.

For example, adopting information behaviors such as creating cave art to store animal images reduced the uncertainty early humans may have experienced when planning to hunt for animals. Information behavior abilities help to reduce human feelings of uncertainty and enhance the ability to plan for the future.

Evolved Behavior

Information behavior is an evolved cognitive mechanism in the same way that language is an evolved cognitive mechanism. Both are fundamental human traits that exist in all cultures. In Fig. 2.2, the most fundamental level of information behavior is the *Evolutionary Foundation Level*. Blumberg (2005) refers to evolved cognitive mechanisms as having both instinctive and environmental dimensions. Information behavior is an evolved behavior as evolutionary forces shaped the origin and emergence of information behavior in early humans. This influence continues today in the information behavior of modern humans. Evolutionary selection and social pressures drove the cognitive changes and the development of information behavior.

To more fully understand information behavior we need to further apply the basic principles of the evolutionary sciences to explore the origin, adaptation and the

contemporary nature of information behavior. This involves understanding the genetic and environmental evolved cognitive mechanisms that underlie the development of information behavior. Learning more about other evolved cognitive mechanisms and how they evolved will help us understand information behavior.

In addition to being an evolved cognitive mechanism, information behavior is also a biologically primary ability. Obviously a biologically primary ability is an evolved mechanism and such evolved cognitive mechanisms are universally experienced by all humans which is a biologically primary ability. Therefore, we see a strong overlap between the contributing factors that underpinned the emergence of information behavior. We now look in more detail at what we mean by biologically primary ability.

Biological Primary Ability

For Geary (1995) a biologically primary ability is an evolved cognitive mechanism that is universally present in all humans in all cultures. Information behavior is a biologically primary ability that is universal and present in all human cultures. This is a key fundamental characteristic and contributing factor underpinning the emergence of information behavior. As a biological primary ability, information behavior is similar to language in being universal and present in all cultures. But in many respects information behavior may be more universally similar in all humans than language which varies in lexicon between different languages. Our processes of information behavior are not as varied in humans as all humans engage in information seeking, foraging, organizing and using.

What differs culturally for humans and their information behavior are the artifacts that humans use in different cultures or societies to support their information behavior, whether it's the Web or libraries, etc. But one could argue that over the last 20 years with the growth of the Web around the world that the differences in artifact use to support information behavior may eventually disappear. In addition to being an evolved cognitive mechanism and biologically primary ability, information behavior is underpinned by its existence as a genetic adaptation.

Genetic Adaptation

Evolved cognitive mechanisms are also described as an evolved psychological or genetic adaptations and traits (Geary, 2004). Our framework includes information behavior as an evolved cognitive mechanism in the form of a genetic adaptation and trait. Adaptationism is a strategy that seeks to identify outcomes of selection and to elucidate the specific selection pressures that forged them in an organism's evolutionary past. A morphological or psychological mutation may produce an effect on an individual's traits that gives that organism a reproductive advantage over other individuals in a population.

A *trait* is any relatively stable aspect of the phenotype that can be discriminated based on any criterion – its causes, its effects, its manifestations, etc. This includes a predisposition to engage in a behavior under some specified conditions. These traits include adaptations that have effects that interact with the environment. For example, language can produce conversations. Traits develop over a human lifetime and are affected by experiences and developmental events. Behaviors and psychological processes regulate a human's interactions with their environment.

Genetic adaptations and traits, such as information behavior, evolve as genes that affect their development evolve. Information behavior evolved as a psychological adaptation for the function of enabling humans to gather, organize and use information. Humans with developed information behaviors were favored by natural selection processes. As a particular trait, information behavior had beneficial effects and by-products for human survivability and exhibits particular special design and allowed the performance of the function effectively. For example, human eyes are a morphological trait evolved for the function of seeing.

Information behavior is only possible because of mechanisms that evolved specifically to enable humans to engage in that behavior. Examining information behavior as a specialized cognitive mechanism enables us to see that being able to engage in information gathering, organizing and using behavior would be advantageous for an early human in cooperating and competing, and underpinning the human motivation to control their environment.

Controlling one's environment is important in social interactions and adjusting one's behavior to take advantage of changing conditions. Information behavior has clear fitness benefits that gave humans an advantage over animals in hunting and gathering. Not having a specialized cognitive information behavior mechanism would disadvantage an individual in the presence of those with well-developed abilities.

Specifically, we propose that information behavior is a genetic adaptation. This is based on the notion that information behavior has an instinctive, genetic and innate basis that represents an adaptation that early humans evolved to cope with the challenges of their environment. Obviously this is a key fundamental that underpinned the evolution of information behavior and relates to many of the other key fundamentals at the evolutionary foundation level. We can also ask how information behavior relates to other genetic adaptations such as language.

Language

Information behavior and language are related instinctive traits. Language is a predominant instinctive trait of the human species (Pinker, 1994). Pinker (1994) says that we know little about how the language instinct evolved in early humans, but he does relate language evolution to natural selection. The human ability to read and write is a key part of our information behavior that is underpinned by language abilities. The ability to conceptualize an information problem and gather, organize

and use information, is tightly bound to our cognitive abilities and our language abilities.

Our information behavior is sometimes expressed in verbal and written acts. Information behavior is not isolated from language development in early humans. Information behavior builds cognitively upon language. They are both instinctive and both rooted in the gradual expansion of cognitive abilities in early humans. Information behavior was further underpinned by the emergence of paleoart, and enhanced by the written word in early humans based on the motivation to control their environment.

We are gathering a complex picture that information behavior emergence in early humans was underpinned by the existence of many contributing factors. Another factor that underpins information behavior is its existence as a human instinct.

Instinct

At a most fundamental level information behavior is also an instinctive ability in all humans. To explore the important concept of instinct more fully a separate chapter was included in the book. Chapter 4 discusses in detail how information behavior is shaped by both instinctive and environmental dimensions. Instinct is also linked to the survival and reproduction pressures experienced by early humans and by people today. The next section discusses how survival and reproduction pressures also underpinned the emergence of information behavior in early humans.

Survival and Reproduction Pressures

Other contributing factors in the emergence of information behavior in early humans were natural and sexual selection pressures. *Homo sapiens* evolved heritable individual differences that were affected by genes and environmental influences (Geary, 2004). Behaviors, such as information behavior, emerged due to the cognitive and social benefits it brought to *Homo sapiens* as they struggled to survive (Alexander, 1989, 1990b).

Natural and sexual selection pressures underpinned the emergence of many human behaviors, such as mating practices, hunting and gathering, and information behavior (Buss, 2008). Being able to seek, organize and use information is an important process that enhances the human ability to find suitable mates, hunt for food and assemble information about enemies and potential safe areas.

Natural selection favors individuals with the social and cognitive competencies needed to undertake successful human behavior. The median heritability values suggest that between 26 and 53% of individual differences in a life history (e.g., age of maturation), physiological (e.g., cardiovascular capacity), behavioral (e.g., mating displays), and morphological (e.g., body size) traits are due to genetic influences (Mousseau & Roff, 1987).

Natural selection processes also favored brain and cognitive abilities that are open to experiential modification. The brain reorganization created specific cognitive specializations, such as information behavior, through new types of interconnections created in the neocortical and subcortial brain regions (Preuss, 2000, 2001). In *Homo sapiens*, increasing cognitive capacity and the use of both tactical and strategic thinking (Weiss et al., 2004) also enabled the development of the cognitive ability to take a perspective (Donald, 1991). One can take a perspective when one is aware of the existence of other perspectives and is aware of others thoughts.

The ability to take a perspective had interesting implications for the development of information behavior in early humans. A cognitive ability to take a perspective enables you to consider and evaluate your environment and make judgments. In addition, an ability to innovate in an environment of uncertainty (Finlayson, 2004) and a strategic thinking ability emerged when *Homo sapiens* were living on the African plains.

Information behavior was achieved by *Homo sapiens* as they cognitively coordinated other cognitive abilities, such as language, problem-solving, planning, etc. An ability to plan and strategically think about the future was important for hunting and gathering, and battling the competition in your environment.

Homo sapiens were also biologically disposed to new kinds of learning that led to the development of specific brain systems specializing in the detection of natural categories, such as knowledge of animal behavior and assorted other biologically important information (Aiken, 1998; Mahon & Caramazza, 2008; Damasio, Grabowski, & Damasio, 1996). One outcome of increased cognitive abilities was the adaptation of the early human brain to cope with visual information through a massive process of cross–referencing. This adaptation led to the emergence of paleoart as an early representation of information behavior.

Cognitive psychologists Pirolli (2007) and Pirolli and Card (1999) also point to the benefits of information behaviors sub-processes such as the ability to information forage. Hunting, foraging and other food acquisition behaviors are also related to the evolution and proximate development of the brain and cognition, and the need to maintain a territory and extract survival-related resources and obtain culturally-valued resources (Pirolli & Card, 1999). Also, cognitive and problem-solving processes are mechanisms that allow humans to mentally represent and manipulate information processed by their sensual and perceptual systems.

We are just beginning to understand how information behavior emerged in early humans as a socio-cognitive ability linked to human need for survival and reproduction. How information behavior enhanced early human survival and reproductive ability is an interesting and important topic in need of further research. The ability to survive and reproduce, as a basic human drive, is also underpinned by a motivation to control the environment.

This theory, first proposed by Geary (2004), and how it also underpinned the emergence of information behavior in early humans is discussed in the next section of the book.

Motivation to Control the Environment

Another contributing factor that underpinned the origin and emergence of information behavior is what Geary (2004) has labeled the human motivation to control their environment. The human motivation to control and dominate their immediate environment was a driving force for human evolution that led to the emergence of socio-cognitive abilities such as language and information behavior (Geary, 2004).

Figure 2.2 situates the human motivation to control their environment is an important contributing factor in the emergence of information behavior within the Evolutionary Foundation dimension. Without such a motivation to control their environment, early humans may not have developed the cognitive connections that allowed them to engage in information behavior. Being able to cognitively undertake information seeking/foraging, making sense, organizing and then using information activities was probably also related to an increased level of confidence that followed a motivation that helped engender a feeling of control.

Early humans evolved a motivation to control their environment including control of relationships, events and resources of significance in their lives. There were many benefits inherent in this early human drive to control one's environment. The evolved disposition to control their immediate environment was important for successful early human survival, control of biological and physical resources, and reproduction (Geary, 2004). However, the motivation to control is also mitigated and constrained by laws, psychological mechanisms such as guilt and social consequences of excessive control mechanisms (Geary, 2004).

Summary

The origins and development of information behavior in early humans is a subject in need of significant further thought and research. An emerging base of understanding is initially grounded in the findings from evolutionary and anthropological research described above. However we are only just beginning to understand more about the origins of information behavior in early humans.

The dimensions that constitute the evolutionary foundations level in Fig. 2.2 provides a basic framework for understanding how information behavior evolved as a cognitive mechanism with many broad attributes and dimensions, including:

- Information behavior is a genetic adaptation and trait
- Information behavior is a biologically primary ability
- Information behavior is shaped by instinctive and environmental factors (discussed in Chap. 4).
- Information behavior enhanced early human survival and reproductive success
- Information behavior emerged as a cognitive mechanism that enhanced early humans' ability to control their environment.

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Chapter 4
Instinct Versus Environment

> *Armed with a recalibrated notion of inheritance and an expanded appreciation of development, the true nature of instinctive behavior reveals itself.*
> (Blumberg, 2005, p. 224)

Blumberg's words provide a valuable insight into the latest thinking on the role of instinct and environment in determining human behavior. A key issue for human behaviorists is examining how instinct versus environment shape human behavior (Blumberg, 2005). The concept of behavior and the role of instinct and what it means has been a major debate in the behavioral sciences.

Currently in the behavioral sciences instinct is generally understood as the innate part of behavior that emerges without any training or education in humans. Much of human behavior is seen as having a major instinctive basis including language that Pinker (1994) asserts is instinctive in humans. In addition to language, another example of an instinctively-based behavior is sucking behavior by babies. Babies engage in sucking behavior that generally emerges unprompted, although some babies have problems with sucking. So sucking is an innate or instinctive behavior.

Within the framework of the behavioral sciences, this chapter explores the instinct/environment attribute in Fig. 2.2 and the role of instinct versus environment in shaping information behavior.

We can ask – *what are the instinctive and environmental dimensions of information behavior*?

We also explore how humans developed an "information behavior instinct". Information behavior is a cognitive process that is not taught, but is innate to humans to the point that people are able to consciously understand that they need to undertake behavior processes of information finding, organizing and using to make sense of their environment. So how can we understand more about this important information behavior instinct?

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Instinct Versus Environment Debate

To help frame our understanding of information behavior we first explore the history and latest thinking on the role of instinct and environment in determining human behavior in general. The "nature versus nurture" debate is ongoing in the behavioral sciences and continues to be an exciting and fundamental point of ongoing scientific dispute. From Charles Darwin to William James to Sigmund Freud to Konrad Lorenz to Mark Blumberg, scholars from different scientific disciplines have argued about the nature and the role of instinct in determining behavior. And this important debate continues today.

The history of the behavior debate generally fall into two different views.

- The *nativist view* believes that all aspects of human behavior are instinctive and humans have inbuilt instinctive behaviors that are genetically determined. Blumberg (2005) describes the nativists as those who "fervently believe that we are born with certain core capabilities and knowledge that provide the basic structure for much of what we continue to learn throughout our lives" (p. xii).
- The *human development view* believes that not all aspects of behavior are instinctive and behavior is also affected by culture and environment. Blumberg (2005) says that "on the other side of this debate are those who believe with equal passion that the instinct concept has outlived its usefulness and that its application to human infants by nativists only retards our understanding of human development" (p. xii).

Debate over the Centuries

Understanding more about the diverse instinct versus environment views allows us to explore information behavior in the context of this important debate. The debate about behavior has evolved over the centuries with insights from different scientific thinkers. This debate led to changing approaches to understanding human behavior within the social and behavioral sciences.

The following brief background on the debate and the current thinking provides a foundation for understanding information behavior. We need to understand the issues surrounding the instinct versus environment debate to bring our thinking on information behavior more strongly into the realm of the behavioral sciences. This provides the basis for our understanding that humans have an instinctive capacity for information behavior that evolved to support the human motivation to controlmotivation to control (Geary, 2004).

Pre-nineteenth Century Debate

The role of instinct versus environment in determining behavior has been the crux of a broad and sweeping ongoing debate for many centuries. The debate evolved as

scientific fields such as psychology emerged in the nineteenth and twentieth century. However, many centuries ago in Ancient Greece, behavior and instinct were already topics of philosophical thought. Aristotle believed that each species had a place in the hierarchy with God at the highest point and Plato wrote about the hierarchy of men in nature.

Other pre-eighteenth century debaters included Condorcet, Lyell, the philosopher Immanuel Kant and Charles Darwin's grandfather Erasmus Darwin. In addition, Lamarck wrote about human inherited characteristics via evolution and Malthus discussed how species are formed and change, and individuals compete for resources.

Blumberg (2005) provides a good discussion of the debate from the eighteenth century writings of David Hume to the thinkers of today. To briefly summarize the key developments in our understanding of behavior in the pre-1920s era we begin with David Hume who stirred the debate in a profound way by questioning the role of God and design in human behavior in his 1776 paper *Dialogues Concerning Natural Religion*. This work was a major criticism of the role of God, and engendered severe response from the church.

Many of the issues concerning the role of instinct and environment in determining behavior also emerged more strongly in the work of Herman Samuel Reimanus who saw instinct as beyond skills implanted by God to patterns of animal behavior due to innate psychological organization (Richards, 1977).

Nineteenth Century Debate

Following the lead from Hume, Huxley, Spencer, Spalding, Weismannism Weismanism (Burnham, 1972) and others, Charles Darwin in *Origin of Species by Means of Natural Selection* (1859) and Adam Smith in *Wealth of Nations*, also criticized the "design by God" view of behavior and laid the foundation for the emergence of evolution as a key driver of future theories.

Darwin's theory of sexual selection proposed adaptation which emerged as a result of competition and sexual survival. He followed the *Origin of Species* with a second book *The Descent of Man and Selection in Relation to Sex* in 1883 that expanded on his previous propositions about human behavior and evolution. However, despite his generative theory of natural selection that lead to social change, in his writings Darwin did not define what he meant by instinct.

In the post-Darwin debate many scholars focused more sharply on the role of instinct in determining behavior and what is meant by human instinct. Romanes discussed how instincts evolved via two routes: primary instincts that emerge from natural selection to benefit the organism and instincts that emerge as habits or permanent instincts (Dewsbury, 1993). Lloyd Morgan (1885) tried to move the debate along by discussing the differences between the many approaches to the role of instinct versus experience in determining behavior.

By the late nineteenth century the three schools of thought on instinct were: (1) instinct as a reflex view, (2) instinct as intuition view and (3) instinct as a predisposition view (Herrnstein, 1998). The *reflexive view*, broadly advocated by

Morgan, Spencer, Watson and Loeb, saw instinct as a reflex called forth in humans by determinate sensory stimulus (Herrnstein, 1998).

Alternatively, James, Fabre and others saw instinct as a *vague special capacity for behavioral adaptation*, which as William James (1980/1983) in the 1890 work *Principles of Psychology* asserted, are modified by experience. William James suggested that instinct was an essential and dynamic part of the human mind (Dewsbury, 1993). He also saw a psychology of consciousness as a foundation for instinct and the variability of instincts. Dewsbury (1993) provides an overview of William James's instinct theory and his antecedents including Spalding and Darwin, and James' influence on later instinct thinkers.

The *predisposition view* of William McDougall and others saw instinct as innate tendencies to certain kinds of human actions and the sole source of human motivation (Ginsberg, 1931). In addition, Richards (1977) paper also traces the development of the instinct versus environment debate from Darwin to C. Lloyd Morgan, Romanes, McDougall to Lorenz.

Twentieth Century Debate

By the 1920s the previous views of instinct were replaced by Sigmund Freud's psychological drive theory. Specifically, instinct was now seen as an invariant core and building block of behavior, and as a stimulus to a response following distinct psychological pathways.

Konrad Lorenz

By the 1930s Konrad Lorenz's (1965) proposed a theory that claimed a strong dichotomy between instincts and experience as the basis of human behavior (Brigandt, 2003, 2005). His behavioral theory had three components; an appetitive behavior motivated by internal accumulation of readiness for specific action precedes the release of an innate behavior pattern; an innate releasing mechanism that disinhibits the innate reaction; and the purpose of the action is the discharge of the consummatory act (Richards, 1974).

For Lorenz, instinct was one part of a behavioral pattern consisting of mutually exclusive sequences of innate and learned or experience components. In addition, Lorenz saw the innate component of behavior as instinctive and not modifiable, and the learned or experience component of behavior as not related to the innate component. For Lorenz, instinct and experience were exclusive, and instinctive behavior did not evolve into what he called more flexible behavior.

Despite agreeing with Freud that instincts are the basis of behavior, Lorenz argued that human behavior resulted from the biological basis of neurobiological stimuli not Freud's claim of psychological drives. However, despite his views, Lorenz never really addressed how human behavior develops (Brigandt, 2003, 2005). Griffiths (2004) provides a more detailed overview of Lorenz's views and his critics including Lehrmann (1953) and Haldane (1956).

By the 1930s Ginsberg (1931) saw instinct as covering "those forms of behavior consisting of a series of inter-related acts which (1) are directed towards an end goal, (2) exhibit a certain adaptability and persistence with varied effort which might connote intelligence, but which (3) are performed in circumstances in which, in the absence of experience, and taking into consideration the level of mentality otherwise attained by the organism in question, there can be no knowledge of the end nor deliberate and conscious contrivance on the part of the individual" (p. 30).

In the 1950s Tinbergen (1951) explored instinct in young animals and examined how they performed behaviors despite no previous experience and suggested four causes of behavior: (1) immediate and proximate causation, (2) function, (3) development, and (4) evolution. In the 1960s cognitivist approaches had begun to reshape the debate with the emergence of ontology as the field examining behavior development and the influence of human development studies.

Late Twentieth Century Debate

In the late twentieth century the debate shifted more strongly towards examining the role of environment in determining behavior. This shift was influenced by scholars such as Wilson (1975/2000) who developed the field of socio-biology and the biological basis for social behavior, and Alexander (1989, 1990c) who proposed an Ecological Dominance and Social Competition/Cooperation (EDSC) model for explaining human behavior as affected by human competition and cooperation.

A more complex view of behavior based on both genes/inheritance, and environment and human development emerged with the growth of genetic research, and developmental and evolutionary approaches to psychology. The view was reflected by Bateson (2000) who highlights the still imprecise understanding of instinct and how instincts can be modified by human experience.

Linguist Stephen Pinker's (1994, 1997, 2003) books including *The Language Instinct* and *The Blank Slate* saw language as instinctive, and that much of behavior is best understood through instinct and the evolutionary forces that shape instincts' genetic foundation. Pinker's thinking on language had a major scientific impact, despite his lack of definition for the concept of instinct (Blumberg, 2005).

Developmental Viewpoint

Building on Pinker, neuroscientist Mark Blumberg reflects the most recent view that instinct is an important element for understanding behavior, however, "advances in our understanding of behavioral development are reshaping the meaning of instinct" (Blumberg, 2005, p. 85). Behavior is now seen within an evolutionary and developmental framework with "a recalibrated notion of inheritance and an expanded appreciation of development, the true nature of instinctive behavior reveals itself" (Blumberg, 2005, p. 224).

Behavior has two elements, one *instinctive* and one shaped by *human development* as "inherited environmental and experiential factors that reliably shape

development from generation to generation" (Blumberg, 2005, p. 224). Behaviors are instinctive and that predisposition is then shaped by species-typical and individual experiences. But not all behavior is predetermined in human genes and emerges during human development. Most behavior is initially instinctive and then modified in humans over their course of their life development.

Latest Thinking

The latest thinking underlines Blumberg's view of continuous and inextricable interrelations between genes and the environment in which genes are embedded. Geary (2004) also views behavior as having both instinctive mechanisms that operates at the subconscious level and also a mechanism driven by environmental and developmental influences that shape behavior.

Most recently, developmental psychologists have come to rephrase the debate from "how much" of any behavior is due to instinct versus environment to "how do instinct and environment interact to produce a particular pattern of behavioral development"?

The developmental approach explores how biological and environmental factors at multiple levels of organization transact to produce a particular pattern of ontogeny. From this perspective, new morphological structures or behaviors do not simply arise as a result of the reading of the genetic blueprint but emerge as a result of the continuous and bidirectional transaction between all levels of biological and experiential factors, from the genetic through the cultural.

Behaviors such as cooperation, sexual behavior, child rearing and aesthetics are seen as "evolved psychological mechanisms" (Buss, 2008; Dickens & Cohen, 2003; Geary, 2004) with an instinctive basis but environmental influences on their development. Evolutionary psychology and behavioral genetics are providing news insights into many behaviors, and led to the development of behavioral economics (Dickens & Cohen, 2003).

Key challenges for the behavioral sciences are to understand the origins of human behaviors, map the genetic, environmental and developmental influences on human behavior, and illuminate the social policy implications.

Shaping Information Behavior

Based on the latest view of behavior, we can understand information behavior as being shaped by an instinctive (genetic) basis that is affected by environmental, cultural and developmental factors. An individual's information behavior is determined by both instinctive and environmental dimensions. Humans consciously realize that they have an information behavior ability that is instinctive. Information behavior is universal to all humans and cultures and therefore has an instinctive dimension.

However, we must also recognize and explore the experiential, environmental, developmental and cultural influences that shape information behavior. Information behavior involves the interrelations between genes and the environment. The

challenge for information scientists is to understand how instinct and environment interact to produce information behavior.

Instinctive Dimensions

We initially asked how information behavior is shaped by instinctive versus environmental factors. Instinctive dimensions form the core of information behavior with instinctive mechanisms operating at a subconscious level. Information behavior is instinctive to humans to the level that they do not generally think about it; it develops during childhood with the development of other cognitive abilities, and is not explicitly taught to children.

Humans' instinctively know how to go about putting together a series of subprocesses such as information finding, organizing and using. They realize that they need to resolve an information problem by seeking out an information artifact such as the Web, or even talking with another person. A person may realize that they have a set of data that needs to be organized, collated and categorized. The results are then used to complete a task. This process that moves from gathering, to organizing and using, is instinctive.

Environmental Dimensions

Information behavior emerges instinctively in humans, but is further then shaped by environmental and cultural dimensions. How humans find, organize or even use information, and the artifacts they use to support their information behaviors are shaped by many factors. For example, a child in a developing country may little formal classroom education, but has information finding, organizing and using abilities that are shaped by language, cultural and political processes. If the child cannot read (is illiterate), has no access the artifacts such as libraries or the Web, and has little food – these attributes will shape the way the child can use their information behavior.

Mapping and understanding more about how these environmental dimensions shape information behavior and people's abilities to use their information behaviors is an interesting area of further research. These dimensions are quite complex and inter-related with many cultural aspects. Such research would also need to use both psychological and sociological research to most fully develop a theoretical framework for environmental factors and how they interact with the instinctive dimension.

Summary

This chapter brings our understanding of information behavior into line with the general thinking on behavior and instinct in the behavioral sciences and provides a basis for further research into the instinctive and environmental aspects of

information behavior. It also expands the intellectual and research horizons for information behaviorists who have largely focused on limited modeling of contemporary information behavior and information seeking as problem-solving or sense-making (Case, 2007; Spink & Cole, 2005). Limited focus has framed information behavior as both affected by environmental and instinctive factors.

We can now move forward with an important understanding in hand – *information behavior has an instinctive basis but is also affected by environmental and developmental factors*. This view is grounded in the latest thinking on human behavior and is an important element in our theoretical framework for information behavior. The next chapter explores in more detail information behavior as a human cognitive and social behavior.

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Chapter 5
Human Cognition and Social Behavior

> *Humans had in some unique fashion become so ecologically dominant that they in effect became their own principal hostile force of nature, explicitly in regard to evolutionary changes in human psyche and social behavior.*
>
> (Alexander, 1990b, p. 4).

> *Combining the cooperation-to-compete hypothesis with the notion of the brain as a social tool allows us to pursue more effectively the understanding of both unique and unusual human traits.*
>
> (Alexander, 1990b, p. 12)

Alexander's words set the scene for exploring more about the broad nature and attributes of information behavior. In previous chapters we explored how information behavior emerged in early humans as an evolved cognitive mechanism with instinctive and environmental dimensions underpinned by a motivation to control the environment. We now focus more closely on the human cognitive and social level in Fig. 2.2 that highlights information behavior as a complex phenomenon with many broad attributes and dimensions that we are only just beginning to understand.

Information behavior has various dimensions at the human cognitive and social behavior level, including;

- Information behavior is a biologically secondary ability
- Information behavior is a form of human intelligence or "information intelligence"
- Information behavior has multitasking and coordinating dimensions
- Information behavior is a socio-cognitive ability
- Information behavior is underpinned by information processing
- Information behavior has affective dimensions

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Biological Secondary Ability

Information behavior can also be understood within Geary's (1995) behavioral framework as a biologically secondary ability. Within Geary's (1995) perspective on *biologically secondary abilities*, such as reading, are culturally specific forms of cognition. Examples of domains are language or arithmetic that includes more specialized abilities such as language comprehension and counting. "Individual abilities, in turn, are supported by neurocognitive systems and consist of three types of competencies, goal structures, procedural skills and conceptual knowledge (Geary, 1995, p. 25).

Information behavior has attributes of both the biological and cultural influences as a biologically based adaptation with culturally taught skills. Information behavior relies on the functioning of neurobiological systems that evolved in social and ecological niches to support survival and reproduction. These biologically primary abilities such as language can be used for other purposes than their original evolved function. Language is a biologically primary ability, but reading is a biologically secondary ability (Geary, 1995).

Information behavior is complex combination of different biologically primary abilities such as language, information processing, decision-making, etc that are found in all humans. All humans in any culture have the ability to find, organize and use information. However, the creation of artifacts to support information finding, organizing and using behaviors, such as Web search engines or libraries, involves secondary culturally based abilities that includes informal or formal instruction, such as the ability to interact with particular types of computer software.

Information Intelligence

Gardner (1983) first questioned the idea that human intelligence is a single entity with one level of intelligence. For Gardner, intelligence is the human "capacity to solve problems or to fashion products that are valued in one or more cultural settings" (Gardner & Hatch, 1989, p. 4). Gardner (1983, 1999) proposed that humans have at least eight forms of intelligence, as described by Smith (2008):

> *Linguistic Intelligence* involves sensitivity to spoken and written language, the ability to learn languages and the capacity to use language to accomplish certain goals. This intelligence includes the ability to effectively use language to express oneself rhetorically or poetically; and language as a means to remember information. Writers, poets, lawyers and speakers are among those that Howard Gardner sees as having high linguistic intelligence.
>
> *Logical-Mathematical Intelligence* is the capacity to analyze problems logically, carry out mathematical operations, and investigate issues scientifically. In Howard Gardner's words, it entails the ability to detect patterns, reason deductively and think logically. This intelligence is most often associated with scientific and mathematical thinking.

> *Musical Intelligence* involves skill in performance, composition and appreciation of musical patterns. It encompasses the capacity to recognize and compose musical pitches, tones and rhythms. According to Howard Gardner musical intelligence runs in an almost structural parallel to linguistic intelligence.
>
> *Bodily-Kinesthetic Intelligence* entails the potential of using one's whole body or parts of the body to solve problems. It is the ability to use mental abilities to coordinate bodily movements. Howard Gardner sees mental and physical activity as related.
>
> *Spatial Intelligence* involves the potential to recognize and use the patterns of wide space and more confined spaces.
>
> *Interpersonal Intelligence* is concerned with the capacity to understand the intentions, motivations and desires of other people. It allows people to work effectively with others. Educators, salespeople, religious and political leaders and counselors all need a well-developed interpersonal intelligence.
>
> *Intrapersonal Intelligence* entails the capacity to understand oneself, to appreciate one's feelings, fears and motivations. In Howard Gardner's view it involves having an effective working model of ourselves, and to be able to use such information to regulate our lives. . . .
>
> *Naturalist Intelligence* enables human beings to recognize, categorize and draw upon certain features of the environment. It combines a description of the core ability with a characterization of the role that many cultures value.

As Smith (2008) asserts the "intelligences rarely operate independently. They are used at the same time and tend to complement each other as people develop skills and solve problems." Gardner (1999) argues that people have a unique blend of intelligences.

We can extend Gardner's model to add another human intelligence – *information intelligence.* This is related to the human information domain and the human capacity to understand that one has information problems and can carry out information behaviors to fulfill certain information gathering, organizing and using goals. In particular, this intelligence is related to the logical-mathematical intelligence, spatial intelligence, interpersonal intelligence and intrapersonal intelligence.

Gardner (1983) derived eight criteria for or signs of particular intelligence in humans. We relate how each criteria supports or does not support the existence of an information intelligence:

1. *Potential isolation by brain damage* – this aspect of information behavior has yet to be researched.
2. *The existence of idiot savants, prodigies and other exceptional individual* – Chap. 6 highlights the research beginning to explore exceptional individual's information behavior.
3. *An identifiable core of operations or set of operations* – the core operation of information behavior are discussed in Chap. 8.
4. *A distinctive development history, along with a definable set of "end-state" performances* – this aspect of information behavior is discussed in Chap. 6.
5. *An evolutionary history and evolutionary plausibility* – the initial evolutionary aspects of information behavior are laid out in this book and support an evolutionary history and plausibility of information behavior.

6. *Support from experimental* psychological traits – this area of information behavior research needs further development.
7. *Support from psychometric findings* – this area of information behavior research needs further development.
8. *Susceptibility to encoding in a symbol system* – this area of information behavior research needs further development.

Many aspects of information behavior are not sufficiently known to currently justify information intelligence being fully accepted as a human intelligence. With the pursuit of research to further understand information behavior a stronger case can be made by information behaviorists.

Multitasking

Multitasking is the ability of humans to simultaneously handle the demands of multiple tasks through task switching (Rubinstein, Meyer, & Evans, 2001). Information behavior includes multitasking behaviors that occur when humans juggle the challenge of seeking information on multiple topics. Multitasking between different types of tasks can reduce productivity (Rubinstein et al., 2001).

People often engage in multiple information seeking/foraging/searching processes on multiple topics (Spink, Ozmutlu, & Ozmutlu, 2002). The process of seeking information concurrently over time in relation to more than one, possibly evolving, set of information tasks (including changes or shifts in beliefs, cognitive, affective, and/or situational states), is called multitasking information behavior (Spink et al., 2002, Spink, Park, & Jansen, 2006).

Information behavior is constructed as a series of behaviors within a behavior switching process. Multitasking is conceptualized as a binding process that works with human coordination behaviors to construct an information behavior process. Multitasking information behavior also provides a framework for coordinating and integrating the different levels within information behavior.

Coordinating

Coordination involves managing dependences between activities and coordination theory as the still developing body of theories about how coordination can occur in diverse kinds of systems (Malone & Crowston, 1994). Coordination is also the management of dependencies, or conflicts, between goals, tasks, and resources of various agents.

Humans commonly face multiple and complex situations in organizing and seeking information that involves interplay of information and non-information tasks. Human information coordinating behavior (ICB) is an important linking and sustaining process for the science of information that binds together the many

information behavior processes (Spink & Cole, 2006). Humans coordinate a number of elements, including their cognitive state, level of domain knowledge, and their understanding of their information problem, into a coherent series of activities that may include seeking, searching, interactive browsing, retrieving and constructing information. A key process is to sustain these activities towards completion of some information goal or object.

People perform interdependent activities to achieve goals or solve problems. These activities may also require or create resources of various types. Humans coordinate information tasks arising from dependences that constrain how tasks can be performed. These dependences may be inherent in the structure of the problem (e.g., components of a system may interact with each other, constraining the kinds of changes that can be made to a single component), or they may result from decomposition of the goal into activities or the assignment of activities to other actors and resources.

Socio-Cognitive Ability

The socio-cognitive dimension represents a combination of two selection pressures – first adaptations due to ecological and secondly, social pressures. Geary (2004) argues that "ecological pressures being primary earlier in human evolution and adaptations to social pressures being primary later in human evolution" (pp. 81–82). This dimension also highlights the instinctive aspects of information behavior that developed from genetic mechanisms.

Alexander (1989, 1990a, 1990b) argues that *socio-cognitive abilities* are based on the human drive for ecological dominance, and the human engagement in both social competition and cooperation. Socio-cognitive abilities are the evolved human cognitive abilities, such as language, problem-solving, etc, that enabled ecological dominance of humans and enhanced their competence in social cooperation and competition. Humans have become ecologically dominant via increased inter and intra group competition and cooperation.

Our framework also includes information behavior as a psychological adaptation and a potential enabler of other socio-cognitive abilities. Various early human species were often in competition (e.g., *Homo sapiens* and *Homo Neanderthalensis*), and the human brain transformed to enable early humans to compete and cooperate with each other (Lovejoy, 1980). The problems that drove the evolution of early human's socio-cognitive abilities were largely from the physical environment but the social environment also engendered the need for both collaboration and cooperation.

Alexander (1989, 1990a, 1990b) designates human social cooperation within the group to counter competition from other groups as the trigger that initiated physical transformations/adaptations leading to human ecological dominance. Human cooperation and competition is driven by information problems related to intra group cooperation and inter group competition, leading to the need to gather, process, sort, organize and use information about the ecology, sociality, morality, creation

of culture, competition and cooperation elements of human existence. Information behavior evolved as a general adaptive protection from hostile forces and to enable human survival and competition/cooperation.

With the increased brain volume new human behaviors emerged with the increasing need for human cooperation among groups to survive in an environment where competition was not so much from the environment itself but from competition from other groups. To compete and cooperate effectively, early humans had to develop new types of socio-cognitive abilities and adaptations such as information behavior. Information behavior evolved in early human as a socio-cognitive ability for information gathering, organizing and using that supported other important behaviors such as competition and cooperation activities (Spink & Cole, 2007). Finding, organizing and using information enabled cooperation between people in hunting and gathering and also tracking enemies.

Information behavior evolved as a survival imperative that drove the need to collect, synthesize and use information about kin, during warfare about competitors, collaborators, mating strategies and sexual reproductive partners. Information behavior via environmental scanning and human communication is reflected in cave art (Mithen, 1996) and other forms of information storage.

Combining Socio-Cognitive Abilities

Human cognition is achieved through combinations of mechanisms. Humans have many different socio-cognitive abilities (Blumberg, 2005; Herrnstein, 1998), but we do not understand the complexity of how these socio-cognitive abilities intersect with each other (Herrnstein, 1998; Lorenz, 1965, 1970, 1971). However, the idea of interacting or intersecting socio-cognitive abilities provides the basis for understanding different levels of socio-cognitive abilities.

Information behavior evolved across human existence into an adaptive socio-cognitive ability manifest in a complex combination of other socio-cognitive abilities such as language, affectation, etc. Information behavior is therefore based in the human coordination of various socio-cognitive abilities including language, theory of mind – information about intentions, verbal and non-verbal communication signals, facial expressions, abstract thinking, decision making, sense making, foraging, systematic planning and the abstract representation of objects. Information behavior manifests by the human coordination and multitasking of various socio-cognitive abilities.

Human coordinate various socio-cognitive abilities simultaneously to form their complex behavior. Like language, information behavior emerges in every human across all cultures as a biological adaptation for information finding, gathering, analyzing, organizing and using. Humans are born with a socio-cognitive ability for information behavior that is also instinctive. However, the absence of other socio-cognitive abilities such as language or cognitive coordination skills affects the ability of humans to utilize information behavior abilities.

Individual/Collaborative

People may act as individuals or collaborate with others in a group during their information behavior (Foster, 2006; Hyldegard, 2009). Their behavior is affected by many factors, including situational and contextual influences, and social dimensions of group interaction.

Information Processing

Newell's (1990) information processing theory explains how humans' cognitively process information in the brain. Information structures are retrieved from long-term memory in reaction to an environmental stimulus to enable the decoding-type processing of the environmental stimulus, controlling how that stimulus is processed and providing a new stimulus is encoded in long term memory.

Early humans' development of cognitive abilities, such as information processing, represented a major underpinning for the later emergence of information behavior. Information processing is an essential part of how the mind functions and the human cognitive architecture (Atkinson & Shiffrin, 1968; Barkow, Cosmides, & Tooby, 1992) which underpins such cognitive abilities as problem solving, memory and language, etc.

Cognitive scientists have made limited explorations into the origins of information processing in early humans (Geary, 2004) and have not generally taken an evolutionary view of cognition, preferring to focus on modeling only contemporary human information processing capabilities. Alternatively, information behaviorists' have begun to analyze information processing and its relationship with information behavior (Savolainen, 2009). Spink and Cole (2007) also provide a limited discussion of the relationship between information behavior and information processing.

In summary, based on what we know about information processing as an important element of human cognition, we can understand that the emergence of information behavior was underpinned by the presence of an information processing capability in early humans. Cognitively, information behavior is not possible without a human information processing capability.

Affective Traits

Information behavior includes personality attributes (Heinstrom, 2003) affective traits, emotions and feelings (Nahl, 2007; Nahl & Bilal, 2007), including personality variables, and gender and individual differences (Heinstrom, 2003). This represents the interplay of cognitive including affective aspects (Nahl, 2007; Nahl & Bilal, 2007) within and individual or collaborative context (Foster, 2006; Hertzum, 2007; Hyldegard, 2009; Reddy & Jansen, 2008). Further research is needed to more fully model the affective aspects of information behavior.

Summary

Looking broadly we see that information behavior is an evolved cognitive mechanism with many socio-cognitive attributes. Information behavior is a biologically secondary ability, and fulfills some of the criteria for an intelligence within Gardner's framework. There is also a degree of overlap between these different attributes and abilities. Information behavior is underpinned by human information processing capabilities, and has multitasking, coordinating and affective dimensions, but further research is needed in these important areas.

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Chapter 6
Lifetime Development

> *All complex behaviors are composed of sub-behaviors, each of which is induced at each stage of development, often in non-obvious ways . . . Evolution, of course, plays a major role in the emergence of complex behavior, not by focusing its attention on genes, but by selecting from the entire developmental manifold.*
>
> (Blumberg, 2005, p. 148)

Blumberg's words above highlight a key challenge for information behaviorists – *How can we understand the developmental patterns of information behavior?*

We previously explored the origins and development of information behavior as a socio-cognitive ability with instinctive and non-instinctive attributes in early humans. As our information behavior emerges and develops over a human lifetime across infancy, childhood, juvenility, adolescence and adulthood, we now explore in more detail the lifetime development level in Fig. 2.2. To achieve this we focus on "thinking developmentally" (Buss, 1995, 2008; Rayner, Joyce, Rose, Twyman, & Clulow, 2005).

To develop a lifetime framework for understanding information behavior we need to explore the latest thinking on human development, developmental psychology and evolutionary life history theory (ELHT). Research in the developmental sciences tells us that humans undergo a lifetime process of physical and cognitive development that are related and act together. *Human development* is thus the study of the psychodynamics of human growth, maturity, aging (Bogin, 1999; Rayner et al., 2005) and cultural processes (Rogoff, 2003).

Information behavior is a complex adaptive behavior that has developmental and evolutionary dimensions. Blumberg (2005), Bjorklund and Pellegrini (2002a, 2002b) and Buss (2008) point to the growing alignment between evolutionary psychology and developmental psychology in understanding more complex adaptive behaviors, and (Blumberg, 2005, p. 89) says "behavioral development is a mosaic created by continuing interaction of the developing organisms and its environment" (p. 90).

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Human Cognitive Development

Humans have a prolonged pattern of growth and development over many *life history stages* (Locke & Bogin, 2006). Human development theories describe the socio-economic, cognitive and physical developments that occur from birth to death, and provide a broad framework for understanding how humans feel, think and act at different stages of their lifetime and cognitive development.

Cognitive development over a human lifetime is generally seen as an ordered sequence of cognitive stages of intellectual, emotional and social-cognitive abilities that lay the foundation for the following stage. Our information behavior framework needs to include information behavior as developing over a human lifetime in a sequence of cognitive development stages.

Obviously any approach to modeling the lifetime development of information behavior would need to be developed initially using the pre-existing models of cognitive development. What models of cognitive development are useful for underpinning a cognitive development model of information behavior? Major approaches to cognitive development were developed by Piaget, Erikson, Vygotsky, Baron-Cohen, Spelke, and Locke and Bogin.

Piaget's Stage Model of Cognitive Development

Major theorist Jean Piaget studied how children develop knowledge (Oakley, 2004a, 2004b; Piaget, 1990; Piaget & Inhelder, 1969). In their stages of cognitive development, children think about and interpret their world in different ways. Piaget's model of cognitive development is based on the three principles of assimilation, accommodation and equilibration:

- *Assimilation* allows new experiences to be incorporated into existing mental structures;
- *Accommodation* revising existing schema with new experience; and
- *Equilibration* is seeking cognitive stability through accommodation and assimilation.

Cognitive development includes a child building a world understanding with new experiences. Piaget's model includes four stages of development in thinking and understanding abilities – sensorimotor, pre-operational, and concrete operational and formal operational.

- *Sensorimotor Stage (0–2 Years)* – This rapid development stage includes sensory and motor development, built-in schemas and reflexes, but limited ability to imitate or integrate information. Later in this stage, as child learns that object and people can be represented by symbols.
- *Pre-operational Stage (2–6 Years)* – This stage includes an increase in language development, symbolic representation and imaginary play. Cognitive thinking is

shaped by egocentrism with difficulty in understanding alternative perspectives and animism or feeling attributed to inanimate objects.
- *Concrete Operational Stage (7–12 Years)* – During this stage, children develop (1) inductive logic or strategies and rules for interpreting and investigating their environment, and (2) class inclusion or the recognition of categories into subgroups.
- *Formal Operational Stage (12–16 Years)* – This stage is characterized by the development of: (1) hypothetical deductive reasoning or solving hypothetical problems, and (2) logical and systematic problem solving.

Piaget's theory stated that normal cognition develops over stages that are characterized by logical capabilities of increasing complexity and generality (Morra, 2007). This conception of mental development has evolved over the decades. However, a clear theoretical language is still evolving to describe the patterns and differences in cognitive development over a human lifetime.

Scholars expanded Piaget's work and cognitive development model. Connectionist models from cognitive psychology, including information load and task complexity, were incorporated to account for non-linearity and discontinuity in behavioral change. Cross-cultural differences and universal aspects of cognitive development were also included (Morra, 2007). In particular, Erikson's developed an alternative approach to cognitive development.

Erikson's Cognitive Development Theory

Erikson's (1950, 1963, 1968) cognitive development theory includes an eight stage sequential model of cognitive and affective stages from infancy to older adulthood. Each stage involves the resolution of various crises to enable movement to the next stage, including:

- *Stage 1: Trust versus Mistrust* – an infant's trust is derived from the mother and environment.
- *Stage 2: Autonomy versus Shame and Doubt* – children establish interpersonal patterns, a sense of self-control without a loss of self-esteem.
- *Stage 3: Initiative versus Guilt* – in the early childhood years we see exploring behavior, language development, and an expanded imagination and guilt feelings.
- *Stage 4: Industry versus Inferiority* – middle childhood years with quick learning, shred obligations, discipline and performance of task with possible sense of inferiority.
- *Stage 5: Identity and Identity Confusion* – this stage develops an adolescence's sense of self-identity with possible identity confusion due to an inability to establish identity.
- *Stage 6: Intimacy versus Isolation* – includes the development of psychosocial intimacy with another person during young adulthood.

- *Stage 7: Generativity versus Stagnation* – this stage includes productivity and creativity during the middle adult years.
- *Stage 8: Ego Integrity versus Despair* – in Stage 8 older adults develop a sense of life and meaning resulting from knowledge and mature judgment.

Vygotsky's Theory

Another approach to cognitive development was developed by Vygotsky (1962, 1978, 1982) who asserted that humans learn in the context of culture and social interaction that influences thinking, behavior and knowledge levels. Social agents, such as parent, teachers or peers, also affect a human's learning. He saw humans as having lower level functions that are genetically inherited and higher level functions acquired by social interaction.

Vygotsky's Zone of Proximal Development (ZPD) is the difference between independent problem solving by a child as compared to problem solving guided by an adult through mediated learning and social interaction. The universal aspect of different cognitive development approaches the idea of an incremental increase in specific skills and domain-specific knowledge (Goswami, 2007; Morra, 2007).

Erikson, Vygotsky and Piaget proposed dialectical views of cognitive development as evolving internal cognitive structures that actively interacted with the environment. Neo-Piagetian theories and models see cognitive development as constructivist process divided into stages defined by different characteristics and increasing cognitive complexity.

Baron-Cohen's Four Hierarchy Modular Mechanism

Baron-Cohen (1995) identified four important hierarchy modular mechanisms develop during infancy and early childhood, including:

- *Intentionality Detector (ID)* – an ability to determine the intentionality of other humans.
- *Eye-Detection Detector (EDD)* – an ability to use eyes to detect patterns of behavior.
- *Shared-Attention Mechanism (SAM)* – an ability to engage in triadic interactions, and
- *Theory of Mind Mechanism (TOMM)* – ability to take a perspective on other people.

Spelke's Physical Nature

Spelke (1991) suggests that infants develop an understanding of the physical nature of objects or core knowledge, including:

- *Continuity* – as objects move in their environment
- *Cohesion* – objects have boundaries, and
- *Contact* – objects are used to move other objects.

The research by Baron-Cohen and Spelke also has implications for the development of a lifetime model of information behavior. Research is needed that examines each cognitive development model and tests their applicability to information behavior. What can emerge from extensive studies is some form of integrated model that draws on the useful elements of previous models.

Lifetime History

In addition to models of cognitive development, human life history studies also model the cognition and cultural dynamics of human lifetime development (Begin & Smith, 1996; Hawkes & Paine, 2006; Hill & Kaplan, 1999; Stearns, Allal, & Mace, 2008), including the human life cycle from birth to death based on natural selection (Stearns et al., 2008), including cognitive and physical development. Human developmental states are affected by learning and environmental experiences that combine to finally produce an adult human.

Human life history studies take into account that humans take 15–20 years to complete the physiological development and cultural learning required for adult function; there is an evolved rate of brain development and the rate at which culture is acquired by learning; and after 5–6 decades of functional adulthood, human aging may deplete cognitive capacity.

A major goal for information behaviorists is to build an understanding and models that depict how information behavior develops over a human lifetime. Limited lifetime histories provide insights into information behavior over a lifetime development and life history stages.

Life History Stages

Life history evolution studies explore how life is designed by natural selection. Humans have slow physical and brain development and cognitive capabilities that are gradually acquired over a relatively long life span (Calow, 1978; Stearns et al., 2008). Rayner et al. (2005) suggest that "each developmental level provides a new pattern of problems to solve and achievements to enjoy" (p. 7).

Locke and Bogin (2006) point to biological, cognitive and linguistic cognitive patterns, changes and abilities that emerge over each human life history development stage through five lifetime stages from infancy to adulthood:

- *Stage 1: Infancy* – From birth to 36 months physical and cognitive development occurs at a fast pace, bipedalism develops, and infants begin to combine lexical items and develop a structural linguist system.

- *Stage 2: Childhood* – From 3 to 7 years (brain mass peaks at 7 years) we see the development of extra familiar human relationships, new learning and behavioral capabilities, and greater social independence, motor, language and cognitive advances. In addition, 2–4 year olds develop the ability to take a perspective on other people and impute one's own and other's mental states (i.e., knowledge, belief, thinking, pretending, doubt, guessing, etc), under the "theory of other minds" (Baron-Cohen, 1995; Premack & Woodruff, 1978).
- *Stage 3: Juvenility* – Are sexually immature but are more independent that children, experience cognitive and social developments, syntactic advances including the persuasive and attractive use of speech with phonological innovation.
- *Stage 4: Adolescence* – Locke and Bogin (2006) point to the emergence of adolescence in Homo erectus in Africa more than 1 million years ago.
- *Stage 5: Adulthood* – This is a final stage of lifetime development that represents a maturity in physical and cognitive development followed by a decline in both.

Within the development research framework we have a range of not only cognitive development models, but also lifetime stage models. The overlap between these models is probably significant, as they are looking at a similar process from different intellectual perspectives. Some level of integration between cognitive development and lifetime stage models could be useful.

Information Behavior

Obviously the cognitive development and lifetime stage models have implications for developing an information behavior model that depicts lifetime development (Bilal, 2007). In addition, the exciting research into lifetime histories can be useful for information behaviorists.

Lifetime Histories

Some people have written about their information behaviors in autobiographies, memoirs, diaries and letters, including historical figures such as Napoleon Bonaparte, Charles Darwin, Giacomo Casanova and others (Currier, 2007; Spink & Cole, 2006; Spink & Currier, 2006a). During their lifetime these people wrote about their information-related behaviors (Spink & Currier, 2006b), including information seeking, organizing and use behaviors.

- *Charles* Darwin (1859) wrote about his information behaviors, particularly in information organizing (Currier, 2007). Currier (2007) provides the most comprehensive lifetime history of a human's information behavior within his study of Charles Darwin.

- The eighteenth century Italian philosopher, librarian, lover and spy *Giacomo* Casanova (1774a, 1774b, 1774c, 1997) wrote in his memoirs about his own information behaviors (Spink & Currier, 2006a). He wrote about his information finding and using behavior in different contexts. Casanova used his information gathering behavior to find information about places, events and people that assisted him seduce women, spy, conduct business, and being a librarian. His ability for information gathering and using was well known.
- *Napoleon* Bonaparte*'s* (1992, 1999, 2001, 2003) works, including the book *Napoleon on the Art of War* provided many instances of information behavior, including examples of information seeking, organizing and use. They outline Napoleon Bonaparte's approach to the importance of seeking information to assist in military campaigns. Information gathering, organizing and using was a major feature of Napoleon's military strategy and a process he regarded as important.

The previous studies above are partial life histories that focus quite specifically on information behavior and not a person's general behavior. However, building on research from developmental psychology and human life history we can begin to develop a framework for how information behavior develops over a lifetime.

Lifetime Development

A lifetime development framework for information behavior needs to be underpinned by a model combining aspects of cognitive development, lifetime stages and lifetime histories. Based on the cognitive development approaches described above we see that information behavior develops incrementally as a specific socio-cognitive ability within a constructivist process divided into stages defined by different characteristics and increasing cognitive complexity.

We propose an initial information behavior lifetime model that is divided into stages based on previous modes by Piaget, Erikson and Vygotsky.

Stage 1: Piaget's Sensorimotor Stage (0–2 Years) includes development of sensory and motor skills, built-in schemas and reflexes. However, during this stage the child has limited ability to imitate or integrate information. Later in this stage, as child learns that people and objects can be represented by symbols.

Stage 2: Piaget's Pre-operational Stage (2–6 Years) includes an increase in language development, symbolic representation and imaginary play. Cognitive thinking is shaped by egocentrism with difficulty in understanding alternative perspectives and animism or feeling attributed to inanimate objects.

Stage 3: Piaget's Concrete Operational Stage (7–12 Years) includes the development of (1) inductive logic or strategies and rules for interpreting and investigating their environment, and (2) class inclusion or the recognition of categories into sub-groups.

Stage 4: Piaget's Formal Operational Stage (12–16 Years) includes the development of: (1) hypothetical deductive reasoning or solving hypothetical problems, and (2) logical and systematic problem solving.

To fully develop a staged theoretical framework for a lifetime development model we need to understand how information behavior works and how it manifests in humans. Within the framework of natural selection, adaptations and selection pressures, certain socio-cognitive abilities evolved as a result of successful use (MacNeilage & Davis, 2005; Spink & Cole, 2007). In other words, information behavior did and continues to do something for the human organism that provides adaptive value.

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Chapter 7
Information Behavior Sub-processes

We have found a strange footprint on the shores of the unknown. We have devised profound theories, one after another, to account for its origins. At last, we have succeeded in reconstructing the creature that made the footprint. And lo! It is our own.
Sir Arthur Stanley Eddington (1882–1944) Space, Time and Gravitation (1920)

Sir Arthur Stanley Eddington was obviously a phenomenologist. In the vein of Eddington, this book is a first stab at devising theories to account for origins and reconstructing the creature. But how do we reconstruct such a creature, how do we account for its origins and say what it has become? Based on what we know so far about the origins and development of information behavior, we have a theoretical framework with evolutionary, instinctive, socio-cognitive and lifetime developmental dimensions.

The theoretical framework depicted in Fig. 2.2 does not include every possible information behavior dimension. However, the framework does link our understanding of information behavior with the latest thinking in the broad behavioral, evolutionary and developmental sciences. The theoretical framework represented in Fig. 2.2 identifies the important information behavior dimension information grounds, and sub-processes such as information seeking, foraging, sense-making, organizing and using. In this chapter we briefly examine these information behavior dimensions and sub-processes.

Information Grounds

Figure 2.2 shows that information grounds represents the *physical, socio-cognitive* and *virtual* locations or places where information behavior exchange occurs. Information behavior includes an exchange process that takes place between people in their "small world" (Chatman, 1991) context. Information grounds are smaller than peoples' small worlds (Chatman, 1991; Fisher & Naumer, 2006). For example, an information ground could be a dentist's waiting room, coffee shop, Internet chat etc., where diverse people exchange and talk. The concept of information

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grounds includes consideration of information behavior as including a physical location, a physiological location that would include cognitive behaviors, and potentially a virtual location. These issues need to be explored in further research.

Information Behavior Sub-processes

Figure 2.2 portrays information behavior as made-up of sub-processes that include information seeking, everyday life information seeking (ELIS) (including sense-making), information foraging, information searching, information organizing and information using (Spink & Cole, 2006). Information behavior occurs as interplay of the different sub-processes over time. For example, a person might information seek then information forage, and then organize and use that information.

Information Seeking

Information seeking is one sub-process within information behavior that includes the purposive seeking of information in relation to a goal or information task (Spink & Cole, 2005). In Fig. 2.2, information seeking exists in parallel with the other sub-processes as people switch between seeking, foraging and sense-making. The starting state of the information seeking process is conceptualized as occurring as an information gap or anomalous state of knowledge or an information need. The construction of an information seeking process evolves in stages with key variables stated as relevance judgments and uncertainly.

The goal state is the resolution of the problem or cognitive state and humans adopt different strategies and exhibit different information behaviors at different stages of their information seeking process (Kuhlthau, 1993) and related to social behavior (Brown, Ganesan, & Challagalla, 2001). Information seeking has four broad stages: (1) problem identification, (2) problem definition, (3) problem resolution, and (4) problem solution statement or presentation (Spink & Cole, 2005, 2006). These stages are not yet well defined, but include changing affective and uncertainty dimensions (Cole & Leide, 2006; Spink, Wilson, Ford, Foster, & Ellis, 2002).

Everyday Life Information Seeking – Sense-Making

Information sense-making and everyday life information seeking (ELIS) is a combination of non-purposive and purposive sub-processes. Inputs are bits and pieces of data the individual gathers both consciously and unconsciously for the purpose of making sense of a problem situation. The problem situation can be very wide, such as the problem of human survival. The process starts only when the individual achieves a sense of comfort or coherence. This is knowledge-based

output where the individual has made temporary sense or coherence from what Dervin (1992) suggests is the constant discontinuity of human existence. Within information seeking the goal state is mastery of life.

Within the everyday life information seeking/sense-making levels, the information user is conceptualized as constructing information based on the values and specific environment of the "small world" in which the user exists concurrently apart from and as a member of the larger society (Chatman, 1991; Savolainen, 1995).

People often engage in a combination of purposive and non-purposive information seeking. During information seeking people may be seeking a mastery of life. Humans make sense during information seeking as they construct information based on the values and specific environment of their "small world" (Dervin, 1992, 1999) and make new sense by seeking information from the environment which the individual interprets into sense to build a bridge over the gap. The bridge is a "sense made over a gap between one time-space moment and another and simultaneously between material and interpretive worlds" (Dervin, 1999). For example, Chatman (1991) found that school system janitors did not accept or act upon information from outside the group if doing so negatively affects established relationships within the insider group.

Information Foraging

Information foraging starts when people select an information patch looking for clues to where to find the information they want by maximizing the gains of valuable information per unit cost (Pirolli & Card, 1999). Information foraging developed as part of the human ability to forage that is much discussed in evolutionary psychology and anthropology (Mithen, 1989, 1990; Stephens & Krebs, 1986).

Human forager adapts to the environment by shifting direction when external and internal cues are received that help it localize a resource site. These cues can be auditory signals, a visual pattern, or they can be made up of some chemical. The human information forager, similarly, uses what Pirolli and Card call "the proximal perception of information scent" to assess profitability of an information source in relation to other potential sources (Pirolli & Card, 1999). If the scent is strong, the information forager can make the correct choice; if there is no scent, the forager will have to perform a "random walk" through the environment.

Information Searching

People often search information retrieval (IR) and Web technologies during their information behavior (Spink & Cole, 2005). Their interaction process consists of entering queries often created from multiple words and making judgments about the retrieved documents or Websites. Humans may often switch between searches on many information problems during multiple interactions over time (Spink et al., 2002).

Information Organizing

Information organizing behavior is the sub-process of analyzing and classifying materials into defined categories (Cole & Leide, 2006; Spink & Cole, 2005), e.g., the Dewey Decimal Classification System (McIlwaine, 1997).

Information Using

Information using begins with preconscious data pick-up from the environment while the individual is attending to other information foraging activities. Dervin (1992) states that information use is a process condition where the user tries to make sense of discontinuous reality in a series of information use behaviors. There are internal use behaviors (comparings, categorizings, polarizings, etc.) and external use behaviors (listenings, agreeings, disagreeings, etc.).

A problem solving definition of information use is the incorporation of found information into their pre-existing knowledge base, by thinking, by taking notes, or in some way cognitively processing/acquiring the information (Ford, 2004; Todd, 1999).

According to this definition, studies of user cognition during user-IR system interaction should be labeled as information use research (Cole, 2000; Ford, 2004).

Incorporating found information into a human's pre-existing knowledge structure may provide a link into the wider notion of information behavior because it describes the precise moment when the information environment and human come together. Overall, limited studies have investigated information using in relation to other information behaviors sub-processes.

Information using involves the incorporation of information into a person's existing knowledge base (Savolainen, 2009; Spink & Cole, 2005; Vakkari, 1997) and is a process condition where the user tries to make sense of discontinuous reality in a series of information use behaviors (Dervin, 1992). A problem solving definition of information use is the incorporation of found information into their pre-existing knowledge base, by thinking, by taking notes, or in some way cognitively processing/acquiring the information (Ford, 2004; Todd, 1999).

Summary

This chapter has briefly explored the important information behavior dimension of information grounds and details some of the sub-processes that make-up information behavior as depicted in Fig. 2.2. Including these levels in Fig. 2.2 links our information behavior understanding to the latest thinking in the broad behavioral, evolutionary and developmental sciences depicted on the other levels.

This model needs much more development over time following further information behavior research that models the integration between the different information sub-processes. Further detailed discussion about these information

behavior sub-processes and their integration is provided by Spink and Cole (2005). A much more detailed account for some information behavior sub-processes, such as information seeking, is covered by Case (2007), and information foraging by Pirolli (2007). This is a crucial research area in need of more substantial study within the frameworks in Figs. 1 and 2.

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Chapter 8
Supporting Information Behavior over the Ages

> *To understand the evolution of things, one must understand something about their history as well as the environmental forces that had shaping influences upon them.*
> (Pirolli, 2007, Preface)

As Pirolli reminds us, many forces shaped the emergence of information behavior and many artifacts were developed over the centuries to support information behavior in different cultures. Information behavior has been an important aspect of human behavior from early humans such as *Homo sapiens* and also for the people of today.

Over the centuries people have used their ability to engage in information behavior and various artifacts were created to support these information behaviors. Obviously the creators of these artifacts realized that information behavior existed in humans and themselves, and therefore needed to be supported. This was a complex intellectual undertaking, but we saw the development of different types of artifacts over the centuries.

Information behavior has been an important element of daily life over the centuries (Spink & Cole, 2005, 2006, 2007). Humans have used their information gathering, organizing abilities for military, scientific and personal purposes. Many people use their information organizing and using behaviors to create personal libraries to support information gathering behaviors. Classifying papers or books by subject was also a common behavior even before the development of cataloguing schemas by Dewey and Otlet.

This chapter briefly reviews the latest thinking on what we know about how information behaviors were, and still are, supported by different artifacts and technologies over the centuries. The artifacts developed to support information behavior changed over the centuries from cave art to clay tablets to libraries, printed books and organizing schema, to today's computer technologies, the Internet and the Web.

This chapter is not a comprehensive overview of the artifacts that humans developed to support their information behaviors. These artifacts are discussed extensively in the scientific literature (Borgman, 2003; Wright, 2008).

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Time Period	Artifacts Supporting Information Behavior
30000 BC	Cave Art or Paleoart
6600 BC	Ideographs
4240–3000 BC	Calendars, Paper (Papyrus), Cuneiform
2700–1300 BC	Ink, Hieroglyphs, Alphabet, Phaistos Disc, Logographs, Maps
1250–500 BC	Scrolls, Manuscripts, Glossaries, Dictionaries, Paper(Parchment)
320–8 BC	Library, Bibliographies, Concept of Categories, Library Classification System
79–1200 AD	Codex, Woodblock Printing, Tree Diagram, Quill Penn, Library Catalogue, Movable Type, Almanacs, Paper (Rag)
1309–1626 AD	Registers, Printing Press, Bookbinding, Public Lending Library, Library Catalogue (Printed), Dictionaries, Newspapers, information Graphics
1735–1900 AD	Taxonomy (Binominal), Magazines
1900 AD–Today	Marc (Metadata), Hyperlink, Internet, Web, Digital Libraries.

Fig. 8.1 Information behavior and artifacts created over the centuries to support information behavior

Figure 8.1, adapted from Bergman's Timeline of Information History (http://www.mkbergman.com/?page_id=327), provides a summary of the significant events and developments in the innovation and management of information and documents from cave paintings (ca *30000 BC*) to the present.

Figure 8.1 shows some of the artifacts created by humans over the centuries to support information behaviors from early to modern humans. Over the centuries we can see the development of different forms of artifacts that supported human information gathering, organizing and use behaviors.

Information Artifact Timeline

Around *30000 BC*, as we saw in earlier chapters, cave art or paleoart were early example of humans' creating artifacts to support their information behavior by drawing images of animals.

By *6600 BC* early humans had developed ideographs that were proto-writing systems of ideographic, mnemonic symbols or scripts that could be markings on artifacts. The earliest example of an ideograph is a prehistoric tortoise shell with 16 markings from Jiahu, China.

From *4240 BC* Egypt we see the first calendar – the civil Egyptian calendar that was divided into 12 months with 365 days. The period BC in human history also saw the development of paper made of papyrus in Egypt and cuneiform as the earliest form of written expression by the Sumerians.

During the period *2700 BC–1300 BC* the next group of artifacts created to support information behavior were developed in the second and third centuries BC, including ink, alphabet, hieroglyphs and maps. These artifacts supported humans' information organizing behaviors and the human ability to then find certain types of information, e.g., in 1800 BC alphabets or writing system with characters emerged in Egypt during the era of the military leader Alexander, the philosopher Plutarch and military historian Xenophon (Russell, 1999).

Information behavior is also evidenced during the *eighteenth century BC and the fourth century BC* with Xenophon, Aeneas Tacticus, and Alexander (Russell, 1999; Spink & Currier, 2006c). Classical Greek was an information age (Payne, 1993) with the move from an oral to written culture that transformed information behaviors (Spink & Currier, 2006c). Payne (1993) discusses the information behaviors of Herodotus and Theophrastus. Herodotus collected his information from a variety of sources including logographers (historically oriented storytellers), city and temple archives, inscriptions such as those on monuments, and Egyptian priests (Payne, 1993; Spink & Currier, 2006c).

Maps first emerged during the *fourteenth–twelfth centuries BC* in Babylon and 16,300 years ago in the Lascaux caves showing the sky and stars. The second and first centuries BC saw some important artifact development including scrolls or papyrus rolls of parchment for information organization and use.

Artifacts such as manuscripts, glossaries, dictionaries and parchment paper developed during the period *320 BC–8 BC*. In the last century BC, more systematic ways of thought led to the development of bibliographies or lists of publications, books or articles, and the conceptualization of categories, paper libraries, and the first classification systems for libraries. The Royal Library of Alexandria in Alexandria Egypt was the largest library in 280 BC with between 500,000 to 1 million scrolls.

The first two centuries AD from *79 AD to 1200 AD* saw the development of more cognitive complex artifacts to support information organizing and finding behaviors, including the codex, woodblock printing, tree diagrams, quill pen, library catalogues, movable type, almanacs and paper made from rags. Library catalogues, as a register of bibliographic items in a library, were first used in medieval and Islamic libraries.

From *1309 AD to 1636 AD* at the beginning of the Renaissance Era we saw the development of the printing press as an artifact that supported information gathering, organizing and using behaviors. Other artifacts were developed including registers, bookbinding, public lending libraries, library catalogs (printed), dictionaries, newspapers, and information graphics. In particular, public lending libraries were environments where people could explore their information behavior abilities. Library catalogs were also developed to support the more effective human use of information behavior abilities.

From *1700 AD to Today* we saw the development of a new range of more complex information behavior supporting artifacts, including binomial taxonomies, magazines, machine readable catalogs (Marc) with metadata, hyperlinking, the Internet, and the Web (Borgman, 2003; Wright, 2008).

Summary

How and why these artifacts were developed to support certain information behaviors is an interesting area for further research. Who were the people who developed the artifacts and did they conceptualize the behaviors their artifacts would support in psychological terms? The thought processes and social influences on the development of these information behavior supporting artifacts is a fascinating realm of inquiry.

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Chapter 9
Key Propositions and Conclusions

This book has broadly explored many diverse and interesting issues, and has proposed new theories and ideas. At the beginning of the book we said that such a treatise will probably raise more important and interesting questions than will be answered. Raising important and interesting questions without providing all the answers may be frustrating for the reader (and the author), but does provide a necessary and critical key beginning for confronting future research challenges.

The book has highlighted the many important, interesting and exciting challenges confronting information behaviorists. The last chapter of the book draws together some of the key propositions in the book and discusses how to move forward with further research to build our understanding of information behavior.

A key issue to think about is why our understanding of information behavior, which is a daily task for most humans, is still quite underdeveloped. It seems that information behavior is and has always been a long term proposition. It's been with us a long time and exists with us during our lifetime. To understand information behavior and its various dimensions also requires a more long-term exploration of the human information behavior condition beyond the current limited contemporary modeling.

Despite the difficulties inherent in researching information behavior from early hominins to today, information behaviorists need to draw more fully, and in an ongoing way, on the research from the evolutionary cognitive and anthropological fields to develop more comprehensive information behavior theories and models. Overall, when we look across the broad sweep of human existence, we can say that information behavior is an important instinctive, socio-cognitive ability. All humans have an information behavior instinct. However we are just beginning to understand the complex nature of information behavior including its origin, evolution and development.

Information Behavior Emerged in Early Humans

A key proposition in the book is that information behavior emerged as a behavior in early humans. For some people this may be no great revelation as they feel such a proposition is obvious. But in research nothing is obvious until we have enough

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evidence to substantiate a scientific claim. In the first chapter I tried to provide enough information to form an initial base for stating and supporting a claim for this proposition.

The evidence for this key proposition is drawn from other scientific fields, such as anthropology, evolutionary psychology and cognitive archaeology that are also exploring the origins of other human behaviors such as mating, hunting and gathering, etc. Information behavior is only one dimension of human behavior. Many other human behaviors are being researched as to their origins in early humans in far more detail than information behavior. Studies of the origins and evolutionary and contemporary dimensions of human mating are endless! (Buss, 2008).

Building on the base provided in this book we need to develop a much more comprehensive picture of how, when and why information behavior emerged in early humans. This can be done. But to move forward in this complex research area means understanding the findings from other fields, such as anthropology, evolutionary psychology and cognitive archaeology, and extrapolating any key findings related to information behavior. This involves a greater degree of collaboration between information behaviorists and scholars from these other fields.

Alternatively, information behaviorists can begin to conduct their own research into the origins of information behavior. However, this would be a quite difficult proposition without some level of collaboration with scholars from more evolutionary behavioral fields.

Information Behavior Emerged During the Neuro-Evolution

In a similar vein to our proposition about the origin of information behavior, we also propose that information behavior emerged during the neuro-evolution or the growth of socio-cognitive abilities in early humans. Again, the basis for this proposition is based in research from other fields that claim that other human behaviors also emerged during this period of human evolution. Information behavior is but one of many behaviors that are being explored by evolutionary psychologists.

How to move ahead in this area will to some degree depend on the growing evidence about how the neuro-evolution happened and what caused the expansion in socio-cognitive abilities in early humans. Many theories have been proposed by such scholars as Coolidge, Wynn, Mithen, Geary and Alexander, etc. The brain volume expansion is not really in dispute. However, what is not yet understood are the stages of human brain development and the causes. These issues will probably not be resolved in the next few years and form a long term research agenda.

What is important for information behaviorists to accomplish is to more tightly link our understanding and models of information behavior to key cognitive issues such as information processing and other cognitive abilities that emerged in early humans. In particular we need to focus on *Homo sapiens* and their evolution. We also explored a number of other cognitive capabilities such as information processing that underpinned the emergence of information behavior. However, we

also need to understand more about how information behavior's emergence underpinned and works with other human behaviors, such as hunting and gathering, mating, etc.

Information Behavior Is Driven by a Human Motivation to Control

Certainly, this proposition is tightly linked with Geary's theory about the role of a human motivation to control the environment in underpinning the emergence of human behavior in general. Currently, Geary's theory has viability for understanding information behavior. Not completely, but at least partially. However, tying information behavior to the concepts of human motivation and control requires further exploration. They are not concepts that we have normally associated with information behavior. But information behaviorists need to break the bonds and push the envelope to understand more profoundly what information behavior really is and how and why is manifests in humans.

Human motivation is a major concept that psychologists have explored extensively. In collaboration with gratification, these concepts form a long list of dimensions of information behavior that have largely been ignored. Information behaviorists need to take a step back from pragmatic and applied studies, and urgently determine the fundamental dimensions of information behavior before other evolutionary and behavioral scholars move into that turf. Exploring how motivation works with information behavior would be a good start.

Control is another concept we need to link more closely with information behavior. This concept has also been extensively explored by psychology with implications for information behavior. We need to tie the dimensions of motivation and control to uncertainty, relevance and other concepts already examined in the information behavior context.

Information Behavior Shaped by Instinct and Environment

If human behavior in general is shaped by instinctive influences and also environmental influences, then information behavior, being only one of many human behaviors, is obviously more productively seen from this perspective. If we can take this proposition on board, then we can start to fill out the instinctive and the environmental dimensions of information behavior, and look at how the two work together. Unless we do that, information behavior will wallow as a "behavior" that is not growing in level of understanding by both information behaviorists and ordinary people alike. It would be important to be able to tell people that their information behavior is part of their human make-up that certain aspects are instinctual, such as their ability to conduct such cognitive processes, but these processes are also shaped by many environmental factors.

This returns us to the lack of an information behavior vocabulary highlighted in the first chapter of the book. We need to move forward in understanding and contributing to the instinct versus environment debate to help us develop that vocabulary. We can conduct experiments and studies to determine how and when the information instinct emerges in humans and how that is shaped by influences such as culture and technological access. If we're going to advise people on how to develop their information skills and literacy, we need a much stronger basis for our models of information behavior that are based in solid psychological processes and validated by rigorous scientific and theoretical research.

Information Behavior as Information Intelligence

Throughout this book we have proposed that information behavior is a human intelligence from the Gardner perspective. We need to examine: (1) how information intelligence enables humans' to carry out information behaviors to fulfill information gathering, organizing and using goals, and (2) how our information intelligence relates to our logical-mathematical intelligence, spatial intelligence, interpersonal intelligence and intrapersonal intelligence.

Further research is also needed to examine many aspects of information behavior that have not been explored that underpin our information intelligence. In particular, one of Gardner's criteria for an intelligence is the potential isolation of the intelligence by brain damage. Limited research has isolated information behavior in neurological terms and examined what levels of neurological damage affect the human ability to engage in information behavior. We need to identify a core set of information behavior operations and definable "end-state" performances. We need to develop an evolutionary understanding for information behavior and conduct further experiments to support psychometric findings and a symbol system.

Information Behavior Evolves over Human Lifetime Development

This is another under-researched area of information behavior. We need to move forward in this area by taking a good look at the field of human development and thinking about information behavior from a human development perspective. Again, a lot of research has been conducted into mapping the stages of human cognitive development and the development of human life histories. The framework for mapping the lifetime development of information behavior is already available from the field of human development.

Advancing every aspect of information behavior is important. Many of the previous discussed dimensions, such as origin and evolution are much harder to explore. But making a start on mapping the human lifetime development of information behavior is feasible with a basis in the human developmental sciences. A good

understanding will require a quite long term view and possibly longitudinal studies. Tracking the emergence and development of people's information behaviors from childhood to adulthood would be very valuable from a scientific point of view. But also from the point of view of an ordinary person, understanding more about your own cognitive development has great value.

Information Behavior Theoretical Framework

For most people their information behavior is something they partake in, probably on a daily basis, but generally they don't think about. It's not a conscious thing they think about. But if they did try to think about their information behavior by reading a book about information behavior – they would probably be confused. We have no clear theoretical framework for mapping the levels and dimensions of information behavior and thus no complete models of information behavior. We have some models of information seeking, some of information foraging, and one attempt at an integrated information behavior model (Spink & Cole, 2005), some others models, etc. But nothing that helps ordinary people say – yes that makes sense to me and I now understand more about my information behavior.

So in the framework in Fig. 2.2 has been presented as a fairly high-level model based on the key propositions discussed in the book. Of course, every model is incomplete and in need of enhancement. But unless we ground our theoretical framework of information behavior in solid dimensions such as an evolved cognitive mechanism, socio-cognitive ability, etc, then our more detailed, more cognitive psychology models of information behavior will not be grounded in the major findings in the evolutionary, cognitive, and social and behavioral sciences.

To develop those more complex and sophisticated cognitive psychology models of information behavior, we need to develop them to the extent that they are tested and retested, and then presented to not only other information behaviorists, but also presented to other cognitive, social and behavioral scientists for further validation. Theoretical frameworks and models of information behavior cannot be isolated from the other social, cognitive and behavioral sciences. Otherwise, the work of information behaviorists will have no broad impact, and will be either ignored by other behavioral fields or supplanted by them. Information behavior is growing as the purview of many fields. The best and most viable model and theories will survive and be accepted across the broad sciences.

Conclusions

Cleary, there is a great deal more to know about our information behavior to help us understand the holistic nature of the phenomenon. We need both broad and more detailed research into information behavior by early humans to modern humans in the social and behavioral sciences. This exploration is a major challenge

for information behavior which is a quite small research field. However, top quality fundamental research is always possible and is critically needed to move our understanding of information behavior forward.

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Index

A. Spink, *Information Behavior*, Information Science and Knowledge Management 16,
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