A case for cognitive spectacles

William Jones, Research Associate Professor Emeritus, The Information School, University of Washington.

The physical declines that come with increasing age are readily apparent. We look older of course but changes are more than skin deep. Beginning in our early 40's many of us will experience problems seeing clearly at close distances. About 1 in 5 of us over the age of 65 will develop cataracts. Our knees and hips will fail. And so on.

Not so long ago, these physical infirmities would have drastically curtailed the activities of an otherwise healthy person. A person with *presbyopia*, the inability to focus on things nearby, a condition most people develop as they age into their 40's and beyond, could no longer read the text of a standard document. A person with severe cataracts could hardly see at all. A person whose knee or hip failed might never again lead an active life.

We are already cyborgs

Fortunately, we now have tools and technologies to help. Cataracts can be surgically removed. Reading glasses help us to see text. Knees and hips can be replaced. We may think of "cyborgs" as the stuff of a science fiction future, but that future is already here for many of us in the form of artificial body parts and extensions. This present future has been a long time coming. The first eyeglasses were thought to have been made in Pisa, Italy about 1290.[1] The first metallic hip replacement was made in 1940.[2] The first knee replacement occurred in 1968.[3]

Tools and technologies in support of our physical bodies have had a profound impact not only on those who benefit directly but also on the collective impressions of the physical disabilities so corrected. Without the person telling us, we might hardly know that a person's knee or hip is artificial or that she now sees normally because of cataract surgery. Wearing glasses, by young and old, is now commonplace. And those who wish further to disguise this "disability" might wear contacts or even opt for corrective surgery. When some 75% or more of us have corrected vision[4], we hardly think that corrected vision is even a consideration, let alone a disqualification, in decisions of employment.

Comparable to the physical declines in various forms that come with aging are declines in mental ability. Short-term memory capacity (the number of things we can keep in mind – the digits of a phone number,

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[1] https://en.wikipedia.org/wiki/Glasses#Precursors.

[2] https://en.wikipedia.org/wiki/Hip_replacement#History.

[3] https://orthoinfo.aaos.org/en/treatment/total-knee-replacement/#:~:text=Knee%20replacement%20surgery%20was%20first,procedures%20in%20all%20of%20medicine.

[4] http://www.glassescrafter.com/information/percentage-population-wears-glasses.html#:~:text=According%20to%20the%20Vision%20Council,42%25%20of%20men%20wear%20glasses.

for example, or items to buy at a grocery store) declines gradually with normal aging. More generally, working memory capacity – characterized as the ability to keep a problem representation active as we endeavor to solve it (Engle et al., 1999) – is in gradual decline beginning in our 20's. Raw processing speed decreases (Salthouse, 1996). We are less able to recall episodic detail: "Where are my car keys?" And then later… "Where did I park the car?"

Where are the cognitive eyeglasses? Can we reach a point where age-related declines in working memory, processing speed, episodic memory, etc. are no more a hinderance, nor a consideration in matters of selection (e.g., for employment), than age-related declines in the ability to focus on nearby objects without reading glasses?

We have our laptops, our tablets, and our smartphones. We have our wireless earbuds -- for noise cancellation, sound amplification, and hands-free communication not only with other people but even more so with virtual assistants like Siri.[5] We have the web for ready look up of information; we "mine" our own inboxes and our collections of digital photos in support of our memories for personal, episodic information. What is the name of their new-born daughter? Look for the announcement sent in email. If we can't recall what the person we talked to at yesterday's party said about his line of work, we can look the information up on Facebook or LinkedIn. If we need to remember information on a business card, we can take a picture

Many studies do suggest that current information tools, overall, further advantage the young vs. the older.[6] But the factor of age is mixed with other factors -- most notably that older people generally have less experience with current information tools and possibly have less of a supportive, reinforcing community of friends and colleagues who also use these tools. Moreover, as argued below, research on interactions between age and variations in information tool design is…well… immature.

A call for a more systematic search for cognitive spectacles

For a glimpse of what might be in the way of information tools working as "cognitive spectacles" we can look not to the future but to the past. Elsewhere I consider[7] two innovations (in their time): 1. Full-screen document processing. 2. Direct-access (search- or tag-based) retrieval of information from the web. In both cases, interactions were observed between the variable of age and the innovation – full-screen vs. line-based editing in one case, tag-based (search-based) vs. taxonomic navigation in the other. In both cases, the innovation removed or greatly reduced the disadvantages of advancing age.

Alas there has not, to my knowledge, been an effort to replicate the results of either study. And the impetus to do so has faded. Full-screen, WYSIWYG editing is clearly better for everyone than is line-based editing; similarly, direct searching (i.e., with suggested completions as in Google) is preferred to

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[5] https://en.wikipedia.org/wiki/Siri.

[6] (Charness & Boot, n.d.; Chevalier et al., 2015; Sanchiz, Chevalier, et al., 2017; Sanchiz, Chin, et al., 2017)

[7] (Jones, 2022).

navigation as a means for finding public information (e.g., on the Web).[8] Why bother with continued explorations of potential interactions with aging?

But newer questions in information tool design arise continually and explorations into design alternatives are ongoing. Why not more systematically factor age into these studies? As we do so, our focus can shift in a potentially profound way -- away from the study of old age as, at least implicitly, a disability and towards a more systematic study of the process of aging as something we are experiencing.

Consider that studies of design alternatives don't typically attempt to sample systematically for the factor of age but, instead, sample from the available population (which is often a younger population of college students). There is a largely separate line of research into the challenges older people face as they use computer-based information tools (e.g., smartphones and smartphone applications, web browsers and web applications).[9]

Factoring age into standard studies of information tool design alternatives, would at minimum, mean purposefully sampling so that study participants are diverse with respect to the factor of age. A step further would be cross the factor of age with the factor design. And then, perhaps not just "younger" vs. "older" people. For example, Salthouse (2006) argues for the inclusion of an intermediate group, which we might call "middle-aged" or the "younger old".

We are all aging, and, by some measures of cognitive ability, we experience declines as early as when we turn 20 even as other cognitive abilities continue to improve through our 50's and into our 60's (and possibly beyond).[10] I argue for a focus on the process of aging and on its potential interactions with information tool design. Recognize the possibility that the information tools (or variations in these) that work best for people in their 20's and 30's may be quite different from those that work best for people in their 40's, 50's and 60's and these, in turn, may be quite different from those that work best for people in their 70's and beyond. And then consider the tantalizing possibility that adults properly "fitted" for information tools may perform comparatively across a broad range of ages.

Building a better personal space of information

A point of *distributed cognition[11]* is that our ability to do smart things, indeed, to function at all, is very much a function of our extended selves – extended to include the information we have access to or are impacted by "out there" as well as the tools we use to work with this information. Information and information tools combine to form a *personal space of information* (PSI).[12] We each of us has a PSI,

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[8] But see Bergman (2012; 2018) for evidence that people prefer navigation as a primary method of return to personal files.

[9] See, for example (Allah et al., 2020; van Oostendorp & Karanam, 2016).

[10] (Hartshorne & Germine, 2015)

[11] See https://en.wikipedia.org/wiki/Distributed_cognition. See also, https://en.wikipedia.org/wiki/Extended_mind_thesis, https://en.wikipedia.org/wiki/Situated_cognition, https://en.wikipedia.org/wiki/Social_cognition, and https://en.wikipedia.org/wiki/Embodied_cognition.

[12] (Jones, 2007, 2012).

unique to us. Also, as a part of our PSIs, are our connections to information (e.g.., the Internet, the local library) and our various sources of information including, perhaps most important, the people whose company we keep (e.g., family, friends, work colleagues and even casual acquaintances).

Our PSIs play a critical role in our ability to manage information to get things done in our daily lives[13]. The loss of our smartphone, an interruption in Internet connectivity, or even, simply, a misplaced document – these disruptions in the landscape of our PSI can profoundly impact our ability to get things done and to function.

There is increasing awareness of the importance to build our PSIs not only for the present but also for the long run to support us as we age and as an inheritance to our loved ones with our passing.[14] Elsewhere, I write of steps we can take to improve our PSI.[15] We begin by taking an inventory. How many devices? How many email accounts? How many social media accounts? How many web stores? Do we need them all? Can we simplify? What constellation of information, information tools, and information sources will best "age gracefully" with us? And then what do we want to bequeath (with account information and requisite passwords) to our next-of-kind with our passing? Cleaning our PSI both for our future selves, and then also for our posterity, can be likened to the cleaning and possible downsizing of our physical spaces in anticipation of later life and passing.[16]

Conclusions

There is a need and a tremendous opportunity to include, more consistently, more systematically, the effects of aging in studies of information tool design, i.e., across studies of tool design in general and not just studies whose primary purpose is to target the needs of older people. More broadly, we need to assess the impacts that various information tools (and information channels) will have on our ability to live happily and function effectively inside our PSI where these impacts may change over time as we age.

Of special interest in the context of successful aging are variations in information tool design that are better in general for everyone regardless of age but that are especially good for older people. Such an interaction might occur, for example, through innovations that reduce the demands on cognitive facilities such as working memory, shown to be in decline for *all* of us in adulthood. Conversely, this might happen through user interfaces that better exploit facilities such as vocabulary – an aspect of crystallized intelligence that is known to improve with age. Either way, such innovations hold the promise of providing general improvement, only especially so for older people.

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[13] https://en.wikipedia.org/wiki/Personal_information_management

[14] (Jones et al., 2016). See especially Chapter 12 with its discussion on "building a better PIM" ("PIM" as in a practice of *personal information management*, where a PIM practice includes, in addition to the PSI, a person's methods for working with the PSI.

[15] (Jones, 2015)

[16] Although we might wish for a better expression, see the discussion of "death cleaning" in (Magnusson, 2018).

References

Allah, K. K., Ismail, N. A., & Mohamad, M. A. (2020). Web Search User Interface for Elderly: A Systematic

 Literature Review. *International Journal of Grid and Distributed Computing*, *13*(1), 744–772.

Bergman, O., & Benn, Y. (2018). A neuro-cognitive explanation for the prevalence of folder navigation

 and web browsing. In *Information systems and neuroscience* (pp. 93–99). Springer.

Bergman, O., Whittaker, S., Sanderson, M., Nachmias, R., & Ramamoorthy, A. (2012). How do we find

 personal files? The effect of OS, presentation & depth on file navigation. *Proceedings of the*

 2012 ACM Annual Conference on Human Factors in Computing Systems, 2977–2980.

 https://doi.org/10.1145/2208636.2208707

Charness, N., & Boot, W. R. (n.d.). Aging and Information Technology Use. *Computer*, *50*(64), 65.

Chevalier, A., Dommes, A., & Marquié, J.-C. (2015). Strategy and accuracy during information search on

 the Web: Effects of age and complexity of the search questions. *Computers in Human Behavior*,

 53, 305–315. https://doi.org/10.1016/j.chb.2015.07.017

Engle, R. W., Tuholski, S. W., Laughlin, J. E., & Conway, A. R. (1999). Working memory, short-term

 memory, and general fluid intelligence: A latent-variable approach. *Journal of Experimental*

 Psychology: General, *128*(3), 309.

Hartshorne, J. K., & Germine, L. T. (2015). When Does Cognitive Functioning Peak? The Asynchronous

 Rise and Fall of Different Cognitive Abilities Across the Life Span. *Psychological Science*, *26*(4),

 433–443. https://doi.org/10.1177/0956797614567339

Jones, W. (2007). *Keeping Found Things Found: The Study and Practice of Personal Information*

 Management (1 edition). Morgan Kaufmann.

Jones, W. (2012). *The Future of Personal Information Management, Part I: Our Information, Always and*

 Forever. Morgan & Claypool Publishers.

 https://www.morganclaypool.com/doi/abs/10.2200/S00411ED1V01Y201203ICR021

Jones, W. (2015). *Building a Better World with our Information: The Future of Personal Information Management, Part 3* (Vol. 3). Morgan & Claypool Publishers. http://www.morganclaypool.com/doi/10.2200/S00653ED1V01Y201506ICR042

Jones, W. (2022). Information, knowledge, and successful aging. In *Information Issues for Older Americans: Vol. Chapter 2* (William Aspray, ed., pp. 17–62). Rowman & Littlefield.

Jones, W., Bellotti, V., Capra, R., Dinneen, J. D., Mark, G., Marshall, C., Moffatt, K., Teevan, J., & Van Kleek, M. (2016). For Richer, for Poorer, in Sickness or in Health…: The Long-Term Management of Personal Information. *Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems*, 3508–3515. https://doi.org/10.1145/2851581.2856481

Magnusson, M. (2018). *The gentle art of Swedish death cleaning: How to free yourself and your family from a lifetime of clutter*. Simon and Schuster.

Salthouse, T. A. (1996). The Processing-Speed Theory of Adult Age Differences in Cognition. *Psychological Review*, *103*(3.403-428). http://rpadgett.butler.edu/ps320/coursedocs/Salthouse96.pdf

Salthouse, T. A. (2006). Mental exercise and mental aging: Evaluating the validity of the "use it or lose it" hypothesis. *Perspectives on Psychological Science*, *1*(1), 68–87.

Sanchiz, M., Chevalier, A., & Amadieu, F. (2017). How do older and young adults start searching for information? Impact of age, domain knowledge and problem complexity on the different steps of information searching. *Computers in Human Behavior*, *72*, 67–78.

Sanchiz, M., Chin, J., Chevalier, A., Fu, W.-T., Amadieu, F., & He, J. (2017). Searching for information on the web: Impact of cognitive aging, prior domain knowledge and complexity of the search problems. *Information Processing & Management*, *53*(1), 281–294.

van Oostendorp, H., & Karanam, S. (2016). Supporting Information Search by Older Adults. *Proceedings of the European Conference on Cognitive Ergonomics*, 1–8. https://doi.org/10.1145/2970930.2970943