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Older Worker Training: What We Know and Don't Know

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The AARP Public Policy Institute, formed in 1985, is part of the Policy and Strategy Group at AARP. One of the missions of the Institute is to foster research and analysis on public policy issues of importance to mid-life and older Americans. This publication represents part of that effort.

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FOREWORD

The U.S. workforce is aging. Just over 16% of the labor force is at least age 55, up from nearly 12% in 1995. The Bureau of Labor Statistics (BLS) projects that this figure will rise to 21% in 2014. If BLS projections prove close to the mark, more than 34 million persons aged 55 and older will be working or looking for work in 2014, an increase of more than 10 million over the figure for 2005.

The actual number of older labor force participants could be even greater than official projections suggest, if older workers realize their retirement work expectations. According to AARP research, for example, 8 in 10 boomers expect to work at least part time when they retire. Although it is unlikely that so many will end up working in retirement, it seems reasonable to conclude that the labor force participation rate for the 55-plus population, which has been rising for the past two decades, will continue to increase. If labor shortages materialize, employers will have a reason to encourage continued employment.

Today's global economy requires a trained and flexible workforce able to adapt quickly to new technology, changing methods of production, and evolving consumer demands. Not all employers, however, are convinced that older workers have what it takes to meet their needs in this new economy. In particular, they have reservations about older workers' technological competence and ability to learn new technology.

Given the increase in the number and proportion of older persons in the U.S. workforce and the need to ensure that older workers have and maintain the skills employers seek, AARP's Public Policy Institute (PPI) undertook a project to assess the state of knowledge of older worker training. PPI was specifically interested in learning more about such issues as the ability to learn at older ages; on-the-job training vs. training in experimental settings; the impact of the "healthy worker" phenomenon on training success; age comparisons in the length of time it takes to learn new skills; and whether successful training techniques vary by age. We were also interested in what we still do not know about older worker training.

In *Older Worker Training: What We Know and Don't Know,* Neil Charness of Florida State University and Sara J. Czaja of the University of Miami Miller School of Medicine summarize the literature on the ability of older persons to learn new skills and highlight training issues and questions that must be addressed to ensure the productive employment of older men and women. The findings are encouraging. Older workers may take longer to master new skills, but they can master them, even those that involve computers and other forms of technology. Moreover, Charness and Czaja find that many training techniques are effective for older adults. We hope that findings such as these can be used to encourage more employers to promote older worker training.

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EXECUTIVE SUMMARY

Background

Due to the aging of the baby boomers, persons aged 55+ are becoming a significant proportion of the population. In 2002, there were about 61 million people in this age group in the United States. By 2025 this number will increase to about 103 million, representing 30% of the population. This population shift in age will also impact the age composition of the labor force; a significant portion of workers will be age 55 or older. In fact, by 2015, 32 million workers will be 55+, representing approximately 20% of the workforce. This rise in the number of older workers will occur for both men and women.

There are a number of factors influencing a person's decision to work longer, including financial incentives, benefits, health, employment opportunities, and socialization. However, whatever the reasons, America needs to prepare for an aging workforce. Although much is known about aging as a process, relatively less is known about the implications of aging for performance of everyday activities such as work. This report summarizes what is currently known about an important aspect of work and employment, namely, training, and retraining.

Purpose of the Report

An investment in older workers could be extremely beneficial to employers and organizations, individuals, and society at large. For example, it could help employers fill labor gaps and help individuals experience financial security and remain productive and socially engaged. However, the achievement of these benefits depends on the government and employers creating work policies and practices that promote opportunities for older workers. It also depends on individuals taking advantage of these opportunities and maintaining the skills that are needed to compete in today's workplace. Given the continual influx of technology in most workplaces and the subsequent change in work demands, training is an issue of critical importance to everyone. In order to keep pace with changes in jobs and job demands, workers need to constantly learn new skills and new ways of doing things. However, older workers usually have not had recent training (e.g., Sparrow and Davies, 1988), so the need for training and retraining programs is even more crucial for them. At the same time, employers need to ensure that opportunities for training and retraining are available to older people and that training programs are designed to meet the learning needs and preferences of older adults.

The purpose of this report is to (1) summarize what we currently know about the ability of older adults to learn new skills and adapt to new environments and (2) highlight issues and questions that need to be addressed to promote healthy and productive employment for older adults. In addition, where possible, guidelines for the design of training programs for older adults are presented. The information is based on a review of the gerontological, psychological, and human factors engineering literature including summaries of our own research. It is hoped that the information provided will (1) underscore the importance of this issue; (2) provide information on aging and training relevant for employers; and (3) highlight gaps in existing knowledge.

Summary of Findings

We know that many older adults wish to remain employed and to engage in productive activities. In addition, current and future cohorts of older people are healthier and better educated than previous generations.

Meta-analyses have been conducted on learning success for older adults based on a mix of laboratory and applied study. Overall, the results of research in this area are encouraging in that they indicate that older adults are able to learn new skills, even ones involving new technology. Nonetheless, they are typically slower to acquire those skills than younger adults. Some of the slowing in learning new tasks may be attributable to older adults' preference for accuracy over speed, with the reverse holding true for younger adults. The literature indicates that training interventions can be successful in terms of improving performance.

There have been numerous attempts over the past 50 years to find techniques that are best suited to older learners. However, very few instances of interaction between training technique and age have been observed. Generally, what is best for the young adult is also best for the older adult. In recent years, however, a few exceptions have been observed. At least two studies have shown that there are greater gains for older adults when performing procedural (action or hands-on) activities compared to conceptual training. In brief, many techniques for training prove to be effective for older adults, but there is not yet an adequate research base to determine whether some training techniques are differentially beneficial for older workers on a consistent basis.

The majority of older adults remain reasonably healthy and functionally able until very late in life. It is also important to recognize that conclusions regard age-performance differences are often based on the comparison of averages and that older adults are more variable as a group than younger adults.

Conclusions

Evidence suggesting age differences in actual work performance is limited. However, due to the explosive developments in technology and the shift from production work to information management and service sector environments, workplace and job demands are changing at an accelerating pace. Training and retraining are critical issues for all workers, but particularly for older adults. Aging as a process results in changes that could affect learning, such as declines in vision and hearing and changes in memory, attention, and processing speed. Thus, learning a new skill may be more challenging for older people, and older adults may take longer than younger adults to acquire new skills. We also know that older adults are receptive to interacting with new technologies and are able to learn new skills. However, providing access to training and ensuring that the training program is suitable to the needs and preferences of older adults are critical to "learning success."

The ever-changing technology in the workplace implies that people will need to learn new systems and new activities at multiple points during their working lives. Workers not only have to learn to use technical systems, but they must also learn new ways of performing jobs.

Although the learning and training literature is vast, there are many questions that need to be answered and issues that need to be addressed in order to better meet the training needs of older workers. A key finding of this report is that the available research suggests that there is little relationship between age and productivity. How well current and future older workers adapt to the demands of the increasingly competitive labor environment is of critical importance to the productivity of the economy as well as to the well being of individuals.

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OLDER WORKER TRAINING:
WHAT WE KNOW AND DON'T KNOW

Background and Introduction

Prior to discussing issues related to aging, work, and training, it is important to define what is meant by the term "older worker." This is somewhat arbitrary as there is no strong consensus on when someone becomes an older worker. Common cut-off points often cluster along cultural/legal dimensions, such as age 40 eligibility for coverage by the Age Discrimination in Employment Act in the United States. A marker of being an *older worker* would be the age beyond which an able-bodied person is first entitled to collect national pension funds such as Social Security, currently age 62 in the United States. Other cut-off points emphasize the number of years in a job (e.g., 30, a point at which those with defined benefit pensions often see the present value of a pension start to decline, or mandatory retirement requirements such as age 60 for airline pilots). Psychological cut-off points might be age 45, an age where, normatively, most of the population must use corrective lenses for near-vision acuity, or even age 20, an age at which much of the population has peaked in the ability to process information rapidly. A normative, though dynamic, estimate might be the median age of the U.S. civilian non-institutional working population, which we calculate to be about 40.6 years of age based on 2005 data from the U.S. Department of Labor's Bureau of Labor Statistics. However, as a recent National Academy of Sciences report points out (Wegman and McGee, 2004), it is wiser to consider that we are all *aging* workers.

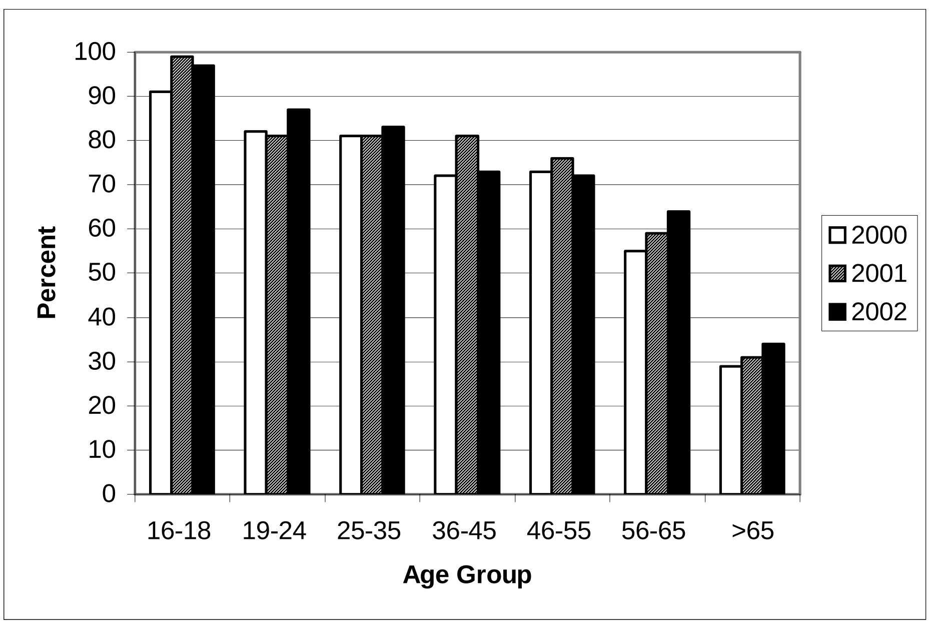
Contributing to a renewed interest in the topic of aging and work are the aging of the baby boom cohort; changes in retirement policies, programs, and behavior; and increased concerns about dwindling resources to support retirement incomes. In 2002, there were about 61 million people aged 55+ in the United States, a number that is expected to grow to 103 million by 2025, or to 30% of the population (U.S. General Accounting Office, 2003). This change will have a significant impact on the composition of the labor force. By 2015, the number of workers aged 55+ will be about 32 million. The projected growth in the number of workers over the age of 55 will occur among both men and women. Importantly, there will also be an increase in the number of workers over the age of 65 (Fullerton and Toossi, 2001; U.S. General Accounting Office, 2003).

Trends in retirement patterns are also changing. Instead of full-time leisure, many workers and retirees in their 50s, 60s, and 70s seek more work options, such as reduced hours or days per week; more time off over the year; special project or contract work; greater flexibility; part-time work; and even the opportunity to start new careers, including unpaid community service (Moen, 2003). In fact, the terms "phased retirement" and "bridge employment" have emerged to describe current work practices. Phased retirement generally refers to staying with a particular job on a part-time or part-year schedule while phasing out employment over a number of years to retirement. Bridge employment generally refers to moving to another company or career before retirement, a practice that is common among today's workers. Currently, about half of all workers aged 55 to 65 have some sort of bridge job before taking full retirement (Purcell, 2002). A shift to a different job or occupation often creates a need for retraining.

We are also witnessing dramatic changes in organizational policies and practices, work environments, and jobs. Computer, information, and automation technologies are increasingly being used in work settings. In 2003, more than half (55.5%) of the workforce within the United States used a computer or some other form of technology at work. This number is continuing to grow, as will the scope and sophistication of technology (United States Bureau of Labor Statistics, 2005). Technology-based occupations are also expected to grow significantly in the upcoming decades. Thus, the question of how the increased use of technology in work environments affects employment opportunities for older workers is an important one.

Essentially, technology changes the types of jobs that are available, the way they are performed, their content, and demands. Thus, for many workers, existing job skills and knowledge may become obsolete and new knowledge and skills are required, creating enormous needs for worker training and retraining. Although the observations are not new (see Belbin, 1965; Dubin and Willis, 1990), issues of skill obsolescence and training are highly significant for older workers. The current and upcoming cohorts of older workers (those now in their 40s) are less likely than younger workers to have had an extensive exposure to technology such as computers (e.g., Czaja and Sharit, 1998; Czaja et al., 2006). Recent data for the United States indicate that, although the use of computers and the Internet among older adults (typically out of the workforce) is increasing, there is still an age-based digital divide. As seen in Figure 1, in 2002 about 34% of people age 65+ accessed the Internet compared to nearly 100% of 16- to 18-year-olds (UCLA Center for Communication Policy, 2003). Also, as will be discussed in a later section of this report, there are age-related changes in perception and cognition that are relevant to learning and training.

Figure 1. Internet Use by Age, 2000-2002



Source: UCLA Center for Communication Policy, 2003

The purpose of this report is to (1) summarize what we currently know about the ability of older adults to learn new skills and adapt to new environments and (2) highlight issues and questions that need to be addressed to promote healthy and productive employment for older adults. In addition, where possible, guidelines for design of training programs for older adults are presented.

Who Are Today's and Tomorrow's Older Workers?

In recent years a great deal of interest has centered on the baby boom cohorts, the approximately 76 million Americans born between 1946 and 1964, as they transition to the "status of older worker." In contrast to previous generations, the baby boom generation is healthier, more diverse, and better educated (Bass, 1995). This raises interesting questions with respect to work and retirement. For example, between 1970 and 2003 the percentage of adults aged 65+ who completed high school increased from 28% to 72%—and 17% had at least a bachelor's degree (Federal Interagency Forum on Aging-Related Statistics, 2004). Thus, on some levels, the current and future generations of older workers will have a higher skill base than prior cohorts. Consistent with the demographic changes in the U.S. population as a whole, the older population is becoming more ethnically diverse. Currently, about 84% of people aged 65+ are non-Hispanic white; this proportion will drop to about 74% by 2030 and 64% by 2050. The greatest growth will be seen among Hispanic persons, followed by non-Hispanic blacks (Federal Interagency Forum on Aging-Related Statistics, 2004). Individuals from ethnic minority groups are less likely to own or use technologies such as computers (U.S. Department of Commerce, 2002). Thus, to promote employment opportunities for older minorities, technology training programs need to be targeted to these populations.

Today's older adults are also more active and likely to be engaged in productive activities. In fact, many older workers, according to a variety of studies, say they would prefer to continue to be engaged in some kind of productive activity following their retirement, and a significant number of full-time retirees say they would like to be employed. For example, a recent survey of workers aged 45 and older found that 69% reported wanting to work into their retirement years (AARP, 2002). Work plays an important role in shaping physical and emotional health and also in defining personal and social roles. Further, older workers typically experience higher levels of occupational well being than their younger and middle-aged counterparts (Warr, 1992), although the effect of age is small. Work provides benefits beyond income, such as social status and access to social participation; hence, this activity may be attractive to seniors who wish to remain fully engaged.

By some measures, today's older adults are also healthier than previous generations. The number of people aged 65+ reporting very good health and improvements in physical functioning (such as the ability to walk a mile or climb stairs) has increased in recent years. In 2004, 37% of people in this age group rated their own health as excellent or very good. The percentage of older adults who meet the recommended level of physical activity (e.g., 30 minutes of moderate intensity activity such as brisk walking) has increased (U.S. Department of Health and Human Services [USDHHS], 2005).

Disability rates among older people are also declining. The age-adjusted proportion of older people with chronic disabilities declined from 28% in 1984 to 20% in 1999 (USDHHS, 2004). However, the likelihood of developing a disability increases with age, and many older people have at least one chronic condition (the most common being arthritis, diabetes, high blood pressure, hearing and vision impairments, and orthopedic impairments) (USDHHS, 2004). In addition, the likelihood of having a memory impairment increases with age.

Disability rates among older adults have important implications for the design of training programs. For example, to make training programs accessible to workers who have functional limitations, employers may need to provide adaptive equipment or technology such as low vision aids or speech recognition devices.

It is also important to note that many people in their middle to older years may be engaged in some type of caregiving. In 1997, about 22 million U.S. households were involved in caring for someone over age 50, and this number is expected to increase to 39 million households by 2007. This has vast implications for employment. For example, about 60% of baby boomer caregivers are currently working for pay either full or part time. Many employed caregivers face difficulties juggling their work and caregiving roles and have to rearrange their schedules, decrease their work hours, or take an unpaid leave of absence to care for others (Family Caregiver Alliance, 2005). This may also mean that caregivers who are employed may have difficulty attending work-related training programs. Thus, it is important that the needs of these workers be considered when training programs are scheduled to ensure that they have opportunities to participate. On-line training may be particularly applicable for this group.

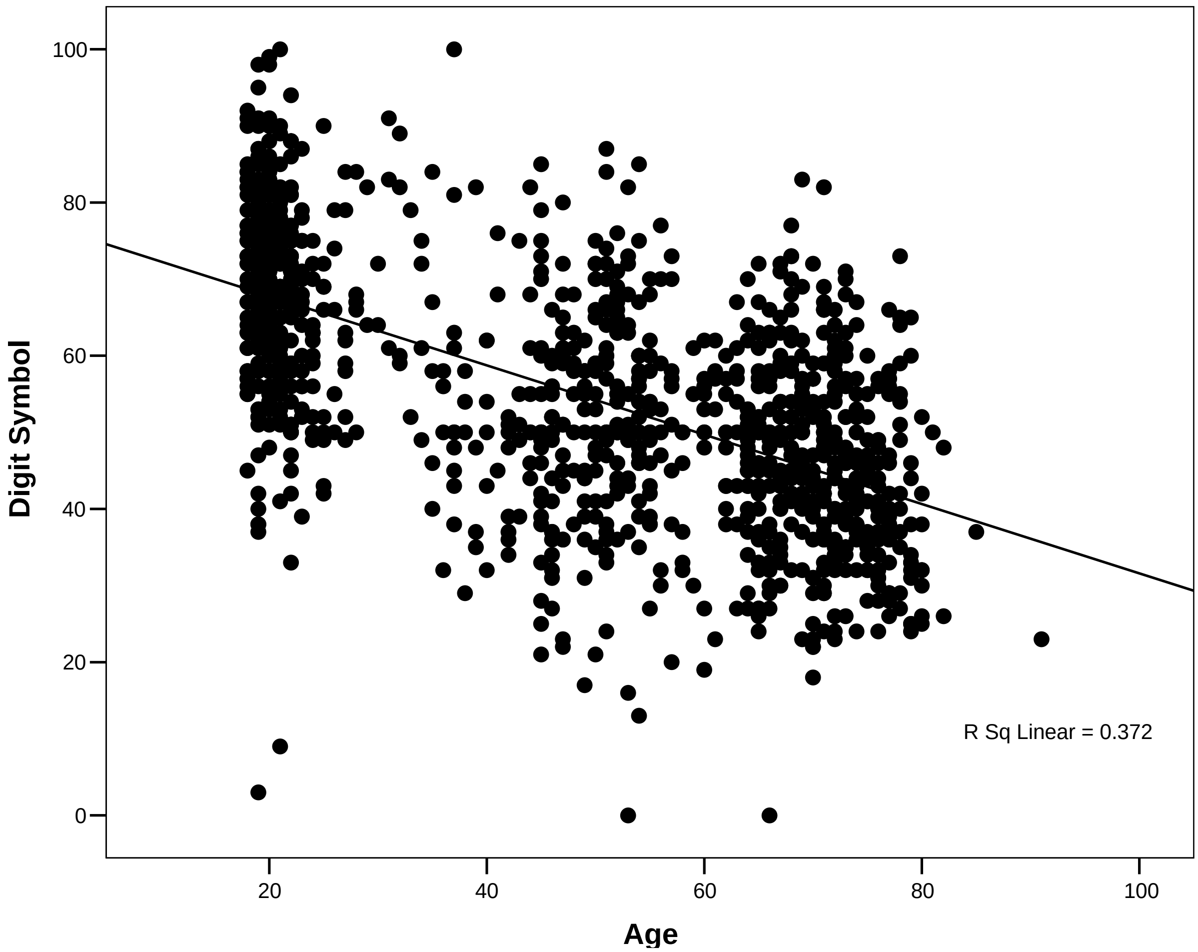
There are also a number of changes in abilities associated with “normal” aging that have implications for the design of training programs. For example, currently about 14 million people in the United States suffer from some type of visual impairment, and the incidence of vision problems increases with age. Although most older adults do not experience severe visual impairments, they may experience declines in eyesight sufficient to make it difficult to perceive and comprehend visual information. Age-related changes in vision have implications for the design of written instructions, manuals, and lighting standards.

Many older adults also experience some decline in hearing and changes in motor skills—including slower response times, declines in the ability to maintain continuous movements, disruptions in coordination, loss of flexibility, and less movement precision (Rogers and Fisk, 2000). These changes in motor skills may make it difficult for older people to use current input devices such as a mouse or keyboard. Changes in perceptual motor abilities may also make it harder for older adults to successfully interact with on-line training programs or multi-media programs. As will be discussed in the next section, there are a number of age-related changes in cognitive abilities that are relevant to learning and training. To date, however, it is not clear how age-related changes in abilities specifically affect learning and skill acquisition. This type of data is important as it provides direction for the development of training programs.

What Do We Know About Older Adults and Learning?

Although there is some variation depending on the type of study—cross-sectional studies (which measure inter-individual differences) or longitudinal ones (which measure intra-individual change)—the basic findings for age and cognition seem robust. For activities that require new learning and problem solving (so-called “fluid” intelligence), peak performance comes in the decade of the 20s or perhaps 30s and then there is gradual decline. For activities that rely on stored knowledge (so-called "crystallized" intelligence), peak performance may move toward the 40s and 50s and then show modest decline, with increases in the rate of decline in the 80s. A set of representative functions are shown below in Figures 2 and 3, taken from data that the authors collected in a sample of more than 1,200 young, middle-aged, and older adults (Czaja et al., 2006).

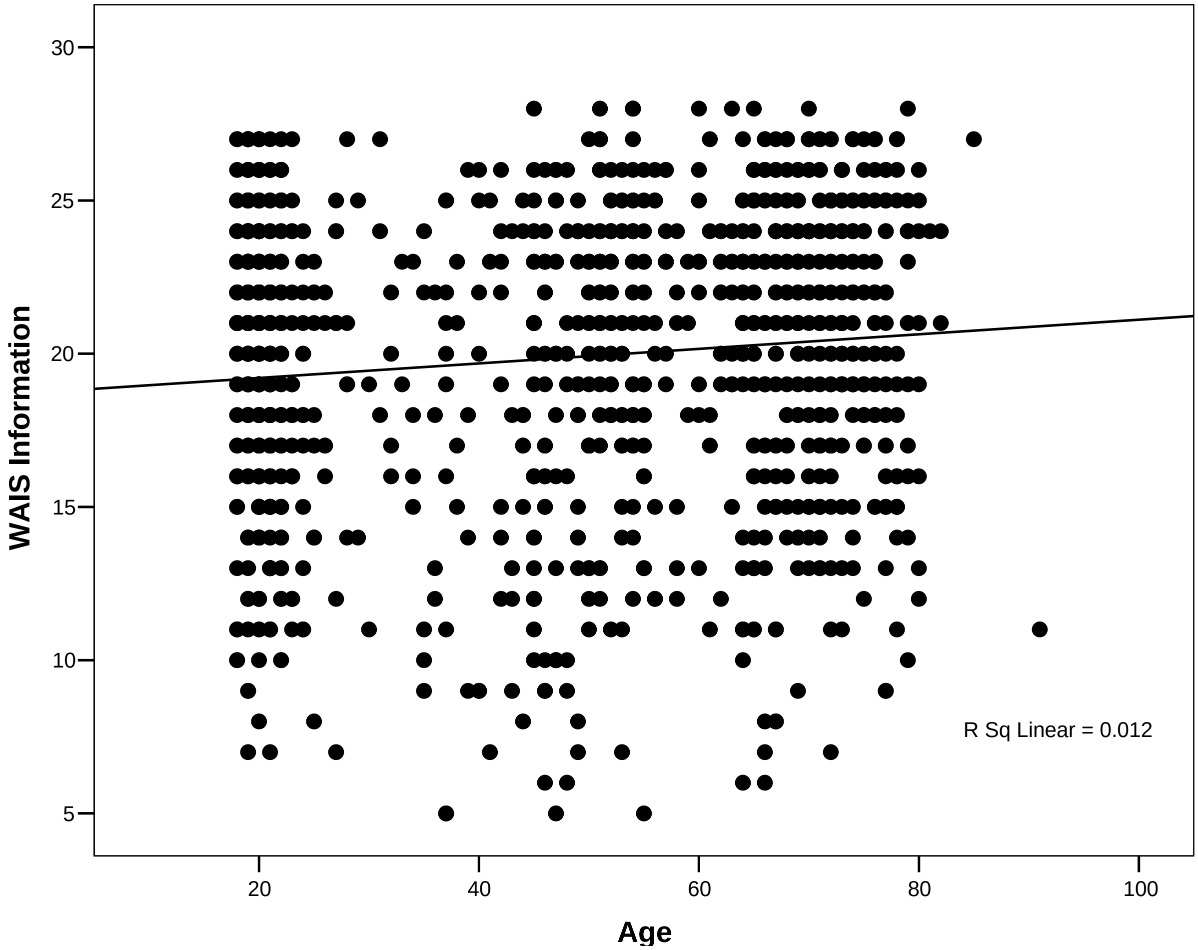
Figure 2. Digit Symbol Substitution Performance by Age



Source**:** From the data set in Czaja et al. (2006)

Figure 2 shows a measure, digit symbol substitution, that is a reasonable marker for fluid intelligence and an excellent indicator of speeded performance. (People are asked to use a digit-symbol key to fill in as many digit-symbol pairs as possible in 90 seconds.) The regression equation predicting performance from age is: Digit Symbol score = 76.8 -.45*Age; F (1, 1201) = 712, p < .001. There is a large (using criteria from Cohen, 1988) negative linear trend (*r* = -.61) with age.

Figure 3. WAIS Information Performance by Age



Source: From the data set in Czaja et al. (2006)

By contrast, Figure 3 shows Wechsler Adult Intelligence Scale Information, a general knowledge measure that is a good indicator of crystallized intelligence. It shows a small positive (r = .11) linear increase with age. (WAIS Information = 18.7 + .024 * Age; $F(1, 1201) = 14.4$, $p < .001$.) Of course, with a sample size this large, even trivial relationships are statistically significant, and very small differences in slopes are reliably different. The purpose for showing these graphs is merely to illustrate that there are differing patterns of development, some positive, some negative, across cognitive abilities. Further, as the scatterplots vividly portray, there is enormous variability in performance even among people in the same age group. Some older adults outperform many younger adults even for an ability showing a strong negative age trend.

It should be stressed that longitudinal studies tend to show slower rates of change with age when the change is measured within individuals, rather than across individuals as shown above. Further, different birth cohorts show different developmental trends in longitudinal

studies. Today's digital calculator-using generation of younger adults might be expected to have poorer mental arithmetic skills than those who were young adults in pre-personal calculator days. Note that even longitudinal studies have some weaknesses, such as practice effects, which tend to inflate estimates of performance when the same tasks are given year after year. Such studies also tend to suffer from selective attrition effects, wherein the initially more able adults are the ones who continue to return to the study and the less able tend to drop out of the study.
More central to the issue of learning and age is about a century's worth of data specifically on memory tasks. Although the tasks tend to be somewhat artificial ones—people are given word lists or paired associate lists to learn—the data tend to resemble those shown for fluid intelligence. Modern neuroscience findings suggest that the difficulty older adults experience in acquiring new information (such as word lists) may stem from changes in structures in the brain responsible for consolidating new information (such as in the hippocampus), which forces them to compensate by recruiting other brain regions (e.g., Grady, McIntosh, and Craik, 2005).

We need to differentiate two kinds of memory: primary or short-term memory, and secondary or long-term memory. (This differentiation is quite simplified, and a richer description involves constructs such as working memory and long-term working memory. For an introduction to these and other concepts in cognitive psychology, see Matlin, 2005.) Short-term memory is the type associated with one's ability to repeat back a list of newly seen or heard items, such as an unfamiliar telephone number. Typically, with such items of information only about seven (plus or minus two) items can be immediately recalled. This form of memory shows very modest decline with age, except when processes such as Alzheimer's disease intervene (Bäckman, Small, and Wahlin, 2001).

The second form of memory, long-term memory, refers to the knowledge store that a person acquires throughout life. One's name, one's current telephone number (if well known), and the letters of the alphabet are all examples of information that an individual acquires and can recall when given an appropriate retrieval cue, even though this person may not have them currently active in short-term memory before the cue is given. Older adults probably have accumulated more information in long-term memory than younger adults as seen in the positive slope with age for WAIS information in Figure 3. However, the rate at which one can "transfer" or consolidate information that was recently encoded in a short-term store to a long-term store shows significant age-related decline. It becomes more difficult to learn new information as one ages.

Further, the consolidation process for new information depends a great deal on how many chunks of information are present. For those growing up in the 1930s, "scallywag" is probably a recognizable word, although it is probably not known to young adults. So one can construct "word" lists that are easier for old adults to memorize than young adults. Thus, experience is a potent mediating variable in determining how effectively someone can learn new information. If the information is related to prior stored information, learning will be faster than if the information is unrelated. Some other important mediators are the strategies used to learn new information as well as self-monitoring practices when learning. (See Dixon, de Frias, and Maitland, 2001, and the upcoming special issue on cognitive training in the *Journal of Gerontology: Psychological Sciences*.)

One useful technique for summarizing the results of many different studies is meta-analysis. A meta-analytic study gathers the results from a large number of studies, perhaps 50 or more, and attempts to assess the average *effect size* for a phenomenon. Effect size, in the case of comparison of old and young adult groups, refers to how big, on average, is the difference, d, in performance between the two groups. Effect sizes are usually given in standard deviation units for the mean difference and are roughly categorized in the social sciences as small, medium, and large when d is 0.2 units, 0.5 units, and 0.8 units, respectively (Cohen, 1988). The other statistic that is often used in meta-analysis is the correlation coefficient, r, which indicates the degree of relationship between two continuous variables, such as age and response time when age is continuous in the sample. Following Cohen (1988), for r, small, medium, and large effects are values of 0.10, 0.24, and 0.37, respectively. Note that these are somewhat arbitrary values, although they are generally accepted in the research community.

Several meta-analyses have been conducted on age and memory performance (Verhaeghen, Marcoen, and Goossens, 1993; Verhaeghen and Salthouse, 1997). In the most recent one, for measures of primary/working memory and episodic memory, Verhaeghen and Salthouse found r values of -0.27 and -0.33, that is, medium to near large negative age effects.

Learning Variability Within Older Cohorts

Recall the medium-sized, $r = -0.3$, correlation between age and memory performance. Another statistic, the square of the correlation coefficient, is used to assess how much of the variability in performance is attributable to age, where a perfect correlation ($r = 1$) means that 100% of the variability is attributable to age. The medium-sized age-memory correlation, when squared, is 0.09, meaning that only 9% of the variability in memory performance that you see in a mixed group of younger and older individuals is attributable to age. Ninety-one percent is attributable to other factors. Those other factors might include word knowledge, memorizing strategy, education level, etc. So, although age is a fairly powerful individual difference variable in the social sciences, it leaves a lot to be explained by other individual difference variables. Note, however, that very small relationships may have important implications for a large population. For instance, drug effects that result in statistically significant differences in survival rates between placebo and control groups often are tiny in size ($r < 0.1$) yet result in treatment recommendations. As an example, Meyer et al. (2001) noted that the relation between chemotherapy and surviving breast cancer was $r = 0.03$.

When looking at variability in performance, one can distinguish two major types: inter-individual variability and intra-individual variability. In cross-sectional studies, one observes inter-individual variability (that is, how different older and younger individuals are from each other). With longitudinal research, one observes intra-individual variability (how a given individual changes across two or more measurement occasions).

For inter-individual differences, one almost always finds that younger persons vary less from each other than do older persons (Christensen et al., 1994). This pattern can be attributed in part to the fact that older individuals have had more of an opportunity to develop and hence differentiate from one another than have young adults. (Think of variations in the knowledge base—for instance, vocabulary—of a group of toddlers versus a group of seniors.) As well, any large group of older adults will include some who have aged well and others suffering from the ill effects of disease processes. Statistically speaking, if one plots the performance of people across age, one sometimes sees an increasing heterogeneity or spread in performance as age increases.

Similarly, if one examines intra-individual or occasion-to-occasion variability, one finds older adults more variable in performance (Hultsch, MacDonald, and Dixon, 2002). This means that prediction of performance becomes less certain as people age. Some will do very well and some very poorly. Further, from day to day, an older adult will vary more than a younger adult. Age, however, may not be the best variable to use when attempting to predict someone's performance.

The Healthy Worker Phenomenon and Its Effect on Training Success

Considering the medium to strong correlations found between age and performance in laboratory research, it is surprising to find very little relationship between age and job performance (McEvoy and Cascio, 1989; Sturman, 2004; Waldman and Avolio, 1986). There are a number of reasons why the difference between performance in the experimental lab and performance on the job is so great for older individuals. As Salthouse and Maurer (1996) noted, studies of older worker productivity have a variety of weaknesses. Not many truly older workers (age 65+) have been examined, so the age range in the studies is somewhat restricted. This makes it difficult to compare with laboratory findings, where much older samples are typically gathered. Productivity measures have unknown reliability and validity (that is, the measures may not measure productivity consistently or accurately).

However, one important factor to consider is that older workers have had many years to find a work niche appropriate to their skill levels and to develop the skills appropriate to their jobs. Large-scale longitudinal studies of workers have shown, for instance, that younger workers are more likely to change jobs in a given year than older workers (Swaen et al., 2002). The adaptation of changing to a more accommodating job is known in the literature as the "healthy worker effect." That is, those who remain in a job may have a unique fit to the constraints of that position. That fit may be the result of (1) "shopping" for jobs that require a unique skill set that the worker already possesses or (2) developing the unique skills that a position requires, or more likely some combination of the two mechanisms.

Another term used to describe these types of effects is "selective attrition." Those who remain in a longitudinal panel study are usually more able than individuals who drop out. For instance, in a classic study of age and intelligence, people who returned time after time for testing performed better at the very first time of testing than those who left the study panel (Botwinick and Siegler, 1980). Another good example is found in shift work. Individuals who cannot tolerate the change in the sleep/wake cycle for some shifts may leave that form of employment. Those who remain may be unusually robust individuals. Hence, when comparing persons who stay and those who leave, Volkoff, Touranchet, and Derriennic (1998) showed that older workers who leave shift work have greater morbidity (illness) than those who remain. An interesting example from middle age is seen in a recent study of professional drivers and their ability to maintain alertness when driving late at night (Otmani, Rogé, and Muzet, 2005). A comparison of performance in a simulator by young and middle-aged drivers showed that the younger drivers were more affected by time of day than the older drivers. A healthy worker effect might explain these findings.

People should be seen as actively adaptive—that is, modifying both themselves and their environments to suit their particular needs. One implication is that older workers who discover that their abilities are waning may refrain from training or retraining activities so that those who do participate may represent an unusually healthy and able group. However, as the literature suggests, older adults are also likely to suffer the effects of stereotypes about age-related performance decline (Kite and Johnson, 1988; Kite et al., 2005). This might result in both negative manager perceptions and negative self-perceptions about trainability (Sterns and Doverspike, 1989). One meta-analysis suggests that the effects of such beliefs in simulated employment contexts are generally small (Finkelstein, Burke, and Raju, 1995). Hence, the more severe risk would seem to be the failure of management to provide appropriate incentives and training opportunities to older workers (Noe and Wilk, 1993; Rix, 1996) rather than that older workers would either be unwilling or unable to profit from training. Of course, management may fail to train older workers for fear of an inadequate return on investment, given an expected shorter horizon to retirement. However, older workers are much less likely to change jobs than are younger ones (Swaen et al., 2002).

In a recent model of developmental activities at work, Maurer, Weiss, and Barbeite (2003) stress the need to ensure that workers, particularly older workers, perceive a benefit to training, believe that they are capable of being trained, and have the opportunity to receive training. Age had a weak negative relationship ($r < -0.2$) to motivational variables (self-efficacy belief, perceived need for training) and other situational variables that lead to participation in training. However, the best-fitting models of the pathways to training activities did not have direct linkages to age, but rather to situational and motivational variables.

Factors Influencing Learning and Skill Acquisition

As mentioned above, although basic abilities such as memory, the capacity to pay attention, and speed of processing show age-related decline, age does not typically account for that much of the variation in learning performance. Some additional factors that may account for variations in learning could include:

Person-related factors. People experience unique life histories that change their capabilities in unique ways. Learning depends in large part on the knowledge base that someone has already acquired, as indicated previously. A recent realistic study of learning about xerography and cardio-vascular disease (Beier and Ackerman, 2005) assigned both in-class video-based learning and at-home learning to younger and older adults. Prior general knowledge of the two domains were measured at the beginning of the study. The authors found that previous knowledge was a strong and direct positive predictor of learning performance both for the in-class and the homework learning activities. General ability measures (fluid and crystallized intelligence) were also significant, although they were found to be indirect positive predictors. (Determination of direct and indirect influences was accomplished with multivariate path modeling procedures.)

Other person-related factors that can influence learning include perceptual and psychomotor abilities. As we age, sensory and perceptual systems become less acute, and signals in the environment become more difficult to perceive. Thus, the failure to design appropriately for such expected age-related changes in vision, hearing, and psychomotor ability will unduly handicap older learners (see Fisk et al., 2004). A simple example is the size of print used for reading materials. Because of the inability of the aging eye to focus on near objects called *presbyopia*, (nearly universal by the fifth decade of life) older adults have difficulty reading small print, even with correcting lenses. If training manuals are printed in small type or rendered in small sizes by computer software such as web browsers, older workers may struggle unnecessarily to read them.

Another important visual factor is the contrast ratio for print. High contrast conditions, such as black text on a white background, are important for older workers to be able to perceive print given the negative age-related changes in the transmission of light to the retina. Many web pages violate this principle by providing text on colored or patterned backgrounds. Similarly, putting important auditory signals in high frequency ranges that older adults have difficulty hearing (e.g., above 8000 Hz) will differentially impair their ability to learn from those signals compared to younger adults.

Social factors. Research on the way social factors influence older worker learning of realistic tasks is very limited. One study on learning to use computer applications compared partners versus individuals learning alone. On a measure of percent of tasks completed successfully the study showed that pair-based learning, despite each partner having half of the hands-on experience of a single learner, proved equally effective as individual learning for older adults (Zandri and Charness, 1989).

Social factors may be more important in modulating motivation to train (e.g., see training models by Colquitt, LePine, and Noe, 2000; Maurer, Weiss, and Barbeite, 2003). For instance, the meta-analysis by Callahan, Kiker, and Cross (2003) showed that modeling was effective in promoting learning in older adults. (Modeling refers to having a model demonstrate how to perform the task to be learned.) Although speculative, it might be more motivating if an older adult serves as the model. One clear implication from the cognitive changes section above is that mixed age groups would not be ideal for training carried on mainly via the lecture system. Lecturing rates chosen for a mixed group might possibly be too quick for older learners and too slow for younger ones. Age-segregated groups might be taught more efficiently.

Environmental factors. Learning often occurs in less than ideal conditions (e.g., compared to laboratory research that carefully controls the noise, lighting, and temperature). Learning environments can be noisy, too hot or too cold, have less than ideal lighting conditions (such as glare), and suffer from vibration or other distracting conditions (like odors). There is little empirical information about the extent to which such factors affect older adults differently than younger ones, particularly for realistic learning tasks lasting more than an hour (the typical time taken for a laboratory study).

Basic experimental work on attention spans generally shows that older adults have greater difficulty inhibiting distraction (ignoring irrelevant information) than do younger adults (Carlson et al., 1995), although this is not always the case (Schneider, et al., 2000). It is probably safe to assume that negative environmental conditions are going to affect older workers more than younger ones. It is worth noting that although environmental distractions may be potent initially, people adapt reasonably well (e.g., to background noise, see Banbury and Berry, 1997), but the extent to which this adaptation process varies with age requires further investigation.

Preparing for Tomorrow's Jobs

When preparing for an aging workforce it is important to consider the types of jobs that are likely to be available in the future as occupational/employment opportunities affect job demands and the types of skills that are needed. Generally, the long-term shift from goods-producing to service-providing employment is expected to continue, and service-providing will account for the largest increase of the new wage and salary jobs. Within this employment sector, professional and related occupations will grow the fastest and add the most new jobs. Much of the growth will come from three occupational groups: computer and mathematical occupations; health care practitioners and technical occupations; and education, training, and library occupations. Other occupations that will experience growth include management and financial; sales and related; office and administrative support operations; and installation, maintenance, and repair (especially within the telecommunications industry) (U.S. Department of Labor, 2005).

The data also suggest that technology will have a major impact on the future structure of the labor force, changing the types of jobs that are available and the way in which jobs are performed. Most workers, including older workers, will need to interact with some type of technology to perform their job. Computer occupations will account for 8 out of the 20 fastest growing jobs, and the use of computers and other forms of technology will also become more prevalent in other occupations. In 2001, more than half of the labor force used a computer at work. This number is expected to increase as developments in technology continue.

For example, computer and Internet use at work is common among managers, professional workers, technicians, and administrative support personnel. Further, cashiers, sales and bank clerks, and customer service representatives use computers on a routine basis. Computer-based tasks are also prevalent within the general manufacturing and chemical and nuclear power industries. Technology use is increasing within the health care arena for service delivery, in-home monitoring, interactive communication (e.g., between patients and physicians), and to transfer health information. Technology is dynamic and thus the increased use of technology in the workplace implies that employees will constantly need to engage in learning and training activities. Workers not only have to learn to use the technology, but they must also learn job-specific skills.

The number of people who are telecommuting is also rapidly increasing. Telecommuting encompasses a number of work arrangements including home-based work, satellite offices, and neighborhood tele-work centers. It can be done on a full- or part-time basis. In 2001, about 29 million workers in the United States engaged in some form of telecommuting, and it is estimated that there could be slightly more than 40 million telecommuters by 2010 (Potter, 2003). Telecommuting may be particularly appropriate for older adults, as they are more likely than younger people to be "mobility impaired" or engaged in some form of caregiving. Telecommuting also allows for more flexible work schedules and autonomy, and is more amenable to part-time work—characteristics that are generally preferred by older people.

On the negative side, exclusive telecommuting from home may result in professional and social isolation. Employees may miss the opportunities to interact with friends and colleagues and to participate in and receive the benefits of organizational membership. Workers may find it difficult to balance work and family responsibilities. Furthermore, managers often fear that it will be difficult to monitor people who work at home. Also, in today's world, telecommuting typically involves the use of computers and the Internet, which may be problematic for older people as they are less likely to have computer skills.

The prevalence of telecommuting raises other interesting issues with respect to training. For example, can on-line training programs be used to teach "tele-workers?" What is the best way to keep these workers updated on changes in job demands? And what strategies can be used to provide tele-workers with technical support? To date, little research has been devoted to examining the social, behavioral, and organizational implications of telecommuting. This is clearly an area that needs study.

When preparing for an aging workforce, it is also important to consider the types of jobs and job characteristics that older people desire. Currently, older workers hold a wide variety of occupations, but there is some variance according to age. About the same percentage of workers in the age ranges of 40 to 54, 55 to 64, and 65+ are employed in white-collar occupations. However, more workers ages 65 to 74 are employed in service occupations, and fewer are in physically demanding blue-collar occupations compared to younger workers. Most workers ages 55 to 64 are in executive/management occupations and professional occupations, whereas workers ages 65 to 74 are more likely to be employed in farming, fishing, and forestry; sales; transportation; and service jobs. In the future, the percentage of older workers will increase in all occupational categories, but the greatest increase will occur in white-collar occupations such as executives, managers, professionals (e.g., teachers, health care professionals), administrative support, and sales (United States General Accounting Office, 2001).

Thus, if the labor force distribution of older workers remains the same, older people will tend to be in industries that are likely to experience growth. However, this does not necessarily mean that employment opportunities will expand for older workers, as a number of other factors such as the job and skill requirements of these occupations and the receptivity to older workers by employers and organizations influence this equation. Almost two-thirds of the projected job openings in the next 10 years will require specialized education and on-the-job training.
In terms of desired job characteristics, instead of full-time leisure, workers and retirees in their 50s, 60s, and 70s are increasingly seeking more work options: reduced hours or days per week, more time off over the year, special project or contract work, greater flexibility, part-time work, and even the opportunity to start new careers (AARP, 2002; Czaja and Moen, 2004). Most of these scenarios also imply the need for training and learning.

Translation to Real-World Settings: Training and Older Workers

As discussed, the literature on aging and cognition generally indicates that many component cognitive abilities such as working memory, the capacity to pay attention, and spatial cognition decline with age, especially when a task is complex or represents an unfamiliar knowledge/skill area. However, it is also clear that there is a certain amount of room for new learning by older adults, and abilities can be improved through training. One important issue is the relevance of these findings to work tasks within real-world contexts. To the extent that competence in work activities can be attributed to basic abilities, one would expect that older people would perform at lower levels than younger people (e.g., Marsiske and Willis, 1998; Schaie and Willis, 1993). In fact, a number of studies have shown that cognitive abilities are related to job performance (e.g., Schmidt and Hunter, 1992; Czaja et al., 2001).

However, it is also known that work competence involves complex task specific knowledge. As Schmidt and Hunter (2004) have shown with path modeling, experience is a better predictor of job performance than intellectual abilities. Thus, to the extent that older people are familiar with the task and able to draw on task-specific knowledge, age differences in performance should diminish. In fact, the literature indicates that well-learned procedures are maintained into old age, and there is little evidence to suggest that older workers are less productive than younger workers (Czaja, 2001; Fisk et al., 2004).

With respect to acquiring new skills, Kubeck et al. (1996) showed that older adults took longer to complete training and showed less mastery of the training material compared to younger adults. However, the authors emphasize that one cannot make the claim that *all* older adults benefit less from training than younger adults or that performance differences will remain in actual work settings. They also suggest the need for studies of training methods that are appropriate for older workers. The identification of training strategies to maximize that likelihood that older adults will be able to achieve competence in work tasks is especially important in today's society given the increased reliance on and dispersion of information technology.

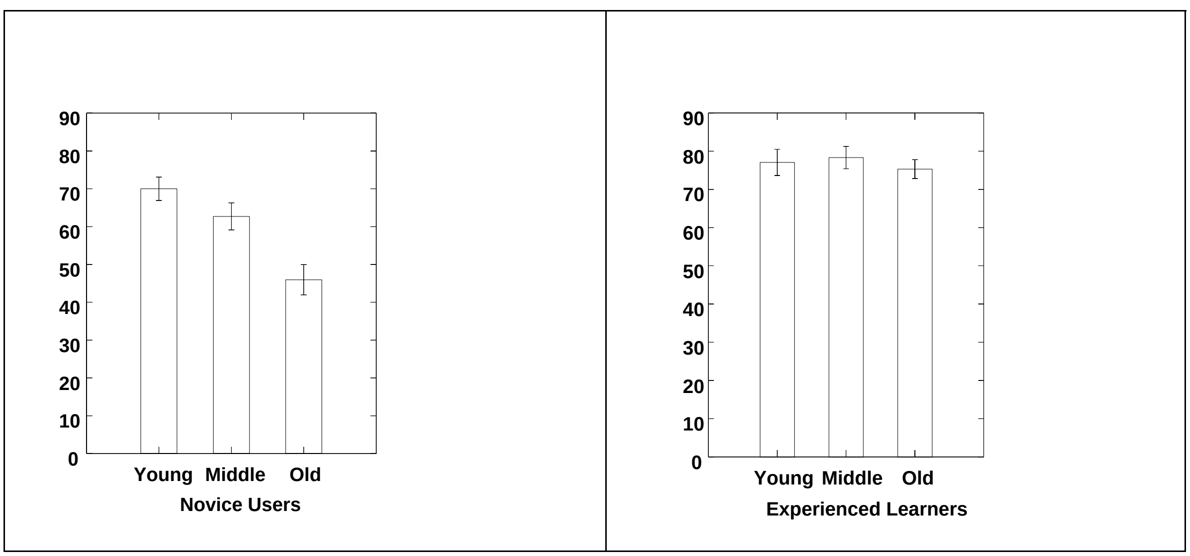
There have been a number of studies (e.g., Elias et al., 1987; Gist, Rosen, and Schwoerer, 1988; Czaja et al., 1989; Charness, Schumann, and Boritz, 1992; Morrell et al., 1995; Mead et al., 1997) that have examined the ability of older adults to learn to use technology such as computers. These studies span a variety of computer applications and also vary with respect to training strategies.

A representative example is shown in Figure 4 below, taken from a cross-sectional study of younger (mid-20s), middle-aged (mid-40s), and older (mid-60s) adults learning to use new word processing software (an early variant of Microsoft Word) (Charness et al., 2001). The data show the scores on the final performance test, which involved editing a document with the new word processing program. Two different groups were trained over a three-day period using self-paced training: a novice group with no word processing experience and an experienced group that knew a different word processing application.

The maximum score that could be achieved was 90. Clear age differences were evident for novice users of the tutorial software package, as seen in the left panel, even though individuals could proceed at their own pace. A very different picture was seen for experienced users of the word processing software (shown in the right panel). There were no real differences in performance for the three age groups at the end of training—and performance was better than that achieved by young novices, as shown in the left panel. However, the researchers also monitored how long people took to go through the self-paced training and found that middle-aged and older adults took much longer than young adults. Older adults took nearly twice as long.

Meta-analyses have also been conducted on learning success for older adults based on a mix of laboratory and applied studies. The findings there are similar to those discussed earlier with respect to memory for word lists. As mentioned above, meta-analysis by Kubeck et al. (1996) investigated whether job-related training programs were equally effective with older and younger adults. They found that, on average, older adults had less effective performance after training than younger adults (r = -0.26). Further, older adults took significantly longer to train (r = 0.42). The type of task made a difference. Larger age differences were found for computer training than for non-computer job-related training. However, because there were so few true training studies (i.e., those carried out in field settings in industry), much of the data for meta-analysis came from experimental studies that resembled real-world training conditions (including several studies from the authors of this report).

Figure 4. Differences in Performance on a New Word Processor by Novices and Experienced Word Processors



Source: From Charness et al. (2001)

Overall, the results of research in this area indicate that older adults are able to learn new skills in dealing with computer software programs. However, they are typically slower to acquire new skills than younger adults.

One of the most robust laws of aging is that older adults (typically those in their 60s and 70s) take roughly 50 percent to 100 percent longer than younger adults (those in their 20s) to perform any new task. General slowing is seen in all kinds of activities, both mental (learning) and physical (response time). Some of the slowing may be attributable to older adults' preference for accuracy over speed, with the reverse holding true for younger adults.

In addition, older adults generally require more help and "hands-on" practice. When compared to younger adults on performance measures, older adults often achieve lower levels of performance. However, the literature also indicates that training interventions can be successful in terms of improving performance, and the research points to the importance of matching training strategies with the characteristics of the learner.

Finally, one important constraint on training studies is the training method. There have been numerous attempts over the past 50 years to find techniques that are best suited to older learners. Modern attempts started with research in the United Kingdom (e.g., Belbin, 1969) on "discovery learning." This encourages the learner to explore the methods and techniques available in a work setting to find those that best suit the learner, rather than teaching a specific method. There was weak evidence favoring this form of learning over more traditional training techniques. The key concept explored in this research was the idea of an interaction between training technique and age. The expectation was that one form of training would prove differentially better for the older adults compared to using the same methods in younger adults. Very few instances of interaction have been observed. Generally, what is best for the young is also best for the old.

In recent years, a few exceptions have been observed. Investigators showed that there were greater gains for older adults when performing procedural (action or hands-on) activities compared to conceptual training in using automated teller machines (ATMs) (Mead and Fisk, 1998). A similar differential advantage was shown for training to search the Internet (Mead et al., 1997).

In their meta-analysis of training techniques, Callahan, Kiker, and Cross (2003) found few practical moderator effects (interactions) in their analysis, suggesting that effective training techniques did not vary much with age, although the researchers restricted themselves to older learners age 40 and above, so there was little chance of finding moderator effects. The focus was on understanding training solely in older learners. The methods they examined were lecture, modeling, and active participation (discovery learning). All three proved to be effective with older adults. The investigators also compared what they called instructional factors: materials, feedback, pacing, and group size. Only self-pacing and group size (smaller is better) were found to be important, with self-pacing the more powerful technique.

Where research is lacking it would be very useful to determine the best practices of companies. Unfortunately, even for those companies known to be friendly to older workers (http://www.aarpmagazine.org/lifestyle/best_employers.html), there are few reliable published reports. There is a precedent, however, for describing best practices in Organization for Economic Cooperation and Development reports (e.g., for job redesign) (Marbach, 1968).

In addition, due in part to the type of research designs typically adopted in laboratory studies (mostly comparisons of young versus old adults), there is not much knowledge about the non-linear relationship of age to training success. That is, does learning vary depending on the age range of the older worker? People generally assume a linear relationship between age and performance, but this should be tested more rigorously.

In summary, many techniques for training prove to be effective for older adults, but there is not yet an adequate research base to determine whether some training techniques are *differentially* beneficial for older workers on a consistent basis. Generally, the process of learning or skill acquisition involves the learner progressing through a number of stages until "mastery" of the material is achieved. The initial stage of learning generally requires a reasonable degree of attention and cognitive effort as the learner is attempting to understand fundamental concepts and basic performance requirements associated with the material to be learned. For example, with the Internet the learner must understand new concepts such as what the World Wide Web is and how it can be used. Various stimuli (buttons, displays, menus, switches, input devices, and a wide variety of technical terms) must be comprehended. For complex tasks, such as learning to navigate the Internet or many new work skills, providing an overview is important at this stage. This knowledge provides the learner with a context for understanding why individual subtasks need to be performed and how they are related.

During the second stage of learning, one attains sufficient command of the background information, facts, and concepts to shape this information into "packets" or "chunks" of knowledge. The use of these chunks enables more efficient use of learned information and smoother performance of the task. An example of a type of packet is the "if-then rule": "If I am in graphics mode on the computer, then I can access a function that allows me to generate data tables."

In the final stage of learning, the procedures or strategies are modified and fine-tuned to increase their reliability and efficiency. Depending on what has to be learned, this stage often requires the longest practice period. For tasks involving a reasonable degree of skill, improvement in performance is much more gradual compared to the previous stages, and can occur over long sequences of repetition.

An important goal for training is for a person to be able to remember and use the information and skills he or she acquired during the learning and training process. Therefore it is critical to ensure that the learning is not just for immediate mastery but transfers to behavior in real-world settings.

There are a number of factors that influence how much of this goal is achieved. As described earlier, these include person-related factors, social factors, and environmental factors. They also include factors specific to the design of the training program—pacing, amount and spacing of practice, feedback, training media, and general training approach (e.g., procedural vs. conceptual training). As discussed by Schmidt and Bjork (1992), procedures that are adopted during training should support two aspects of post-training performance—retention of performance in the long term and the ability to transfer what is learned in training to related tasks and altered contexts. The authors point out that manipulations, such as providing frequent feedback, that maximize performance during training may not necessarily support optimal retention and transfer. They advocate the use of various kinds of transfer or retention tests that evaluate performance beyond the acquisition phase and focus on longer-term retention and generalization.

In this regard, Goldsmith and Kraiger (1997) discuss a method for assessing an individual's knowledge, known as structural assessment, that goes beyond traditional paper and pencil tests or work samples. This method involves evaluating conceptual knowledge and competence within a particular area such as a job or skill and yields an actual representation of a learner's knowledge of concepts, rules, and interrelationships among concepts within that particular area. The basic steps in a structural assessment are to define the structure of a particular activity or task or skill and then elicit, represent, and assess an individual's cognitive structure of that activity/task. A set of procedures is available for performing and scoring the assessment. The advantage of this approach is it offers a potentially rich source of information for directing remediation strategies and is less sensitive to potential memory-related retrieval deficits. The authors point out that structural assessment is not meant to replace the traditional assessment approach but it offers a source of additional information about a learner's knowledge that is not captured in other types of measures.

We know that it is important to allow extra time for training an older adult (1.5 to 2 times the training time expected for a young adult), to ensure that help is available and easy to access (e.g., acquaint the person with sources of help), and to ensure that the training environment allows the individual to focus on the training materials. For example, distractions such as background noise, other worker activities, and too many instructors should be minimized and the use of multimedia should be restricted. It is also important that training materials are organized and that the reading level of all instructions and manuals matches the abilities of the user. It might be helpful to provide a learner with simple support materials such as graphic aids or reminders of procedural steps to minimize the demands on working memory.

In addition, it is important to match the instructional technique and the medium (e.g., text, voice, animation) to the type of material that is being presented. For example, "how to" information should be presented in a procedural step-by-step format and spatial tasks should be taught using a visual medium. Allow the learner to make errors, when safe, but provide immediate feedback regarding how to correct mistakes. The older adult should be actively involved in the learning process, and an engaging environment that captures the attention of the learner should be created. Keep demands on working memory to a minimum, and where possible, capitalize on the learner's pre-existing knowledge base. If the task is complex, training demands can be reduced by using part-task training techniques such as providing practice on task components, and proceeding from simple to more complex aspects of the task.

Due to the rapid development of powerful technology tools multimedia programs are increasingly being used for education and training. Despite the significant use of multimedia in training, there has been very limited effort to evaluate the design of multimedia programs or the impact of this type of training format on user performance (Sutcliffe, 2002). Currently there is little empirical knowledge to guide the developer of these applications. In addition, almost no research has been done with older adults. This issue is especially compelling given that multimedia formats place demands on cognitive processes that show age-related decline such as working memory and selective attention.

In addition to design factors, it is also important to develop strategies to encourage older workers to participate in training and retraining programs. Employers need to ensure that older adults are provided with access to training programs and incentives to invest in learning new skills. Generally, the literature suggests that people are more receptive to engaging in learning activities if they perceive them as having some long-term benefit. Consideration also needs to be given to the scheduling and location of training programs and the potential for industry/community partnerships.

Conclusions

Although business cycles undoubtedly play a more important role in shaping employment environments than do demographic forces (e.g., Cappelli, 2003), it is inevitable that the future work place will include many older workers. Much of the increase will be driven by the aging of the baby boom cohorts. However, due in part to the vagaries of the economy and the marked shift in the past decade away from guaranteed pensions, it is also possible that a greater percentage of the generation preceding the baby boomers will stay in the labor force or will return from retirement to perform part-time work to supplement their incomes. How well these (and future) older workers adapt to the demands of the increasingly competitive labor environment is of critical importance to the productivity of the economy as well as to the well being of individuals.

As mentioned above, meta-analytic studies suggest that there is little relationship between age and productivity. However, an often overlooked factor in evaluating these psychological studies is the relation between age and wage. Even if older workers are, on average, as productive (in the sense of work output measures) as younger workers, they are paid, on average, more than younger workers, so they are less productive in an economic sense. Reasons for such overpayment of older workers (and underpayment of younger workers) may reside in the cost of lifetime contracts between employers and employees (Hutchens, 1986). However, lifetime employment is no longer a likely prospect for most employees, and we may expect to see changing employment models that will result in a flattening of the age-wage structure where current pay is more tightly linked with current productivity/output (e.g., more bonuses and fewer raises).

So, there are two important issues: how do we equip older workers to be productive, and how do we keep all employees productive across their working lives? The former question revolves around the issue of training and retraining. The latter revolves around health and safety concerns (e.g., National Research Council, 2004). If older workers did not undergo cognitive changes such as slowing and if they responded to training in the same way as younger workers, then the road would be straight ahead—that is, find out what works best for younger workers and apply those techniques to older workers. However, some research studies demonstrate that some forms of training may be differentially better for older workers. The research area concerned with fine-tuning training for older workers is still poorly explored and needs significant development.

Part of this development depends on understanding the relationship between age-related changes in functioning and the specific skill requirements of jobs. Although there are age-related declines in most aspects of functioning, the declines are nearly always gradual, and most jobs do not demand constant performance at the level of maximum capacity. The majority of the population of older adults remains healthy and functionally able until very late in life. It is also important to recognize that conclusions regarding age-performance differences are often based on the comparison of averages. In this regard, one important area of needed research is developing a knowledge base that links age-related changes in skills and abilities to specific skill requirements of jobs.

There is a project, O*NET, that does attempt to specify the abilities required for specific jobs (http://online.onetcenter.org/). O*NET classifies jobs based on their requirements, worker attributes, job context, and job content. However, whether normative age-related changes in abilities can be mapped into O*NET categories of job requirements remains to be explored. There is a broader problem that needs to be resolved first. Currently, the relationships among aging, cognition, and work productivity are unclear. A more complete understanding of these relationships would help direct the development of both better selection and training strategies for older workers.

A further issue is how to structure the work environment to accommodate normative changes with age in perceptual, cognitive, and psychomotor abilities. There are remarkably few studies concerning how to optimize work environments for older workers based on ergonomic and human factors principles (Steenbekkers and van Beijsterveldt, 1998; Fisk et al., 2004; Kroemer, 2005). Existing studies have not explored a wide enough range of work tasks to come up with strong recommendations even for such basic factors as print size (Charness and Bosman, 1992) or level of lighting (Charness and Dijkstra, 1999). Particularly troubling is the fact that there is little experimental work to provide guidance on how best to structure the ubiquitous computer workstation on which so many older workers rely.

Recommendations for Future Research

Recommendation 1. Future training studies need to capture the complexity of representative job tasks, particularly the contextual elements of the work environment. In addition these studies need to include a wider age range of workers to assess potential interactions between the type of training and the age of the worker. Studies similar to those done by Czaja and colleagues (see Czaja and Sharit, 1993; Czaja and Sharit, 1998; Czaja et al., 2001; Sharit and Czaja, 1999) are good models.

Recommendation 2. There are well-developed models for understanding motivational antecedents, such as learning self-efficacy, for seeking job training (e.g., Colquitt, LePine, and Noe, 2000; Maurer, Weiss, and Barbeite, 2003). Few studies, however, have examined strategies to influence the antecedent conditions that control the older worker's desire to train or retrain. In particular, studies are needed that examine the entire path from attitudes about training or retraining to training outcomes.

Recommendation 3. What proportion of training is informal peer-to-peer training or self-training versus formal training courses? How does the mix of training types vary with age? These questions are relatively poorly addressed in the research literature and deserve greater attention.

Recommendation 4. Tele-work is becoming increasingly available in the service sector. We know very little about the advantages and disadvantages of this form of work for older people. Studies on tele-work need to focus on assessing the costs and benefits of offering such work to older individuals and on determining the necessary prerequisite training.

Recommendation 5. Careful consideration needs to be given to how we define and measure "training success." We need to move beyond defining success purely on the basis of the achievement of statistical significance on measures, such as knowledge tests, to measures that have practical significance, such as changes in the way that work activities are carried out.

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