CHAPTER 8

The Layperson and Open Access

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Introduction

In this chapter we examine the benefits of open access for laypeople and how this subject relates to information seeking behavior, the public understanding of science, and science communication research. The goal of the Open Access (OA) movement is to promote science and the public good by making the scholarly research literature freely and openly available via electronic journals and digital repositories. Open access was created by scholars for scholars to increase the dissemination of knowledge and the impact of new research and its social utility. Scientists and scholars benefit from open access but their work is a public good; therefore, thought should be given to how this movement will eventually affect the knowledge base and interests of laypeople.

Studies concerning the public understanding of science suggest that members of the general public should become more aware of scientific research if they wish to ground their opinions about science and decide which science-related policies and politicians to support (Sturgis & Allum, 2004). Research also shows that since the 1950s, the U.S. has seen an increase in laypeople's understanding and knowledge of science and scientific processes (Miller, 2004). The technologies of OA—that is, digital repositories and electronic journals—can satisfy curious minds and play a role in the development of civic scientific literacy. New research is needed, however, to determine: (a) where and how laypeople look for peer-reviewed literature, (b) how they make sense of it and use it for everyday purposes, and (c) what type of Web strategies are needed to make evident the value of new scientific results. If more laypeople begin to look for and use open access literature, opportunities may arise for them to "discuss and clarify the public value of science" (Wilsdon, Wynne, & Stilgoe, 2005, p. 29).

The primary aim of open access is to bring about changes to the scholarly communication system so that peer-reviewed research is freely available on the public Internet, thus

> permitting any users to read, download, copy, distribute, print search, or link to the full texts of these articles, crawl them for indexing, pass them as data to software, or use them for any other lawful purpose, without financial, legal, or technical barriers other than those inseparable from gaining access to the Internet itself. (Budapest Open Access Initiative, 2002, online)

Various approaches to open access have been tested and proposed. Archived preprints in institutional repositories (the green route) and online journals without subscription fees (the gold route) have been discussed and debated widely (e.g., Drott, 2006; Esposito, 2004; Harnad, 2003, 2006; Jacobs, 2006; Koehler, 2006; Regazzi, 2004; Swan, 2005; Willinsky, 2003).

It is important to recognize that open access indeed means *open*; thus, peer-reviewed scientific research is and will be available to experts as well as to members of the lay public. Inproved accessibility for scholars "should allow this literature to have a greater impact on future research" (Kurtz & Brody, 2006, p. 45) and "could ultimately lead to a more cost-efficient scholarly publication system" (Ginsparg, 2007, online). The Internet, however, is not just a communication medium for scholars; millions of laypeople are also on the Web, accessing and creating Web sites, reading and writing blogs, and sharing information about everyday personal and political concerns. Willinsky's (2006, p. 111) view is that the open access literature may

> mean little enough, admittedly to most [lay]people, most of the time. Still, it is not difficult to imagine occasions when a dedicated history teacher, an especially keen high school student, an amateur astronomer, or an ecologically concerned citizen might welcome the opportunity to browse the current and relevant literature pertaining to their interests.

We are at the dawn of a new scholarly communication era, thus it is appropriate to consider how OA will affect the information seeking practices of the general public. What do we know about laypeople and how they look for and use peer-reviewed scientific research? What do they understand when they encounter this literature? Also, given the long tradition of science communication in society (i.e., the translation of scientific language to ordinary language in the news and other forms of media) what do we know about the mediation of new research and how can open access literature contribute to the public understanding of science? This chapter addresses these questions based on a review of three fields of study: (1) information-seeking behavior, (2) the public understanding of science, and (3) science communication in society. Each field comprises its own particular theories and research results, which traditionally have not been well integrated. It is not our intention to review or integrate all

literatures from these fields but rather to draw upon specific points of insight to answer the following question: Is there an open access advantage for laypeople?

Key Concepts and Scope

The concept of laypersons or laity appears repeatedly throughout this chapter; hence we begin with the following definition: "the mass of the people as distinguished from those of a particular profession or those specially skilled" (Merriam-Webster, Inc., 2007, online). Open access is designed primarily to support the information needs of skilled professionals, specifically researchers, scholars, and scientists. Scholars and scientists belong to unique disciplinary communities, sometimes referred to as "academic tribes and territories" (Becher & Trowler, 2001). They receive special training in the methods of their disciplines and, with other professionals like themselves, engage in information sharing and production. The training required to become a scientist/scholar requires a long-term investment in education and involves gatekeeping by senior researchers, already established in the profession. Generally a person is not a member of a scientific "tribe" until he or she (normally a doctoral student) can provide sufficient evidence of an ability to conduct valid and reliable research.

A layperson may be categorized as a scientist or a nonscientist, depending on his or her orientation to the scholarly research literature. For instance, an individual who is trained in scholarly research might possess a layperson's orientation, if the information sought is outside his or her area of expertise and needed for personal use, rather than for reasons associated with scholarly work. An example is a physicist with a family history of heart disease who wishes to monitor the latest research on pharmaceutical treatments. If an individual has no advanced training in scientific methods and is not affiliated with a research tribe, he or she is clearly not a professional scientist; nevertheless, this type of layperson (e.g., a high school teacher) could still be sufficiently educated and knowledgeable to appreciate new research. To understand how laypeople might look for and use open access literature, it is important to examine their everyday information needs and information-seeking behaviors.

At present, it is difficult to conceptualize fully the layperson's open access advantage. Open access is typically viewed from the perspectives of scholarly communication, scientific exchange, publishing economics, and issues of distributive injustice (see Jacobs, 2006); the broader implications of lay access to specialized knowledge (i.e., scholarly research) are less widely discussed. The Budapest Open Access Initiative (2002, online) states that

> the public good is the worldwide electronic distribution of the peer-reviewed journal literature and completely free and unrestricted access to it by all scientists ... and other curious minds. Removing access barriers to this literature will accelerate research, enrich education, share the learning of the rich with the poor and the poor with the rich, make this literature as useful as it can be, and lay the foundation for uniting humanity in a common intellectual conversation and quest for knowledge.

If open access is expected to "lay the foundation for uniting humanity in a common intellectual conversation," laypeople will have to demonstrate a motivation to look for and read peer-reviewed scientific literature, as often, perhaps, as popular scientific literature (e.g., a magazine such as *Scientific American*). Once this literature is found and read, they will have to work toward understanding it; and if it is not understood, then someone will have to interpret it for them. In basic terms, advantage refers to "the benefit resulting from some course of action" or "a factor or circumstance of benefit to its possessor" (Merriam-Webster Inc., 2007, online). Open access to peer-reviewed research could lead to myriad advantages (not to mention challenges) for laypeople but much remains in the realm of speculation.

The Budapest Open Access Initiative statement requires clarification: It is difficult to imagine all of humanity united by a "common intellectual conversation" concerning peer-reviewed research if we cannot determine what constitutes a common level of scientific literacy. In the United States, the prevalent view is that a scientifically literate person is "able to read with understanding articles about science in the popular press and to engage in social conversation about the validity of the conclusions" (National Academy of Sciences, 1996, online). In an open access society, however, this may not be enough. To appreciate the open access literature, the layperson will need to understand the terms used in scientific investigations (e.g., greenhouse gases), the methods used (e.g., experiments) and the social and political contexts in which an investigation was carried out. Some laypeople might have the ability to evaluate critically the social strengths and weaknesses, limits, potentials, benefits, and costs associated with the results of a scientific investigation but this depends on the degree to which an individual is university educated and/or committed to learning about science.

Open access is enabled by the Internet; and the Internet is global so it is in the best interests of scholars and scientists to involve as many countries as possible in the open access movement. The green route to open access allows institutions and research communities to develop digital repositories and record their presence on the Web at the Registry of Open Access Repositories (ROAR). The contents of these repositories are growing worldwide; therefore, scholars and curious laypersons can now browse them or carry out searches to see what kind of peer-reviewed literature is available (see roar.eprints.org). The gold route to open access can also be monitored at the Directory of Open Access Journals (a Swedish project),

which lists more than 2,900 open access journals worldwide as of November 2007 (www.doaj.org). Because the United States and the United Kingdom have been active in promoting open access, the reader will notice that most of the research and examples referenced throughout this chapter come from these countries. Some of the work may be generalized to other countries; however, the aim of this chapter is not to make strict geographical comparisons but to use selected works to identify knowledge gaps and generate ideas for future research.

Information-Seeking Behavior

Information-seeking-behavior research is concerned with modeling the cognitive and affective behaviors of individuals with information needs, including how those needs arise in context (Wilson, 1981, 1999) and how individuals make sense of situations to bridge knowledge gaps (Dervin, 1992), manage feelings of uncertainty (Kulthau, 1997), and move through stage-related processes (Ellis, 1989; Ellis, Cox, & Hall, 1993; Kulthau, 1991). Information-seeking behavior occurs in various information use environments (Taylor, 1991) and when an individual receives information, it has the potential to change his or her knowledge structure (Cole, 1997).

Research in this field has been carried out to understand the information-seeking behavior of professionals (e.g., Andrews, Pearce, Ireson, & Love, 2005; Brown, 1999; Ellis et al., 1993; Meho & Tibbo, 2003; Noble & Coughlin, 1997; Wessel, Tannery, & Epstein, 2006), retired individuals (e.g., Chatman, 1991), the working poor (Spink & Cole, 2001; Wilson, 1983), urban teenagers (Agosto & Hughes-Hassell, 2006), and adolescents (Meyers, Fisher, & Marcoux, 2007). Information scientists also study how people look for information on the Web (e.g., Choo, Detlor, & Turnbull, 2000; Ford, Miller, & Moss, 2005a, 2005b; Large, 2004; Savolainen, 1999; Savolainen & Jarkko, 2006; Tombros, Ruthven, & Joemon, 2005) now that the Internet has become a fairly domesticated resource (see Haythornthwaite & Wellman, 2002; Rieh, 2004).

Wilson (1994, 1999), Pettigrew (2001), and, more recently, Savolainen (2007a) have examined core concepts associated with this field. The historical development of information needs and uses research has also been reviewed in *ARIST* by Case (2006), Hewins (1990), Dervin and Nilan (1986), Crawford (1978), Martyn (1974), Lin (1972), and Paisley (1968). In this chapter, only selected research will be emphasized. The term layperson applies to a broad range of people, hence we examine a few cognitive-affective theories of information seeking first, in order to appreciate how people in everyday situations might be motivated to look for and use the open access literature (see also Fisher & Julien in the present volume).

Theories of Information Seeking

In everyday contexts, people can be active information seekers but often they demonstrate less directed, discovery-oriented information seeking that is essentially passive in nature, such as when watching television (Krikelas, 1983; McKenzie, 2003; Savolainen, 1995; Wilson, 1997). Savolainen's (1995, 2005) theory of everyday life information seeking (ELIS) focuses on the basic concepts of "mastery of life" and "non-work" information seeking (Savolainen, 1995, pp. 250–260). The mastery of life may be either passive or active and includes "ways by which individuals orient themselves in (typical) problem situations and seek information to facilitate problem solving" (Savolainen, 1995, p. 265). Non-work information seeking is difficult to determine but generally it is associated with activities outside the workplace. To master life, an individual may try to maintain a sense of order by adopting either an optimistic or a pessimistic view. Savolainen's (1995, pp. 265–268) "mastery of life" typology includes the following psychological variables, which may intervene during problem solving: optimistic-cognitive; pessimistic-cognitive; defensive-affective; pessimistic- affective. In other words, when a person encounters information for problem solving, he or she may have positive or negative thoughts, incorporate information into his or her knowledge structure, or feel that it is best to avoid the information altogether if overwhelmed or uncertain to the point of being pessimistic.

Everyday information seeking can also be characterized in terms of making connections with sources and interacting with sources, including all possible barriers (McKenzie, 2003). A person has the potential to connect and interact with an information source either through active seeking, active scanning, non-directed monitoring, or by proxy (i.e., an agent who looks for information on the person's behalf). Contextual factors can create an environment in which a person is comfortable asking questions to generate information. In a specific context or environment, *sources* of information (for instance, parents, friends, caregivers, or teachers) may be easy to identify; in another setting it may be easier to identify an appropriate *target* for someone offering information (McKenzie, 2003).

Activating mechanisms, such as stress, often motivate a person to determine an everyday information need (Wilson, 1999). The psychological state of the person, his or her demographic situation, or one or more characteristics of the information source can also create a barrier to satisfying the need. If a person is faced with a cognitive or psychological barrier, another activating mechanism may be aroused—a mechanism related to social learning theory or risk/reward theory—to initiate information-seeking behavior. This could involve a passive search, an active search, or an ongoing search until the person has successfully reached the stage of information processing and use.

Information use, according to Dervin (1992, 1998, 1999, 2003) may be characterized in terms of gap bridging. From a methodological standpoint,

an information-seeker-in-context can be asked questions to understand how he or she perceives a knowledge gap, finds relevant information, interprets it, and makes sense of it. Across a time-space continuum, a metaphorical bridge is built by the individual as he or she begins to overcome the knowledge gap. The process of sense making includes affective and cognitive elements, and actions taken by the individual can be both internal (i.e., cognitive) and external (i.e., procedural).

Significant theories, such as those just described, inform the study of information seeking but researchers have yet to use them to examine how laypeople look for and use peer-reviewed scholarly literature. Little is known about their motivations or habits in this regard but we do know that scholarly research is and should be available to them. In his book, *Public Knowledge, Private Ignorance*, Wilson (1977, p. 3) states that

> scholars and scientists engage in attempts to make contributions to a public body of knowledge about the world. They do not work simply to increase their own private understanding of the world, nor simply to increase the understanding of their co-workers in a specialized branch of inquiry. Their work is incomplete until they have made their results public, available to anyone, now and in the future, who can understand and make use of them. Scholarly and scientific inquiry is a public enterprise with a public goal, that of adding to or improving the public stock of knowledge.

Open access assumes that scholarly research results can be useful to the layperson and can increase the public stock of knowledge. However, the process of using and reading scholarly literature is normally associated with students, university professors, and other research professionals: "[journal] reading helps them keep up with the literature of their disciplines and supports lifelong learning, as well as providing an important resource for research, teaching, administration, and other endeavors" (King & Tenopir, 1999, p. 423). Many scholars are still grappling with the implications of electronic publishing for authors, librarians, publishers, administrators, and academics but not for society in general (see Rowlands, 2007). Peer-reviewed science is simply not viewed as everyday reading. If a layperson wants access to it for personal use, there is an underlying assumption that he or she is a subject expert or possesses skills and personal characteristics similar to the professional.

Information Source Selection and Credibility

In everyday contexts, information means different things to different people; thus it is important to understand how individuals select their information sources and how they make judgments concerning an information source's credibility.

In a work context, a scientist will typically start the process of information seeking by discussing a problem with a colleague. He or she may also browse through relevant literature and continue to monitor new scholarly research. Following citations in the literature is called chaining, and looking for differences between research papers is what the scientist will do to decide which ones to filter (Ellis et al., 1993). If a scientist engages in habits such as this in a professional context, might he or she employ similar habits when dealing with a non-work information need? Indeed it is possible—earlier we introduced the idea that a physicist with a family history of heart disease might possess a lay interest in monitoring new pharmaceutical research, even though it is outside his or her area of expertise. Given (2000, 2002) emphasizes the notion that everyday information seeking "allows for [some] overlap between work and non-work information needs" and that academic contexts and everyday contexts can sometimes influence one another (Given, 2002, p. 18). An individual's social capital (e.g., networks of academic colleagues) and cultural capital (e.g., familiarity with scholarly resources) can play a significant role in both contexts.

Many individuals are not scientists, hence the notion of social and cultural capital can take on an entirely different meaning. Agosto and Hughes-Hassel (2006, p. 1394) note that "the essence of teen everyday information seeking is the gathering and processing of information to facilitate teen-to-adult maturation." The public library might be considered an ideal resource, yet the authors note that many teenagers simply turn to family, friends, and teachers. African-Americans from low-income households also focus their information needs "on family members and on neighbors, with lower use of external channels, except for health and employment issues" (Spink & Cole, 2001, p. 45). Low-skilled workers, working-class individuals, and retired women prefer humans as information sources and put more faith in people who are part of their immediate social milieu, rather than outsiders. Outsiders are viewed as being less credible or less capable of responding to the person's everyday concerns (Chatman, 1991; Wilson, 1983).

Credibility is a concept that we associate with believability: "credibility strongly influences the impact of a message," thus "it becomes important to understand how users decide what to believe" (Wathen & Burkell, 2002, p. 134). Credibility also relates to cognitive authority because both are perceived in terms of quality (Wilson, 1983). A person will judge whether a piece of information or person delivering information is a quality source and whether to trust the source (Fogg & Tseng, 1999; Rieh, 2002; Self, 1996). Some laypeople will presume that an information source is credible; others may think that a source is credible by virtue of its reputation (e.g., a doctor, a scientist, a research organization). Credibility judgments can also be based on the superficial scanning of an information source or repeated first hand experience with the source (Tseng & Fogg, 1999).

When a scholarly information source is consulted, Liu (2004) recognizes two additional factors: verifiable credibility and cost-effort credibility. A scholarly document is verifiably credible if a user can see that it has been evaluated, cited, linked to another credible source on the Web, or published in a printed journal. Cost-effort credibility refers to the document's ease of access and whether a piece of Web-based information is free, must be purchased by the user, or requires a subscription fee. Liu (2004) suggests that "the ease in accessing free scholarly information may have an impact on credibility perception." Laypeople "may take free information from the Web for granted" and/or find it increasingly difficult to determine which document should be believed and used (p. 1036).

Media credibility studies focus on the medium delivering the message and the user's preference for that medium's presentation and content. In both Germany and the United States, members of the general public gave the Web a high credibility rating but newspapers were still rated higher (Flanagin & Metzger, 2000; Johnson & Kaye, 1998; Schweiger, 2000). One criticism of media-based research is that it fails to "explore how these credibility differences arise" (Wathen & Burkell, 2002, p. 135). Savolainen (2007b, p. 11) recognizes that "most people find it difficult to assess questions of cognitive authority and media credibility" because the "assessments tend to be situationally sensitive." Wathen and Burkell (2002) also suggest that the credibility of online sources of information is best measured through an iterative process: a user may be asked to rate the credibility of the medium first, based on surface characteristics, and second, vis-à-vis the content of the message. A researcher should also observe how the message presentation and content interact with the user's cognitive state, given that users with a high need for information, or users who are motivated by stress, will likely overlook weak or inconsistent peripheral cues.

Although the concept of credibility has not been explored intensively in relation to science, Treise and colleagues (2003, p. 310) note that it is indeed "a common currency for sources and audiences of [online] science information." People who demonstrate a "high involvement in science (as measured by science background, interest in science, and importance of staying informed about science) exhibit stronger motives to use the Web for science information and report using the Web to visit science sites more often" (p. 325).

When asked which type of Web sites presented the most trustworthy science stories, undergraduates studying science, engineering, and mass communications at an American university indicated a preference for .gov sites over .com sites. According to the researchers, "government institutions were perceived to have the most to lose if they [were not found to provide credible information]" (p. 329). This finding also means that persons who are not highly involved with science information, or who believe that use of the information will not pose serious consequences, are more likely

to form an opinion about a message using cues surrounding the message, such as the Internet domain.

Online Information Seeking and Healthcare

Because much information on the Web pertains to healthcare, a number of scholars want to know how and why adolescents, adults, and senior citizens search the Internet for health and medical treatment literature (Cline & Haynes, 2001; Eysenback & Kohler, 2002; Flynn, Smith, & Freese, 2006; Goldner, 2006; Gray, Klein, Noyce, Sesselberg, & Cantriw, 2005; Warner & Procaccino, 2004). Goldner's (2006) research indicates that the sick and disabled are most likely to turn to the Internet for health-related information; however, findings from the Pew Internet & American Life Project also confirm that "80 percent of adult Internet users, or about 93 million Americans, have searched for at least one of 16 major health topics online. This makes the act of looking for health or medical information one of the most popular activities online, after e-mail (93 percent) and researching a product or service before buying it (83 percent)" (Fox & Fallows, 2003, p. 2).

Fox and Fallows (2003, p. 2) asked health-information seekers what they thought was missing during their online searching of the Web; many said that they wanted "access to information-laden sites that are currently closed." Expanded access to peer-reviewed literature was not specified; yet, forty percent of survey respondents stated that they had "at some point searched online for information about a certain medical treatment or procedure" (p. 7). One respondent wrote that she liked to take "peer-reviewed medical journal articles to her orthopaedist" and although she was not eager to insist that her doctor carry out a particular procedure, she wanted "to use the articles as a starting point to discuss new treatment options" (p. 7).

Consider the problem of HIV/AIDS. On one hand we know that scientists are involved in HIV/AIDS research and on the other that people are living with the virus/disease. Even if HIV/AIDS has not affected an individual personally, he or she might still be concerned about it. We know that individuals can be passively attentive to information they receive regarding HIV/AIDS but some might also actively look for information or have others search for it on their behalf. Medical treatment information may be sought by individuals with HIV/AIDS to help them cope with the uncertainty surrounding their disease. In this context, the information needs of a layperson can have critical implications.

Hogan and Palmer (2005, p. 431) found that people living with HIV/AIDS prefer "getting information from people—including health professionals, family and friends" because people were considered the "most trustworthy and understandable" option. Following a survey of 662 respondents, results showed that "43 percent selected doctors as their most preferred source. The Internet was not rated highly overall but was preferred by those with more education or living in metropolitan areas"

(p. 431). A significant proportion of surveyed individuals (73 percent) also said that they would "actively search for HIV/AIDS-related information" and 80 percent would even "give advice or tell others where to get such information" (p. 431).

People may also seek AIDS-related literature to satisfy political interests. Moore (2006, online) notes that there is "a small clique of scientists and scientifically ignorant laypersons [who] promote the bizarre view that HIV does not cause AIDS, or in a particularly dubious variant of the genre, that HIV does not actually exist." As an HIV/AIDS scholar, Moore (2006, online) fears that there is a cross section of "politically motivated, lazy, and unscrupulous" people in society who will look for and use "peer-reviewed literature selectively, to make arguments that are seriously flawed, or even damaging to public policy."

Researchers generally understand that when a piece of scientific information has not been peer reviewed, it should not be taken seriously. At the same time there are limitations to peer review and even this established system has its flaws. Moore (2006, online) asserts that "not everything in the peer-reviewed literature is correct" and that for most professional scientists, "scientific truth evolves on the basis of a mounting consensus, not through an isolated paper that adopts a maverick position, even if it is peer reviewed." If laypeople are not aware of the limitations of peer review, and that some journals are more stringent than others in terms of what is accepted for publication, there may be consequences. Moore (2006, online) expects a professional researcher to "[laugh] at the notion that HIV does not cause AIDS, [but] some vulnerable, newly infected people, who would like to believe that they have not just contracted a deadly virus, [could] end up surfing the Web for answers."

To some degree, Moore's concern about the surfing habits of laypeople is justified. Research relating to source credibility and online health information has shown that source credibility "has little or no effect on consumers' perception of quality" because users may not be "used to comparing different sources of health information on the Internet," tending to believe "that one Webpage is as good as any other Webpage" (Bates, Romina, Ahmed, & Hopson, 2006, pp. 49–50). Eastin's (2001) research, on the other hand, indicates that people are not altogether unwise. Students were asked to assess the credibility of various health-related Web sites and indicated that a site authored by a doctor who has treated AIDS patients was more credible than a site authored by an AIDS patient or one of his or her family members. Toms and Latter (2007) note that the formulation of a good search query is one of the biggest challenges for people when they surf the Web; making efficient selections from results lists is also difficult. Systematic differences also tend to occur among individuals' most trusted sources of health information. Dutta-Bergman (2003) explains that some people place most trust in their personal doctor or a university-based medical Web site but others

believe that online health information is trustworthy if it is associated with the federal government.

People often engage in health-related information seeking to reduce uncertainty; but "uncertainty is typically tied to feelings of anxiety ... so, acquiring information is to be desired not merely for its instrumental value ... but, also for its emotional value" (Case, Andrews, Johns, & Allard, 2005, p. 355). If a layperson does not understand the context of medical research or the nature of peer review, he or she may be motivated to select literature that will ease anxiety or fear or confirm a previously held belief. Of 21 million American health information seekers "who [said] that they were swayed by what they read online ... 70 percent said that the Web information influenced their decision about how to treat an illness or condition" (Fox & Rainie, 2000, p. 3).

Even if medical treatment literature has the potential to reduce uncertainty or influence decision making, the layperson is likely to find it cognitively challenging. Evidence of a cognitive source barrier is seen in Baker and Gollop's (2004) reading comprehension study of medical textbooks dealing with adult and juvenile diseases. Students were asked to read excerpts from the textbooks and indicate words that they did not understand. Most were "unable to comprehend some of the terms they would need to know to get a clear understanding of the disease in question" (p. 6). In order to make well-informed healthcare decisions, Baker and Gollop (2004, p. 6) suggest that laypeople "supplement their reading of medical textbooks [including peer-reviewed research literature] with material that is more lay-oriented or consult appropriate reference sources, such as medical dictionaries."

Summary

What do we know about laypeople and how they search for and use peer-reviewed research literature? Little is known about how or why laypeople look for and use the scholarly/scientific research literature but we know in general that individuals who search for information often do so as a coping mechanism, as a result of stress, or because they are motivated to find answers to weighty problems. People also have particular source preferences and an individual's preference usually depends on the information source's familiarity and credibility within a particular social milieu.

The Internet has become a significant tool for information seeking, both at home and at work, and people who search the Web are often interested in health-related materials. Medical treatment literature is just a portion of the research produced worldwide; yet as it becomes increasingly accessible, it will be critical to understand how people make sense of it and use it for personal decision making. Many individuals, however, will face the challenge of overcoming cognitive and/or psychological barriers but should be able to do so with appropriate resources. The general benefit to laypeople is that if they are able to make sense of

open access literature (medical or otherwise), they will have the opportunity to satisfy their curiosity, find solutions to problems, and improve their scientific information literacy. Before we discuss this lay advantage further, let us first examine research on the public understanding of science and science communication.

Public Understanding of Science

Core Theories and Research

Research on information-seeking behavior focuses on individuals with information needs and the actions taken to satisfy those needs; research concerning the public understanding of science, however, focuses on the degree to which laypeople "understand the process or nature of scientific inquiry" (Miller, 2004, p. 273). Most scholars and scientists agree that we want a scientifically literate public so that citizens understand the progress of science and the impact it can have on daily life. Many also believe that a scientifically literate public "needs to have sufficient levels of accurate information on which to base their assessments of policy alternatives [so] that their policy preferences best reflect their own self or group interests" (Sturgis & Allum, 2004, p. 56).

In the scholarly literature, there are two dominant theories regarding the public understanding of science; one is the deficit model and the other is the contexualist perspective. Scholars who favor the deficit model assume that people are "deficient" in their knowledge of science and that due to "a lack of proper understanding of relevant facts, people [will] fall back on mystical beliefs and irrational fears of the unknown" (Sturgis & Allum, 2004, p. 57). Proponents of the contextualist perspective assert that it is not enough for laypeople to have a textbook understanding of science—that is, to "recall large numbers of miscellaneous facts" but also to have "a keen appreciation of the places where science and technology articulate smoothly with one's experience of life" (Sturgis & Allum, 2004, p. 58; see also Jasanoff, 2000). An optimal level of understanding can only be the result of a set of combined elements. First the layperson has to understand the formal content of scientific knowledge. Secondly, he or she needs to understand the methods and processes of science, and thirdly, it is critical for members of the general public to recognize science's "forms of institutional embedding, patronage, organization, and control" (Sturgis & Allum, 2004, p. 58; see also Wynne, 1992).

Survey research over the past twenty to thirty years has generated significant insights into the nature and extent of scientific literacy. Much of this research has been carried out in the U.S. but studies have also been conducted in Europe and other parts of the world (Bauer, Durant, & Evans, 1994; Evans & Durant, 1995; Luján & Todt, 2007; Miller, Pardo, & Niwa, 1997; Pardo & Calvo, 2004). Miller (2004, p. 273) has studied the public understanding of science extensively, noting that "the proportion of U.S. adults qualifying as being scientifically literate

has doubled over the last two decades." In spite of noticeable changes, "the current level is still problematic for a democratic society that values citizen understanding of major national policies and participation in the resolution of important policies" (p. 273). According to Miller (2004, p. 273) "17 percent of U.S. adults qualified as being scientifically literate by the end of the twentieth century and this level is equal to the levels estimated for Britain, France, Denmark, and the Netherlands, and better than all other countries, including Japan and other members of the European Union."

What does it mean to understand science? Miller (2004, p. 274) suggests that laypeople need a level of scientific literacy that is "sufficient to read and comprehend the Tuesday science section of the *New York Times*." This definition is considered acceptable but the study of scientific literacy should be sensitive to a variety of factors. A conceptual framework presupposes that laypeople approach scientific literacy when they begin to understand the nature of scientific study, including the concepts of experimentation and probability, and the use of specific constructs in scientific literature, such as DNA, radiation, molecule, and stem cells (Miller, 2004).

Davis's (1958, p. 274) early research found that ten percent of survey respondents from the United States recognized that scientific study "meant using experimental method or other rigorous study methods. Four percent emphasized that scientific study required an open-minded approach, scepticism, and suspended judgement [and] approximately half ... said that scientific study meant thorough and careful analysis." Over the last four decades, "the percentage of U.S. adults with a minimal level of understanding of the meaning of scientific study has increased from 12 percent in 1957 to 21 percent in 1999" (p. 276). Miller (2004, pp. 276–277) attributes this change over time to "continuing increases in the proportion of adult population who have had some college-level experience."

Research concerning the public understanding of science should not disassociate itself from the level of awareness that citizens have about specific research areas or projects (e.g., the genetics of Alzheimer's disease, genetically modified food, the Hubble telescope's view of the universe, and research on global warming and climate change) nor should it ignore the attitudes people hold toward science and scientific research (Miller, 2004). Contrary to what some might think, "a low level of understanding of basic scientific research constructs does not correspond with a lack of public appreciation of, or support for scientific research" (p. 284). Miller (p. 284) has also found that "80 percent of U.S. adults have held a positive view of the benefits of science and technology," even if they are aware of certain risks. Individuals may recognize the value of scientific research but can, at the same time, possess legitimate concerns about how science and technology affect or will affect their daily lives and society.

A father, for example, may be compelled to look for information when he learns that his child has been diagnosed with a rare disease, but will he understand the scientific basis of the disease? The film *Lorenzo's Oil* tells the true story of the Odone family, Augusto and Michaela, and their son Lorenzo's struggle with Adrenoleucodystrophy (ALD)—a genetic disorder characterized by the deterioration or loss of the myelin sheath surrounding nerve cells in the brain. Augusto consulted many physicians regarding his son's condition but the information he was given did not satisfy him. In spite of one doctor's recommendation to avoid the medical papers ("don't bother, you won't understand them" [*Lorenzo's Oil: The Full Story*, 2004, online]), Augusto was determined to learn more about the causes of ALD. He spent countless days at a medical library searching for and reading relevant research. Augusto's determination was so exceptional that he was awarded an honorary Ph.D. for his role in the discovery of two monounsaturated dietary oils, which can normalize the level of very long chain fatty acids in the blood of persons with the ALD gene. Lorenzo is still living today and his father Augusto is now head of a foundation that funds research into diseases that destroy myelin (see The Myelin Project homepage: www.myelin.org/overview.htm).

This true story demonstrates that intelligent laypeople can learn and understand enough about science to promote a research agenda that is important to them. Augusto Odone's initial information-seeking behavior was motivated by a need to save his son from rapid physical deterioration. Later, the film conveys another side to his motivation: a level of mistrust in what biomedical scientists were doing at the time to help eradicate the symptoms of ALD.

A report produced in the United Kingdom shows that the issue of trust is centrally important and that members of the general public have become somewhat skeptical about science:

> society's relationship with science is in a critical phase. On the one hand, there has never been a time when the issues involving science were more exciting, the public more interested, or the opportunities more apparent. On the other hand, ... many people are deeply uneasy about the huge opportunities presented by areas of science including biotechnology and information technology, which seem to be advancing far ahead of their awareness and assent. (House of Lords Select Committee, 2000)

Clearly, some individuals will fear that science is advancing beyond their understanding but others, such as Odone, may want to know more about science and specific research areas because they feel that it is not advancing rapidly enough.

Summary

What do laypeople understand when they encounter peer-reviewed research literature? Because the open access movement is still in its infancy, the public's understanding of science has probably changed very little. However, certain individuals will be motivated to develop new levels of understanding.

Open access technologies, such as institutional repositories and e-journals, could eventually trigger changes in laypeople's search behaviors. Miller (2004, p. 291) believes that new research is needed to "monitor the impact of the information technology revolution on the development of scientific literacy." His central thesis, pertaining to "what we know" versus "what we need to know" (p. 273), is that at present the cumulative Public Understanding of Science (PUS) literature "provides limited evidence about changes in adult information seeking, retention, and use" (p. 290). Consequently, "there is a compelling need to invest in adult studies that will map the dynamics of human information acquisition, retention, and use in general and in regard to science" (p. 290).

Science Communication

Core Theories and Research

Science communication is the interpretation and presentation of scientific knowledge and scientific results in language accessible to a lay audience. Scientific production is "aimed at the advancement of knowledge" and scientific communication is "aimed at bridging the distance between science and the public" (Bensaude-Vincent, 2001, p. 99). The impetus for bridging this gap is the "political duty in democratic societies to inform citizens" (p. 99). Or is it?

According to Bensaude-Vincent (2001, p. 100), critics of science communication view the gap as an "ideological entity created by science popularizers in order to position themselves as mediators." Other scholars, for example Jurdant (1969) and Hilgartner (1990), have examined the "vulgarisation scientifique" or "noble mission" that science mediators or popularizers have undertaken to "bridge the social gap between 'savants' and 'ignorants'" as part of a "rhetorical strategy of self-legitimization" (Bensaude-Vincent, 2001, p. 100). Hilgartner (1990) argues that the popularization or gap-bridging process is often oversimplified and that the task of differentiating scientific knowledge from popularized knowledge is not necessarily straightforward. At best the process is an appropriate simplification and at worst a grave distortion. It is a process that best serves scientists and those who derive their authority from science because it is "a form of power, useful for influencing downstream audiences" (p. 531). An alternative view put forth by Fleck (1979) is that the problem with the popularization process is not so much the gap itself, but the reversioning that a piece

of scientific knowledge (i.e., an article) goes through before it is deemed suitable for the public. Bensaude-Vincent (2001, p. 100) further explains that "the communication of ideas always results in a change of the content, and each passage from one collective to another one creates a new meaning rather than simply transferring a stable message." Although a gap usually does exist we should consider Latour's (1987) notion that such a state of affairs is natural and that the technical nature of scientific literature is not in itself a bad thing, but essential to the construction of hard facts.

How can we limit or close the gap between scientific research and the public? During the 1970s and 1980s the black box of scientific knowledge production was opened up in Europe, when science shops were first created in The Netherlands (e.g., Leydesdorff & van den Besselaar, 1987; Leydesdorff & Ward, 2005). The objective of the science shop was to develop "a working relationship between knowledge-producing institutions such as universities and citizen groups that need answers to relevant questions" (Leydesdorff & Ward, 2005, p. 353). In other words, if scientists exist at one end of the spectrum and members of the general public are at another, the role of the science shop is to engage the public in scientific knowledge production rather than simply educate them about what is happening behind closed doors. Science shops as mediating agents were initially (but not always) linked to universities and gave students opportunities to fulfill graduate program requirements. Across Europe they have taken on different roles; for example, some of the Dutch science shops from the first wave of development in the 1970s (e.g., Utrecht) "were heavily engaged in political actions outside the university" but newer science shops in Austria "mainly provide[d] university students with possible topics for their Master's thesis" (Leydesdorff & Ward, 2005, p. 359).

The co-production model of science (e.g., science shops) reinforces the idea that "laypeople have knowledge and competencies which enhance and complete those of scientists and specialists" (Callon, 1999, p. 89). However, the public education model tends to be more common. Co-production models of science target citizen groups who are likely to have research questions—for example, people belonging to trade unions, pressure groups, nonprofit organizations, social groups, environmentalists, or consumers—whereas general education models of science communication exist widely for everyone regardless of what people want to know.

Bensaude-Vincent (2001, p. 103) notes that the first magazines created to "spread science ... are still published today including the *Scientific American*, founded in 1845, and the British weekly *Nature*, founded in 1869. In French and British newspapers, scientific news moved into daily columns along with the political, social, economic, and literary news." In the U.S., Americans can read the *New York Times* science section and there exists a variety of different science-education columns produced for citizens worldwide.

Moynihan, Bero, Ross-Degnan, and Henry's (2000) research concerning news stories shows that there can be pitfalls: Often the reporting is too enthusiastic and includes inadequate or incomplete information about benefits and risks (particularly in the pharmaceutical industry) or little information is conveyed regarding the financial ties between study groups (the experts) and manufacturers. News reports are also not the best means of conveying research results because journalists often use terms in ways that can create misunderstandings in the minds of readers. Bostrom, Granger Morgan, Fischoff, and Read (1994, p. 968) found that "despite widespread media coverage of global climate change [in the U.S. during the early 1990s] ... lay mental models of global climate change [were] suffering from several basic misconceptions. Few respondents were aware of the radiative properties of greenhouse gases" and many "simply equated the green house effect with global warming" (p. 964). A number of the survey respondents also "held other fundamental misconceptions, such as the literal interpretation of the greenhouse effect as involving increased steaminess on earth" (p. 968). Some scholars are now asking the question: "Through which medium should science information professionals communicate with the public: television or the Internet?" (Koolstra, Boss, & Vermeulen, 2006, p. 1).

Koolstra and colleagues (2006, p. 2) assert that "television is the first medium young people learn to use when they start processing information." Also, comparison studies between television and the Internet indicate that "information processing through television is superior to information processing through the Internet" (e.g., Dijkstra, Buijtels, & van Raaij, 2005, p. 383). Perhaps the information processing advantage is related to the passive attention that people give to television and the relaxed mode in which they receive information. Even so, research also shows that learning from the Internet is comparable to learning from books (Eveland & Dunwoody, 2001); "Internet users and book readers can process information in their own tempo. The possibility of processing information in one's own tempo is often mentioned as a prerequisite for good learning, because it leaves time to think about difficult information" (Koolstra et al., 2006, p. 4). Although Koolstra and colleagues do not state definitively whether television or the Internet is the better mediation channel for scientific information, they do say that "people have more trust in television" and that the "possibilities of the Internet are immense and diverse, whereas those of television are limited and uniform" (p. 4).

Summary

Given the long tradition of science communication in society, what do we know about research mediation and how can open access literature contribute to the public understanding of science? The public education model of science communication began in the nineteenth century and

has become an integral part of the modern information society. Bensaude-Vincent (2001, p. 105) notes that

> Popular science was developed as an alternative practice to science proper and that over time popular science and academic science gradually came to form two distinct but parallel networks. So intense was the activity of science writers and editors that the whole international network of professional scientists that was emerging through international conferences ... was echoed, or doubled, by a network of popular science writers, popular observatories or botanical gardens, as well as popular magazines and publishers.

Scholarly and scientific research is and has been mediated through television, newspapers, and science magazines and can also be mediated via the Internet. There are advantages and disadvantages associated with each form of mediation but the clear benefit of the Internet is that it allows individuals to process information at their own rate and provides opportunities for interactivity.

With open access, online literature can be used to create a new kind of public awareness; the traditional networks of popular science and academic science need not exist separately any longer. As scientific literature becomes more easily and widely available on the Web, there may be greater network interaction or cross-linkages between the two spheres. In the past "'popular science' did not necessarily mean 'popularized science'" (Bensaud-Vincent, 2001, p. 105); but with open access we have an opportunity to move toward popularizing science proper. This could mean that academics might choose to be popularizers of their own research, whether via the Web or in other ways. To some extent, academics are already doing this: Kyvik's (2005, p. 288) study in Norway indicates that "prolific scientists [are] more active in publishing for a lay public" than those who are less prolific and that scholars in the humanities and social sciences tend to contribute more to public debate than colleagues in technology, natural sciences, and medicine.

The Open Access Model

Figure 8.1 presents a metaphor for the literature reviewed here. Scientific knowledge production is represented by the sun. The sun is a system of radiant energy—that is, scholarly communication and research. Its rays represent the aims of science, which are to educate and enlighten the public and produce discoveries to help people lead better lives. Sometimes the sun engages the lay public—this is the co-production model of science communication—and sometimes self-selected intermediaries tell members of the public what they should know—the education model of science communication. A number of laypeople might also look to the sun—as they engage in independent information-seeking behavior for

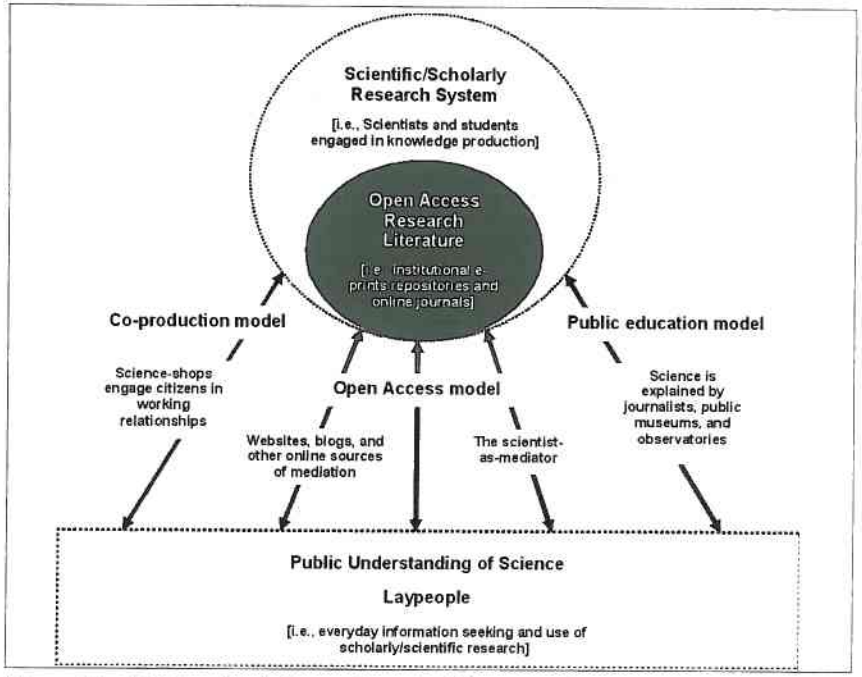

Figure 8.1 Relationship between the scientific research system and the public understanding of science

personal knowledge growth. The brightest and hottest portion of the sun is the open access literature, which is steadily being compiled on the Web in institutional repositories and online journals worldwide.

The open access model differs considerably from the co-production and public education models of science communication. The public education model is "the simplest and most widespread model" and its priority is the education of a scientifically illiterate public. Here "the ties between scientists and the public are indirect: they are the responsibility of the state" (Callon, 1999, pp. 82–83). The co-production model tries to overcome the limits of the public education model "by actively involving laypeople in the creation of knowledge concerning them" (p. 89). The open access model is unique because it does not assume an obvious educational role nor does it attempt to involve laypeople in close collaboration. It simply provides the public with direct opportunities to encounter peer-reviewed research via the Web: anyone can "read, download, copy, distribute, print, search, or link to the full texts of [digital repository and e-journal] articles" (Budapest Open Access Initiative, 2002, online). Open access has the potential to support and encourage public debate by making the reality of scientific research more visible to the layperson in the interactive environment of the Internet. The layperson has the option of reading or not reading open access literature; however, it is not

yet entirely clear how important this choice is for most people or how peer-reviewed research should be mediated online to help improve the layperson's comprehension and ability to make informed decisions.

Is There an Open Access Advantage for Laypeople?

In this section we consider some of the direct and indirect ways in which open access can benefit laypeople, using relevant information from academia, the Web, and recent newspaper reports.

"What's Good for the Goose Is Good for the Gander"

Kurtz and Brody (2006, p. 45) state that the "the history of scientific communication is one of increasing access," hence the "increased accessibility of peer-reviewed literature [on the Web] should allow literature to have a greater impact on future research, which will improve the quality of that research. Those who invest in and benefit from primary research, including the general public, have an interest in improvements to the quality of that research."

If we compare the scientist's view to that of the layperson, there is at least one shared interpretation of the term advantage: Both the scientific community (the goose) and members of the lay public (the gander) benefit from an increase in research quality if new outcomes can improve how humans live, eat, work, travel, and manage their health. It is important to note, however, that the scientific community's contribution has not yet reached its full potential. Proponents of open access are working diligently to persuade scientists to self-archive preprint versions of their publications in digital repositories (e.g., Pinfield, 2005; Sale, 2006; Swan, 2005, 2006) but approximately 85 percent of all peer-reviewed research literature is still not openly available on the Web (S. Harnad, personal communication, July 4, 2007).

Curiosity Satisfaction and Self-Improvement

Increased access to scientific research does not automatically mean that laypeople will have a better capacity to interpret it but individuals living in developed countries are, at the very least, well positioned to find out where scientific research is being conducted and who is involved. Day-to-day encounters with information sources (the Internet, television, magazines, or newspapers) can stimulate a person's curiosity about a particular research project, university, or scientist. According to Esposito (2004, online), open access will "make all research available to anyone who wants to look at it ... not to mention the man on the street, whose democratic desire to read, say, the *Journal of Molecular Podiatry* has been subverted for the past century by the mercenary interests and narrow-mindedness of publishers."

We cannot say for certain that laypeople will want to read the *Journal of Molecular Podiatry* but the first and most obvious advantage is that, if they are curious enough to read it, they can. Esposito (2004, online) believes that laypeople "would personally benefit by being 'empowered' by the access to the world's medical research publications" but he also says that

> By definition, if someone without sophisticated training (that is, our Man in the Street) could even understand a research paper, then it can't be a research paper. ... Academic research papers, after all, are not like pop music, which was designed for a mass market and can be spread around the globe to hundreds of millions of eager listeners via the underground file-sharing networks.

Perhaps the notion of curiosity satisfaction makes more sense if we recall the role of the nineteenth century public library. Willinsky (2006, pp. 112–113) states that "opening the research literature's virtual door to the public ... bears a certain kinship to the nineteenth century public library movement ... when the public library [was seen as] a beacon of self directed and deeply motivated [information seeking and] learning." Open access could be this century's new beacon for the deeply motivated layperson, who is interested in self-improvement and/or finding answers to everyday problems. Self-improvement, of course, could mean that an individual wishes to improve his or her level of scientific information literacy (see section on Civic Scientific Literacy and Public Engagement).

New Points of Information Discovery and Credibility Verification

Many laypeople do not know what a digital repository is or that information professionals are actively developing them; yet, some online information sources, such as Wikipedia, can serve as a point of discovery. Answers.com (a kind of Wikipedia) is a Web site designed to provide explanations for laypeople pertaining to a variety of topics such as stem cell research, climate change, the greenhouse effect, acquired immune deficiency syndrome, and genetically modified food. Often the explanations are detailed and accompanied by research references found in academic journals. At present, hyperlinks to the journals are few but in time we could see more and more links from sites such as Answers.com directed to open access literature. The benefit to laypeople is that the click of a button provides an opportunity to see the relationship between a topic described in lay terms and the scientific research that lies behind it.

The credibility of a piece of scientific information can be enhanced by references to peer-reviewed research but there may be instances when the research cited or linked-to is not credible. Holden (2007, p. 1045), editor of *Science* magazine's "Random Samples" column, wrote a brief

report about a false *Journal of Geoclimatic Studies* article, which received links from several anti-global warming Web sites because it stated that "global warming is actually caused by growing numbers of CO_2 emitting bacteria on the sea floor." Both the research team responsible for the article and the article itself were hoaxes. The article was purportedly written by a man named Mark Cox who wanted to "expose the credulity and scientific illiteracy of 'climate skeptics'" (p. 1045).

The good news associated with Holden's report is that scholars are now trying to understand the nature and bases of credibility on the Web and have been using "existing models of credibility assessment" to make "recommendations for future online credibility education and practice" (Metzger, 2007, p. 2078). Laypeople will eventually benefit from this research effort, which aims to develop practical tools, training approaches, and social applications designed to help make credibility judgments easier. For example, checklist programs teach information users how to ask and answer lists of questions based on specific criteria (e.g., does the site provide information about when the information was last posted or updated?) and seal programs allow organizations with Web sites to display reliability and privacy indicators once they have been evaluated.

The Tax Dollar Trail and Voter Preferences

Tax dollars are often used to finance research, hence the latest open access policies give the public first-hand opportunities to see what scientists and research teams are doing in their home countries and in universities/research centers around the world. Geist (2007, online) summarizes traditional publishing economics in this way:

> University scientists and researchers, who [relied] heavily on federal financial support, typically publish[ed] in expensive, peer-reviewed publications, [that were] purchased by those same publicly-funded universities. Large publishers benefited from the system as they had access to a steady stream of content with minimal investment, yet the public was forced to pay twice for research that it was frequently unable to access.

In Canada, the Canadian Institutes of Health Research (federal government) recently unveiled a new open access policy for research, mandating that thousands of articles published each year be made freely available online to a global audience (Geist, 2007). The Alliance for Taxpayer Access (ATA) in the United States has also given full support to the Federal Research Public Access Act of 2006. Federal agencies that fund more than $100 million of external research annually are now required to make electronic manuscripts of peer-reviewed journal articles

stemming from their research programs publicly available via the Internet (Alliance for Taxpayer Access, 2006).

Laypeople benefit from open access initiatives because the research can now be used to help them make more informed political choices. In the United States, for instance, a voter has the right to know whether and how much of the public's tax money is being spent on stem cell research. Every voter is now in a good position to learn about the scientific nature of this research, discuss his/her opinion with other voters, and decide which politician to support in a federal election. President George W. Bush clearly appealed to a segment of the American electorate when he promised, during a campaign dominated by education and tax cuts, that "taxpayer funds should not underwrite research that involves the destruction of live human embryos" (Lacayo, 2001, online).

Another benefit is that science should become an official part of political debates: "Which candidate can best analyze issues like global warming and stem cells?" (Krauss & Mooney, 2007, online). In the *Los Angeles Times*, Krauss and Mooney (2007, online) indicate that "a presidential debate on science would help voters determine who among the candidates is up to the task of dealing with whatever comes next." The need for a debate on science, according to these journalists, is "incontrovertible" and "would reveal which candidates are best equipped to tackle contentious science-based issues ... [and] help raise the level of scientific literacy across [the U.S.]"

Increased Awareness of Medical Research and Informed Decision Making

Earlier we mentioned the film *Lorenzo's Oil* and Augusto Odone's search for information on ALD. In 1986, Odone did all of his information seeking and reading at a medical library. It took him considerable time to access and interpret the literature. If he had had the benefit of open access, including links to ALD researchers worldwide, he would surely have progressed much faster in his bid to save his son from physical deterioration.

Harnad (2007, online) notes that "the commitment of some supporters of Open Access" seems to be motivated by "the importance of making health-related research accessible to [patients and families] who need it," but stresses that open access is not just a public health matter: It has a much more general research-enhancing mission. In other words, "a focus on the need for direct public access to health-related research leaves out the vast majority of research that is not health-related." Harnad's point is well taken. The scholarly community needs to benefit from the availability of all forms of research; but this does not mean that social scientists should not focus on potential lay benefits. At present, we know that some laypeople appreciate the online availability of medical research literature because it gives them a feeling of empowerment. Many individuals want to take more responsibility for their own health,

and in some instances, specified treatment literature could help them in shared decision making with physicians (see Forkner-Dunn, 2003; Fox & Fallows, 2003; Fox & Rainie, 2000; Gerber & Eiser, 2001; Nwosu, 2000).

The layperson's knowledge of new medical research and standards associated with this research can mean the difference between improved or impaired health—life or death. When and how research information is communicated is also critical. In the United Kingdom, the National electronic Library for Health (NeLH)[1] created a unique awareness service called Hitting the Headlines. Trained scientists from York University were hired by the NeLH to explain the research behind newspaper reports so that laypeople could better appreciate the reliability of health-related news and the evidence on which it is based.

In March 2006, seven newspapers across the United Kingdom reported on a drug (Rosuvastatin) that could reverse heart disease. The academic team behind Hitting the Headlines found that newspapers were "accurate in reporting on the uncontrolled trial, which showed promising results" but failed to note that "further research [was] needed to assess whether the treatment actually saves lives and reduces heart attacks" (National electronic Library for Health, 2006, online). The study associated with the news reports was led by Dr. Nissen from the Cleveland (Ohio) Clinic Foundation, on behalf of the ASTEROID Investigators (A Study to Evaluate the Effect of Rosuvastatin on Intravascular Ultrasound-Derived Coronary Atheroma Burden). It was sponsored by AstraZeneca (the manufacturers of Rosuvastatin), who were also involved in the design. Additional information was given regarding the scientific team's research objective, the nature of the evidence, the type of interventions examined, and the team's overall research findings and conclusions. Under the Reference and Resources section of Hitting the Headlines, hyperlinks were directed to the *Daily Telegraph*, *Times*, and *Independent's* news reports online and another to the paper in the *Journal of the American Medical Association* by Nissen, Nicholls, Sipahi, Libby, Raichlen, Ballantyn, and colleagues (2006). The reference did not lead to an open access journal or repository but if it had, some individuals might have printed it and taken it with them to a doctor's office for consultation and discussion with a family physician.

The Internet, with all its networking power, is now giving people opportunities to retrieve higher quality medical treatment information. However, Willinsky (2006, p. 114) makes an important point: "the quality of the information available to the public ... is dependent on the proportion of peer-reviewed research to which there is Open Access, compared to the vast amounts of other sorts of online information." To counteract what appears to be a growing information quantity versus quality problem, organizations such as patientINFORM.org (www.patientINFORM.org) are playing a significant role, by making it their mission to ensure that patients and caregivers know how to access

medical research literature and know what to look for when reading this literature.

Online Mediation for Public Relevance and Debate

Figure 8.1 illustrates that open access literature is the hottest part of the sun. The addition of peer-reviewed scholarly/scientific literature to the many other types of information on the Web has the potential to confuse and overwhelm the average layperson. Some individuals will simply avoid real scientific work; others will grapple with it because they are motivated. The vast majority of people, however, cannot be expected to achieve an interpretive capability equal to that of scientists. Moore (2006, online) "shudder[s] to think how frustrating it must be for the true layperson to enter an area of research for the first time, without the professional connections to acquire information, let alone interpret it." If the average layperson cannot understand the peer-reviewed literature or the context in which it was produced, Moore (2006, online) fears that he or she will turn to "blogs and Web sites that all too often promote strange, pseudoscientific ideas."

Contrary to Moore's (2006) opinion, interactive listservs and blogs, as well as lay-oriented Web sites, do not necessarily promote strange or pseudoscientific ideas. Some blogs, listservs, and Web sites can make open access literature more relevant to the general public by encouraging online discussion and debate. Stem Cell Research Blog (2007, online), for instance, is a "labor of love" for one individual, who has coped with the "sadness of seeing [his] closest of relatives suffer from diabetes and kidney diseases." On October 4, 2007 (3:53 A.M.) a Weblog entry was posted to describe "new research, published in the *Journal of Clinical Investigation*, by scientists at the University of Rochester Medical Center" who explain "how stem-cell therapy might someday be used to treat Huntington's disease" (Stem Cell Research Blog, 2007, online). A link was not provided to the *Journal of Clinical Investigation* article (note: it is an Open Access journal) but linking to the primary source may soon be recognized as good blogging practice.

Figure 8.1 also illustrates the role that scientists can play as mediators or popularizers of their own research. Scientists often create project Web sites with .pdf preprints of their latest publications. Although it may not be common at present for the scientist to write weekly or monthly laboratory blogs or present public lectures via the Internet, it might be a useful approach for individuals or research teams who wish to update the general public on the progress and value of their work. Walter Lewin, for example, a physics professor from the Massachusetts Institute of Technology, has "emerged as an Internet guru, thanks to the global classroom the institute created to spread knowledge through cyberspace" (Rimer, 2007, online). Rimer's report in the Toronto *Globe and Mail* notes that "Professor Lewin delivers lectures with the panache of Julia Child bringing French cooking to amateurs ... [and that] he is

part of a new generation of academic stars" presenting free online lectures on college Web sites (Rimer, 2007, online).

Civic Scientific Literacy and Public Engagement

Open access itself has the potential to stimulate further policy related activities. For example, policymakers may recognize that there is a need to review current standards for scientific information literacy and set agendas for developing or improving literacy programs. Earlier we defined scientific literacy in terms of the average layperson's ability to read and understand popularlized scientific literature (e.g., science magazines, newspaper reports). Today there is no limit to what the layperson may encounter on the Web, including peer-reviewed, pseudo-scientific, and popularized scientific literature. This demonstrates the complexity of civic scientific literacy.

The Association of College and Research Libraries (2000) has recognized information literacy as a six stage process. First, an adult has to determine the nature and extent of information that is needed. Second, he or she should be able to access the information effectively and efficiently; third, evaluate the information and its sources critically; and fourth, incorporate selected information into his or her knowledge base and personal value system. At the fifth stage, the person should know how to use the information effectively to accomplish a specific purpose; and by the sixth, understand the economic, legal, ethical, and social issues surrounding information access and use. Digital literacy—a type of information literacy—demands a certain degree of fluency in a digital information environment. People who are digitally literate know how to use "specialized tools [and skills] for finding digital information" (e.g., Internet search engines and Boolean commands) and know "how digital information is different from print information" (Illinois Mathematics and Science Academy, 2002, online).

Civic scientific literacy is also a form of information literacy; thus all general stages of information literacy apply, as well as skills required for retrieving and evaluating digital information. A scientifically literate individual possesses some "knowledge and understanding of scientific concepts and processes required for participation in a Digital Age society" and "can identify scientific issues underlying national and local decisions and express a position that is scientifically and technologically informed" (North Central Regional Educational Laboratory, 2004, online). For many developed nations, civic scientific literacy is desirable yet "debate still exists on what constitutes it and, by extension, how to measure it" (Brossard & Shanahan, 2006, p. 48). Scholars typically agree, however, that scientific literacy is multifaceted and that there is a vocabulary dimension, a process dimension, and a societal impact dimension (Brossard & Shanahan, 2006; Miller, 1998).

Civic scientific literacy is also associated with education; thus few, if any, science literacy programs are implemented without a school

curriculum in mind. For example, the American Association for the Advancement of Science (1989) created Project 2061; a long-term initiative to advance school-age literacy in science, mathematics, and technology. The project's main research and development areas focus on learning goals for American children as well as core curriculum materials. In some universities, information professionals are in a good position to cooperate with science teachers and focus on the type of literacy programs that students need to better understand and critique science journal articles (Brown & Krumholz, 2002).

Beyond formal education, it is difficult to develop a scientific literacy program for laypeople; Kim (2007), however, explains that the best approach to scientific literacy is not to focus on the information providers' point of view but to address ways to stimulate the public's engagement with problems and issues related to science. This puts the public's understanding of science "closer to a perspective on behavioral processes [because] it starts by taking the public's point of view (e.g., the information consumer's—but not solely as a communication receiver)" (p. 294). Open access clearly benefits the layperson because it allows him or her to make choices as an information consumer. Treise and colleages (2003, p. 315) remind us that "audiences do not simply expose themselves to information randomly; rather, they actively choose different media channels and types of information purposively, depending on their particular goals and their expectations about how well the media channels and information types will meet those goals."

This implies that the layperson's behavior is paramount; thus research into information seeking and processing practices surrounding peer-reviewed scientific literature should provide policymakers with valuable insights into where and how gaps in scientific literacy might be addressed.

Conclusions

Research concerning the public understanding of science has focused mainly on the cognitive dimension of scientific literacy, or literacy of the "know-what" type, instead of issues more closely related to information literacy. To reap the benefits of open access, laypeople need to be science information literate, that is, prepared to: (a) recognize when scientific research information is needed, (b) know where to look for it and assess its credibility, (c) understand how it is socially situated and produced, and (d) understand what it means within the context of the scientific communication network and society as a whole. Pardo and Calvo (2004, p. 205) state that "work to date on how much people know about scientific advances, what drives them to find out more, or conversely, keeps them indifferent, which channels they use to get information, etc. has been limited in scope, both conceptually and from a metric standpoint." New research in this area is suited to the field of information science,

which has a long history of developing effective methods for studying information seeking and user behavior (Wildemuth, 2002).

Information scientists are also at the forefront of webometrics research where methods for analyzing Web links, log files, and Internet-based RSS (Really Simple Syndication) feeds can provide insights into online information networks (Thelwall, 2004; Thelwall & Prabowo, 2006; Thelwall, Vaughan, & Björneborn, 2005). Link analysis examines the properties of link networks and the impact that Web sites and documents have. Popular science Web sites, research-oriented Web sites, science blogs, newsgroups, and open access literature all exist on the Web as distinct genres; the interconnections between them are likely to grow. So far, link motivation research shows that links to open access literature are normally "created for formal scholarly reasons equivalent to traditional citations" (Kousha & Thelwall, 2006, p. 501). Barjak, Li, and Thelwall (2007) have also found that full-text [scholarly] papers are the most linked-to content on scientists' home pages. Over time, it will be important to study where links to the open access, peer-reviewed literature are coming from and whether they originate with appropriate and high-quality mediation sources on the Web. The information-seeking steps that laypeople take to reach open access literature and possibly benefit from it will not begin and end with the availability of the literature itself. There should be opportunities for them to discover the literature and receive the assistance they require to interpret and understand it.

Finally, information seeking is associated with credibility; individuals who use the open access literature for personal decision making are putting their trust in researchers as well as the institutions creating the repositories in which peer-reviewed research is housed. Gambetta (1990) and Fukuyama (1995) both define trust in terms of cooperation (see also Marsh & Dibben, 2003). Laypeople need to become more aware of open access and trust that open access agents are providing a service that is sufficiently beneficial "to consider engaging in some form of co-operation" (Gambetta, 1990, p. 217). How can the layperson cooperate? Wilsdon and colleagues (2005, p. 29) note that when scientific research is "viewed through a public value lens" it can "encourage dialogue between scientists and the public to move beyond competing propositions to a richer discussion of visions and ends." If laypeople make it part of their daily lives to learn more about what scientists are doing, they are in a much better position to remind scientists "of the contribution that public *values* can make to the setting of research priorities and trajectories" (p. 29).

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Endnotes

1. The NeLH was launched in November, 2000, under the provision of the NHS Information Authority and was made available through the following URL: www.nelh.nhs.uk. In 2006 the NeLH began the process of migrating to the National Library for Health (NLH) site (www.library.nhs.uk).

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