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Nicole Wagner
McMaster University

Khaled Hassanein
McMaster University

Milena Head
McMaster University

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Computer Interaction for Older Users: A Literature Review

Nicole Wagner, McMaster University, wagnerm@mcmaster.ca
Khaled Hassanein, McMaster University, hassank@mcmaster.ca
Milena Head, McMaster University, headm@mcmaster.ca

Abstract

As older adults make increasing use of computers and the Internet, the study of their unique needs and concerns with these technologies becomes increasingly relevant. This paper reviews the coverage of this topic within academic journals in various disciplines and attempts to provide a holistic view of the field. The main research findings to date are discussed within research themes, and suggestions for future research are offered.

Keywords: Computer Interaction, Older Users, Literature Review

Introduction

As the world's population experiences an increase in average age (Lippincott 2004), a similar trend can be observed among users of computers and the Internet. Since older adults are now the fastest growing segment of computer buyers and Internet users (Becker 2005), the study of computer use by older adults is increasingly relevant.

When it comes to using computers, older users have different needs and concerns than younger ones resulting from the natural physical and cognitive changes that come with aging. These changes include declining vision, changes in psychomotor coordination, reduced attention span, and impaired memory (Hawthorn 2000). These changes and their implications for computer use by older adults have been studied by many different researchers in many different contexts. This paper reviews this research and attempts to provide a holistic review of academic research on the concerns of this group. In the following section, the methodology used to gather articles is described. Next, the publication venues, historical overview, and most common research themes observed in the articles are outlined. The final section discusses the findings and suggests areas for future research.

Methodology

Articles for this review were gathered by searching various databases for peer reviewed journals on the subject of computer use by older adults. Since this topic is multi-disciplinary, ten databases were searched in an effort to encompass all of the relevant disciplines: business (ABI/Inform, and Business Source Premier); information technology (Inspec); social sciences (Social Sciences Abstracts, Social Sciences Citation Index, and the Applied Social Sciences Index); gerontology (Age Line and Abstracts in Social Gerontology); education (ERIC); and psychology (PsychINFO). Search strings included reference to aging (age or aging or old or older or senior) as well as reference to computer use (computer or Internet or web or interface) in an effort to find articles whose main topic was the use of computer applications by older adults. This resulted in a total of 120 articles. Upon closer examination, thirteen were eliminated because they studied technologies other than computers (i.e. PDA's, ATM's, or computer peripherals). A cut-off point of 1990 was selected for analysis since this approximates the widespread use of computers, resulting in the removal of five articles. A further eight articles were removed since their content was inappropriate for various reasons. For example, some articles discussed experiments that were conducted using computers, yet the interaction between the older users and the computers was not the main purpose of

the article. The remaining ninety-four articles (listed in full at <http://buscom.mcmaster.ca/Users/wagnernm/articlelist.html> due to space limitations) were each reviewed to determine the following information: age considered “old”, details regarding the sample studied, what methodology and statistical techniques were used, variables or constructs studied, research questions or hypotheses, tasks involved in the experiment, and relevant findings. Due to space limitations, we focus our discussion in this paper on the findings from these articles, the disciplines that they are published in, and the themes among them.

Literature Analysis

Publication venues

As one would expect, given the multi-disciplinary nature of our topic, we found articles in a very diverse range of journals. To enable analysis by discipline, we set out to find a classification scheme for this list of journals. Although a listing was found that contained each of the relevant journals (Ulrich's Periodical Directory), the resulting categories were too broad to be useful. As an alternative, a panel of four experts was consulted in order to categorize the journals. This panel of experts consisted of two Professors and two doctoral students in the Information Systems (IS) area, each with expertise in human-computer interaction. Each expert was provided with a list of the journals, each journal's description from its website, and a list of eight possible disciplines to assign each journal to: business, communications, education, gerontology, human-computer interaction (HCI), healthcare, information systems, and psychology. This list of potential disciplines is similar to the categories found in Ulrich's with the exception of HCI and IS which were added to permit more granular analysis in these areas. Analyzing the assignments completed by the four experts revealed an Inter-rater reliability of 0.76, as calculated using a variant of Cohen's kappa (Fleiss' kappa) to accommodate four raters. This reliability is above the recommended minimum of 0.70 (Straub, Boudreau et al. 2004). A complete list of the journals, along with their corresponding disciplines and the number of related articles found in each, is provided in Appendix A.

Historical overview

In general, the study of computer use by older adults has received steadily increasing attention over time. As illustrated in Figure 1, interest has increased most dramatically in the last few years. Although the figure is presented in year ranges for clarity, it is interesting to note that prior to 1997, 1994 was the only year with publication of more than one article in this area. In 1997, the first wave of Baby Boomers became 50 years of age (Foot 1996). It is not likely coincidence that the number of articles published per year increased to at least 5 in that same year. As this large cohort continues to age and remain in the workforce, research on the topic is likely to continue this upward trend.

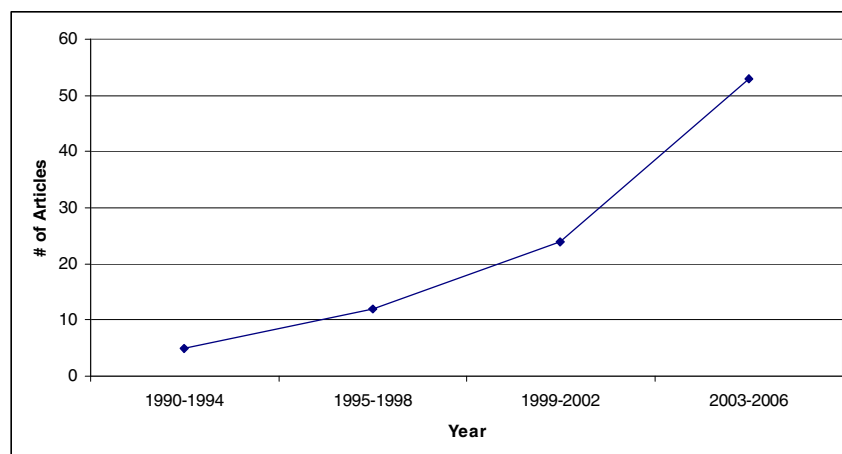


Figure 1: Articles published by year

It is also interesting to observe the publication trends within each discipline, as illustrated in Figure 2 below. Over time, the Business discipline has paid increasing attention to the issues of older computer users. Interest began in the Marketing-oriented journals, recognizing older computer users as potential target audience for marketers. Later focus began to include Labour-oriented journals, which investigated older computer users in the workforce. Communication journals were later to take older adults into consideration, with the first publications not appearing until 1999. Interest from the communications discipline has been fairly limited, with only five articles found in total. Gerontology as a discipline has been one of the main contributors to research in this field. A total of 25 gerontology articles were found, making it second in number only to the HCI discipline, with 38 articles. Both of these significant contributors have shown increasing publications in this area over time, particularly HCI in the last few years. IS has begun to pay more attention to older users in the past few years, with six of the eight articles found in that discipline published between 2004 and 2006. Psychology has contributed modestly with one publication per year in most recent years. The Education and Healthcare disciplines have shown surprisingly little interest in this area, especially considering that continued learning and access to healthcare information are often listed as ways in which computers and the Internet can be of the most assistance to older adults (Bitterman and Shalev 2004).

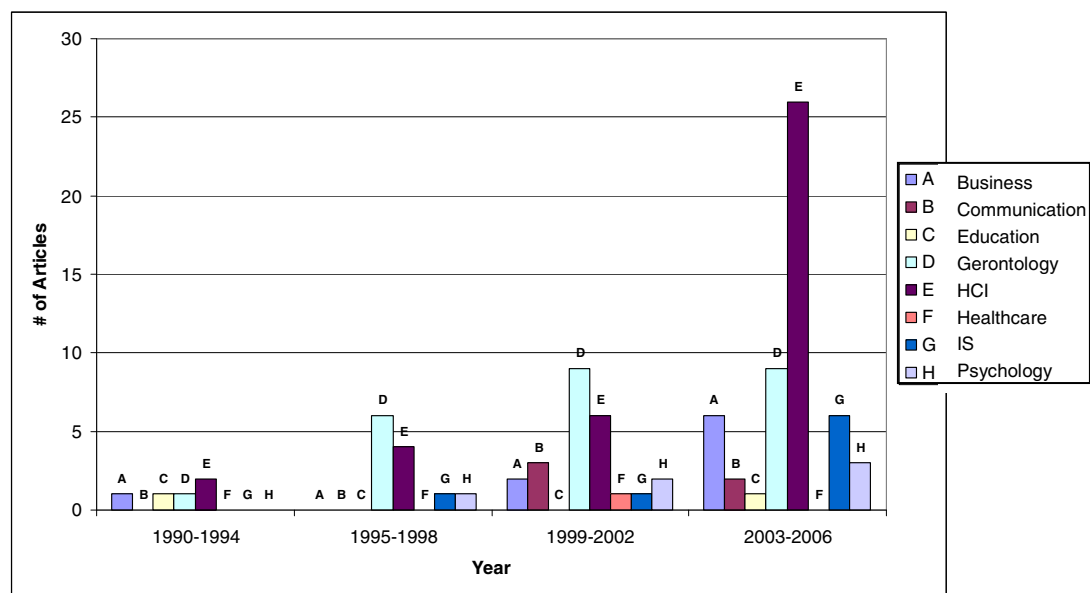


Figure 2: Publication trends by discipline

Research themes

Similar to the classification of journals by discipline, each of the articles was classified for further analysis by research theme. While reviewing each of the articles, a list of research themes was compiled. Once all 94 articles were read and analyzed, the list was refined into six main research themes: *adoption*, *affective*, *development*, *performance*, *psychosocial*, and *training*. Each of the articles was subsequently coded according to the main theme of the article. Article publication trends by research theme are illustrated below in Figure 3.

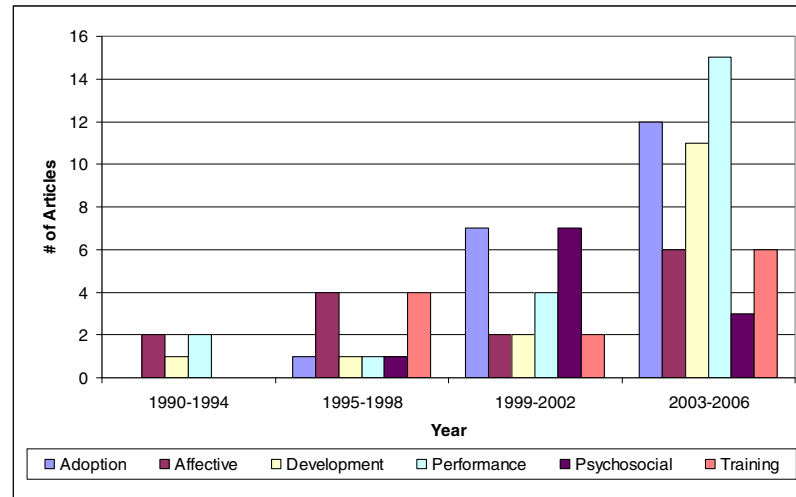


Figure 3: Publication trends by research theme

The *adoption* theme was assigned to articles focusing on utilitarian topics such as use of or access to computers. While there were no articles in this theme prior to 1998, there has been steady growth in number of articles per year since then. The *affective* theme contains articles pertaining to hedonic concepts involving users' emotions toward computer systems. This includes constructs like attitudes, trust, and satisfaction. Although this was one of the most studied themes in the first half of the time period studied, its relative contribution has been declining over time. The *development* theme describes articles concerned with the creation of applications for use by older adults. Usability and interface design articles were included here. This is another theme that has been experiencing growth in the last few years. Articles classified in the *performance* theme focus on measuring objective indicators (as opposed to subjective perceptions) including speed, accuracy, and efficiency of older users. In recent years, *performance* has been the most studied theme. The *psychosocial* theme refers to general emotions, not directed specifically toward computers, such as loneliness, depression, or life satisfaction. Articles in this theme first appeared in 1997, became quite popular in 2002, and have subsequently declined. Finally, the *training* theme was assigned to articles dealing with training older adults to use computers. While this was a popular topic in the 1995-1998 range, its relative proportion has declined since. The main findings of the articles within each of the identified themes are discussed in the following sections.

Adoption

With 20 articles, *adoption* is the second largest theme after *performance*. Several of the articles in this theme focus on predictors of use or non-use of computers by older adults. In general, users are likely to be younger (Morrell, Mayhorn et al. 2000; Loges and Jung 2001; Czaja, Charness et al. 2006), more educated (Morrell, Mayhorn et al. 2000; Czaja, Charness et al. 2006), and have more access to a computer (Morrell, Mayhorn et al. 2000; Czaja, Charness et al. 2006). While access to a computer was a predictor of use, several studies examined lack of access to computers. Many older adults were reliant on some sort of outside computer access (Cutler, Hendricks et al. 2003; Selwyn, Gorard et al. 2003). Other predictors of use include lower computer anxiety (Cody, Dunn et al. 1999; Czaja, Charness et al. 2006), higher cognitive abilities (Kelley, Morrell et al. 1999; Eastman and Iyer 2005), higher interest in technology (Kelley, Morrell et al. 1999; Morrell, Mayhorn et al. 2000), higher performance scores (Kelley, Morrell et al. 1999), more computer knowledge (Morrell, Mayhorn et al. 2000), and less physical mobility (McMellon and Schiffman 2000). In contrast, predictors of non-use were also observed. These include perceived guilt about not being sufficiently active (McMellon and Schiffman 2000), lack of interest (Selwyn, Gorard et al. 2003), and perceived lack of relevance to life (Selwyn, Gorard et al. 2003).

In terms of types of use, the activities of older and younger users appear to be similar in the non-workplace setting (Bucur, Renold et al. 1999; Vuori and Holmlund-Rytkönen 2005). Other studies looked specifically at computer use in the workplace. Loges et al. (2001) found that differences in connectedness between old and young users do not appear to be related to employment status. Although one study found that age did not impact computer use in the workplace (Knight and Pearson 2005), several others disagreed. Two studies found that the oldest workers (55-64) exhibit use patterns different than other workers (Friedberg 2003; Schleife 2006), especially in the case of the oldest female workers (Morris, Venkatesh et al.

2005). In general it seems that impending retirement, rather than age alone, influences the reactions of workers to computerization (Friedberg 2003). Computer users, however, were more likely than non-users to continue working until later in life (Friedberg 2003; Schleife 2006).

Affective

The fourteen *affective* articles found deal with the feelings that older adults express toward computers. The earlier articles suggest that age is negatively related to positive emotions (Baack and Brown 1991; Festervand and Meinert 1994). Older adults also appeared to have higher levels of computer anxiety than younger adults (Laguna and Babcock 1997). In the mid-nineties, research began to examine whether experience with computers impacted attitudes. Several studies found that these feelings were in fact modifiable, with more experienced users exhibiting more positive emotional responses (Festervand and Meinert 1994; Czaja and Sharit 1998; Hogan 2005).

In more recent years, a new picture of affective outcomes of older adults towards computers was emerging. While some older adults remained skeptical about computer benefits, others were realizing the benefits computers could provide in satisfying information needs and communicating with friends/family (Saunders 2004). While older adults demonstrated higher levels of “technophobia”, anxiety was also shown to lessen with experience (Hogan 2005). Interestingly, regardless of any anxiety or negative attitudes, studies found that older adults exhibit a high level of trust in the recommendations of computer system (Kressig and Echt 2002; Ho, Wheatley et al. 2005).

Development

The fifteen articles in the *development* theme are similar to some of those in *training* in that they do not involve studies investigating the relationships between constructs. Rather, many are a general discussion of how natural changes associated with aging (vision, hearing, physical, memory, training/learning) have implications for the development of interfaces for older adults and some guidelines for effective interface design for this demographic group are often provided (Morris 1994; Hawthorn 2000; Bitterman and Shalev 2004; Charness and Holley 2004; Zajicek 2004; Czaja and Hiltz 2005). Specific case studies examine considerations in the development of a healthcare system (Deatrick 1997) and more usable websites through user-centred design (Ellis and Kurnlawan 2000). Others describe usability studies conducted with older adults using an e-learning application (Stoltz-Loike, Morrell et al. 2005) or an email application (Dickinson, Newell et al. 2005). Finally, some articles discussed reviews of existing websites where they were evaluated for usability for older adults based on the guidelines for website design for older adults published by the National Institute on Aging. One article examined websites for health information (Becker 2004) and others looked at government websites (Becker 2004; Becker 2005).

Performance

The performance of older adults when using computers was the most studied theme with twenty-two articles. Performance was judged through objective measures such as time, accuracy, efficiency, errors, etc. The most frequently studied performance measure was speed. There was consensus among the articles reviewed that increasing age negatively impacts speed (Czaja and Sharit 1993; Freudenthal 2001; Fukuda and Bubb 2003; Sjolinder, Hook et al. 2003; Grahame, Laberge et al. 2004; Sayers 2004; Sjolinder, Hook et al. 2005; Stronge, Rogers et al. 2006). Age was also found to have a negative impact on number of errors made (Czaja and Sharit 1993; Birdi, Pennington et al. 1997), work output (Czaja, Sharit et al. 2001), and efficiency (Lin 2003a; Graff 2005; Sjolinder, Hook et al. 2005). Interestingly, Czaja et al. (2001) found that the age effect on performance was mediated by contextual factors including experience and cognitive abilities. This is consistent with other studies finding that computer experience also has an impact on performance of older adults (Czaja and Sharit 1993; Mead, Sit et al. 2000; Czaja, Sharit et al. 2001; Jacko, Emery et al. 2004; Sjolinder, Hook et al. 2005; Priest, Nayak et al. 2006). Several studies found that older users are less likely than younger users to be successful with more complex computer functionality or tasks (Mead, Sit et al. 2000; Sjolinder, Hook et al. 2003; Lin 2003a; Lin 2003b; Stronge, Rogers et al. 2006). Also, multi-modal feedback, such as visual, auditory, and haptic, can help to improve performance (Jacko, Moloney et al. 2005).

Psychosocial

With a total of eleven articles, psychosocial impacts have received modest attention over the years. Several articles suggest that computer use can lead to improvement in several psychosocial characteristics in older adults. The most common assertion is that computer use creates a sense of community and interaction (Furlong 1997; Wright 2000; Opalinski 2001; Blit-Cohen and Litwin 2004). Computer use has also been found to decrease loneliness (White, McConnell et al. 1999; White, McConnell et al. 2002), depression (White, McConnell et al. 2002; Blit-Cohen and Litwin 2004), and life stress (Wright 2000). Other studies indicate that computer use can increase confidence (Alexy 2000) and feelings of empowerment or control (McMellon and Schiffman 2002). While computers may improve confidence in general, it seems that elderly people are less confident in themselves when it comes to their knowledge and abilities in the computer domain (Marquié, Jourdan-Boddaert et al. 2002).

In contrast, other studies expecting to demonstrate positive psychosocial impact of computers found insignificant results (White, McConnell et al. 1999; Chen and Persson 2002; White, McConnell et al. 2002). These authors suggest that the lack of significant findings may be caused by ceiling effects of the instruments used for measuring psychosocial characteristics. In contrast, a recent article reviews studies claiming that Internet or computer use has a positive impact on the well being of older adults (Dickinson and Gregor 2006). The authors of this review claim that each of these studies is faulted in some way and that computer use in fact has no impact on well being.

Training

Of the twelve articles discussing training older adults to use computers, almost half were a general discussion of the unique training needs of older adults due to the cognitive changes associated with aging and making recommendations for how to best implement such training (Kelley and Charness 1995; Jones and Bayen 1998; Mead, Batsakes et al. 1999; Lippincott 2004; Mayhorn 2004). The remaining articles discuss the various findings of training studies conducted. In general, a negative relationship was found between age and computer skills acquisition (Reed, Doty et al. 2005), learning speed was impacted by age (Charness, Kelley et al. 2001), young-old adults learned more from a training course than old-old adults (Echt, Morrell et al. 1998), older adults were able to learn from e-learning (Trentin 2004), and older adults retained more when images or animation were added to text (Lin 2004).

Discussion

While each of the articles found was classified into a major theme for the discussion in the previous section, many articles involved the examination of constructs from multiple themes. For example, a study may have looked at the relationship between trust (*affective*) and use (*adoption*), even though the main theme of the article was determined to be *adoption*. These interactions between the constructs of different themes are illustrated below in Figure 4. The example article in this paragraph, discussing the interaction between trust and adoption, would be illustrated below as one of the ten articles examining the interaction between *adoption* and *affective*. The numbers inside the theme boxes illustrate the amount of articles examining the relationship between constructs within that theme only. The *development* and *training* themes are absent from this diagram since articles within these themes included general discussion of issues or case studies which did not involve the measurement of specific constructs.

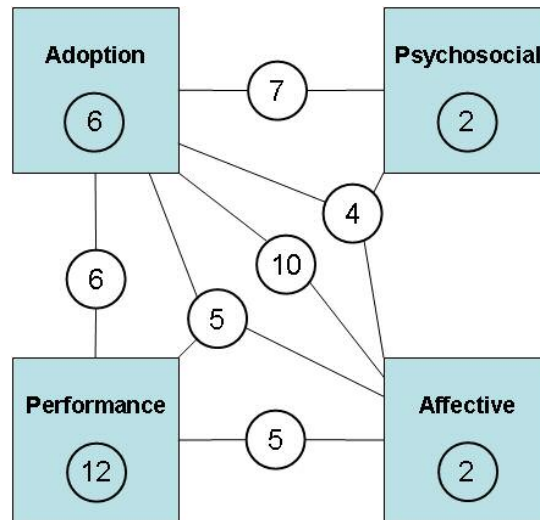


Figure 4: Theme construct interactions within articles

A few interesting points emerge from this illustration. First, we notice that the constructs from most themes are studied in conjunction with a construct from another theme. The exception is *performance*, which is studied often on its own. Also, this figure shows clearly that we found no studies examining the interaction between *psychosocial* and *performance* constructs, or between *psychosocial* and *affective* ones. For example, there has not been interest in examining the impact of wellbeing on accuracy, or depression on attitude toward computers. Finally, the most often studied interaction has been between *adoption* and *affective* constructs, indicating that researchers have been very interested in the relationship between older adults’ feelings about systems and their actual use of them.

To bring together our discussion of disciplines and themes, we examined the number of articles published by theme in each journal discipline, as shown in Table 1 below.

Theme	Discipline								Grand Total
	Business	Communication	Education	Gerontology	HCI	Healthcare	IS	Psychology	
Adoption	6	2		4	4		3	1	20
Affective	2		1	4	6			1	14
Development		1		2	8		3	1	15
Performance				3	16		1	2	22
Psychosocial		1		6	2	1	1		11
Training	1	1	1	6	2			1	12
Grand Total	9	5	2	25	38	1	8	6	94

Table 1: Article theme by journal discipline

It is interesting to note that the interest in some disciplines is distributed across many themes, while other disciplines have focused only on specific themes. For example, articles in the Business discipline focus primarily on adoption. Gerontology and HCI journals have had the most coverage, with multiple articles in each theme. Nevertheless, Gerontology has placed slightly more emphasis on *psychosocial* and *training* issues, while HCI has had strong focus on *performance*.

Conclusions & future research

As older adults make increasing use of computers, the study of their unique needs and concerns merit increased research focus. In this paper, we have reviewed the research in this field to date, describing its history and coverage across many disciplines. The main research themes have been described, along with the relevant findings within each.

This detailed review of the field brings to light a number of potential areas for future research. We classify these areas into three categories, as described below.

Breadth & depth of coverage within disciplines: The body of knowledge concerning computer use by older adults will be most complete if disciplines apply their unique optic to the study of each research theme. While the HCI and Gerontology disciplines have published at least one article in each of the identified research themes, the other disciplines lack the same breadth of coverage. Depth of coverage is achieved by making sure that the level and rigour of analysis/investigation for each theme by each discipline matches that which is expected within the specified discipline. For example, Table 1 illustrates that IS has focused primarily on *adoption* and *development* while no attention has been paid to *affective* issues. IS as a discipline, however, has substantial expertise in the areas of trust and satisfaction which are affective constructs. This IS proficiency and depth of research on these constructs should be leveraged to the study of *affective* issues in the context of use of computers by older adults.

Cross-discipline learning: As discussed, computer use by older adults is a multi-disciplinary topic by nature. Researchers within each discipline can enrich their own knowledge by exploring research conducted in other disciplines. For any given discipline, the discovery of different methodologies, operationalizations, constructs, or relationships from other disciplines may inspire further research and ultimately broaden the understanding of the topic as a whole. Breadth of coverage of research themes across the different disciplines is a necessary step for this to happen.

Empirical validation of guidelines: Finally, we note that many of the articles offering guidelines for interface and training design do so based on previous general research in the psychology of aging. For example, guidelines for teaching older adults to use computers are provided based on previous research for training older adults in general. Since learning to use computers is a unique context, these guidelines should be empirically tested with older adults to verify their appropriateness in other contexts.

Overall, although there has been significant research dedicated to the use of computers by older adults by various disciplines in different theme areas, there certainly is still a plethora of opportunity for further study in this important field.

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Appendix 1: Journal List

Journal	Discipline	Articles
ACM Transactions on Computer-Human Interaction	HCI	1
Advances in Consumer Research	Business	1
Ageing & Society	Gerontology	1
Aging & Mental Health	Gerontology	1
American Behavioral Scientist	Psychology	1
Behaviour & Information Technology	HCI	9
Communication Education	Communication	1
Communication Research	Communication	1
Communications of the ACM	IS	2
Computers in Human Behavior	HCI	6
CyberPsychology & Behavior	Psychology	2
Educational Gerontology	Gerontology	9
Ergonomics	HCI	1
Ergonomics in Design	HCI	1
Generations	Gerontology	3
Gerontologist	Gerontology	1
Holistic Nursing Practice	Healthcare	1
Human Factors	HCI	3
IEEE Transactions on Engineering Management	IS	1
IEEE Transactions on Information Technology in Biomedicine	IS	1
IEEE Transactions on Professional Communication	Communication	1
Industrial & Labor Relations Review	Business	1
Interacting with Computers	HCI	10
International Journal of Behavioral Development	Psychology	1
International Journal of Consumer Studies	Business	1
International Journal of Human-Computer Interaction	HCI	2
International Journal of Human-Computer Studies	HCI	2
Irish Journal of Management	Business	1
Journal of Aging Studies	Gerontology	1
Journal of Applied Business Research	Business	1
Journal of Applied Gerontology	Gerontology	2
Journal of Communication	Communication	1
Journal of Computer Assisted Learning	Education	1
Journal of Consumer Marketing	Business	1
Journal of Management Information Systems	IS	1
Journal of Managerial Issues	Business	1
Journal of Occupational & Organizational Psychology	Psychology	1
Journal of Organizational and End User Computing	HCI	2
Journal of Research on Computing in Education	Education	1
Journal of Technology in Human Services	IS	1
Labour	Business	1
Marketing Intelligence & Planning	Business	1
New Review of Information Networking	IS	1
PsychNology Journal	HCI	1
Psychology and Aging	Gerontology	5
SOCIAL SCIENCE COMPUTER REVIEW	IS	1
Spatial Cognition and Computation	Psychology	1
Technical Communication Quarterly	Communication	1
The Journals of Gerontology	Gerontology	2