Designing Mobile Applications for Older Adults with Cognitive Decline: Inclusive Design Considerations for User Experience Designers

by

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Abstract

Older adults with cognitive decline vary in their needs, abilities and attitudes to technology. They also increasingly use mobile technologies such as tablets. Most UX designers, however, lack knowledge about cognitive accessibility and design for seniors, especially in mobile. This MRP targeted UX designers and argued that seniors with cognitive decline represent a vital 'edge case' that leads to better designs for everybody. Guided by a model of 'Inclusive UX' as more than usability for average users, it assembled a comprehensive set of research-based inclusive design considerations for the wide range of UX designers working in mobile. The main methodology was content analysis based on design, psychology and human-computer interaction literature as well as an 'inclusive survey' with thirteen professionals including designers, inclusive design experts, academics and doctors. This MRP will be of interest to UX designers as well as students and academics in design, computer science and human-computer interaction.

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Dedication

To Parul

Table of Contents

List of Tables

List of Figures

1 Introduction

User Experience (UX) designers working in information communication technology strive to make the experience of using technology as engaging, learnable and intuitive as possible. As a result, they place significant emphasis on making systems *enticing*, *comprehensible* and *meaningful* to all users.

UX designers and design thinkers are beginning to realize the value of inclusive design in ensuring that user experiences are as accessible, adaptable and engaging as possible. Inclusive design considers the full range of human diversity with respect to ability, language, culture, gender, age and other forms of human difference. Inclusive designers focus on the statistically less significant 'edge case' users in order to identify challenges and affordances that can make a better overall design for everybody.[1] Some UX professionals working in agile/lean UX teams in fields such as healthcare, education and government have been considering the needs of users with visual impairments, hearing loss, and motor/dexterity issues. A smaller subset of UX professionals have begun to design specifically for older adults 65 years of age and older – the world's fastest growing demographic.

Despite these trends, however, UX designers rarely focus on the needs of users with cognitive disabilities, a broad range of conditions that includes learning disabilities, autism, dementia and cognitive decline (age-related cognitive decline and mild cognitive impairment). Older adults, who comprise the largest growing demographic with cognitive decline, are no exception. This is largely due to a lack of awareness and education about cognitive disabilities in general, both within and outside the design field. According to WebAIM (Web Accessibility In Mind), a non-profit based out of Utah University, "web accessibility for individuals with cognitive or learning disabilities is varied and complex. It is an area with little definitive research and few concrete

[1] For more information about the three dimensions of inclusive design see Part 2: Concepts.

recommendations" (WebAIM, 2013c). The situation is even more pronounced in mobile.

This major research project (MRP) argues that older adults (65+) with cognitive decline (specifically age-related cognitive decline and mild cognitive impairment) represent a vital 'edge case' whose needs cannot be ignored by UX designers. It presents a set of design considerations in Part 6 that UX designers working on mobile applications can apply to ensure cognitive accessible products and experiences for older adults with cognitive decline. The purpose of this set of considerations is to help designers design effective and compelling digital experiences for *all* older adults, with and without cognitive decline. These design considerations are especially relevant for applications on mobile devices that are popular with older adults such as the iPad and Kindle; however, they may also be useful for the design of apps for children or apps for people who need to navigate interfaces in a foreign language. Indeed, everyone benefits from cognitive accessibility; therefore, this list is also a general resource for UX designers who simply wish to create better mobile user experiences for all users.

In addition to presenting a set of UX design considerations for UX designers designing apps for older adults with cognitive decline, this MRP also includes an overview of the user experience field and makes important connections to the theoretical and practical dimensions of inclusive design. To my knowledge, this is the first time an "Inclusive UX" position has been articulated in the literature. It also includes a literature review that examines existing strategies, current guidelines and best practices.

The goal of this MRP, therefore, is two-fold. The practical goal is to help make mobile apps easier to use, especially for older adults with cognitive decline. The pedagogical goal is to enhance awareness of cognitive accessibility among UX professionals and academics. The main research methodology is content analysis based on a review of literature from the fields of design, psychology and human computer interaction, as well as two rounds of surveys with experts (n=13) including designers, inclusive design advocates, healthcare professionals,

policy professionals and academics. This MRP will be of interest to UX professionals, students of inclusive design and academics in design, computer science and human-computer interaction.

1.1 Primary Audience: UX Designers

UX designers are the main audience for this MRP. I hope they will also be the main users of the consequent design artifact: the list of UX design considerations in Part 6. As Sloan et al. (2014) state, a major challenge of inclusive UX is “getting accessibility in the process.” Because UX designers come from a wide range of backgrounds including visual design, interaction design and design research, any attempt to create a useful list of UX design guidelines must consider their diverse needs. Presenting the List to UX Designers in Part 6 discusses how to present the set of design considerations so that it becomes an effective tool for the widest range of UX design professionals.

1.2 Target User Group: Older Adults with Cognitive Decline

Cognitive decline (age-related cognitive decline and mild cognitive impairment) represents an important ‘edge case’ (a key component of inclusive design) that is nevertheless statistically significant and projected to be even more so in the near future. Designing with a view to the needs of older adults with cognitive decline also presents the opportunity for an important ‘curb cut’ (see definition of inclusive design in Part 2, below). As I discuss, UX design considerations for older adults with cognitive decline are generalizable to a wide range of the population who use information communications technology, especially mobile. Designing for older adults with cognitive decline, therefore, helps make better user experiences for everyone.

1.3 Design Challenge

Despite the fact that the world's population is ageing rapidly and increasingly using mobile technology,[2] studies (Rosenberg, 2009; Patomella et al, 2011; Massimi et al, 2007) show that adults with cognitive decline still consider mobile devices among the most difficult technology to use – a finding reinforced by the fact that neurologists in medical settings often use mobile devices (especially mobile phones) to help diagnose cognitive impairment in older adults.[3] Existing mobile user experience design is still geared towards younger users (Massimi et al, 2007, p.155). In order to address these gaps, UX designers must help create strong positive user experiences for older adults using mobile information communication technology, especially older adults with cognitive decline. In the process, designers need to increase their awareness and understanding of cognitive decline and inclusive design for older adults with cognitive decline.

Although universal design principles such as equitable use, flexibility, simple and intuitive, perceptible information and tolerance for error apply to mobile interfaces, as do parts of the WCAG 2.0 (Forbes, 2013), there is still no inclusive set of UX design considerations for mobile. Such a set of design considerations needs to reflect a comprehensive inclusive UX position that focuses not only on usability concerns but also on fostering stimulation, evocation and identification with products and services. It must leverage the diverse perspectives of edge-case users to emphasize the more holistic, human-connected realities of mobile platforms. This includes design considerations around mobile-enabled community networks including networks of human help and support.[4]

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[2] See Older Adults with Cognitive Decline – A Vital Edge Case in Part 2: Concepts, below.
[3] Dr. Shreyans Shah, Chief Resident, Neurology, Kingston General Hospital (personal correspondence)
[4] Nicol et al. (2014) brought researchers together to reimagine mobile interfaces for older adults. Among their findings was the fact that "mobile technologies can lead to increased community involvement and personal independence" (from the abstract).

Early efforts at an accessible user experience manifesto by Sloan et al (2014) hint at "the benefits that inclusive design can contribute to product usability and desirability."[5] A "paradigm shift" is needed in the UX industry "from technical accessibility towards accessible user experience" (Sloan et al., 2014). The design challenge for this MRP, therefore, is to assemble a comprehensive set of research-based inclusive design considerations for UX designers so that they can design to meet the needs of older adults with cognitive decline – something UX designers do not have now.

1.4 Design Approach & Methods

I followed a four-step design approach for developing the final list of inclusive UX design considerations:

1. Establishing the foundational concepts and criteria
2. Developing the preliminary list from the literature review
3. Refining the list after feedback from experts
4. Creating the final list

I then considered how the list might best be presented to reflect the diverse needs of user experience (UX) designers. This structure lends itself to the design of the MRP as well.

In general, my research targets the intersection of five areas where there are strong opportunities to inculcate inclusive practices:

- Design for mobile (trends, accessible practices)
- UX design (definitions, trends, best practices)
- Cognitive Accessibility (key considerations, best practices)
- Cognitive Decline (definitions, treatment)
- Design for older adults (best practices, key considerations)

[5] For more on Sloan et al.'s work, see Accessible UX in Part 2.

Together, these areas form a conceptual framework that helps guide the research and development of my list of inclusive UX design considerations. The main research methodology is data collection and content analysis (Berg, 2001) based on a review of relevant literature from the fields of design, psychology and human computer interaction, as well as two rounds of surveys with experts (n=13) including designers, inclusive design advocates, healthcare professionals, policy professionals and academics. Since the goals of inclusive design apply to design *methods* as much as to deliverables, both the literature review and the survey seek to gather as many perspectives, viewpoints and facets as possible regarding the design considerations. Consensus is less important than gaining diverse perspectives. Both the survey and the final list of UX design considerations, therefore, are designed to be as inclusive as possible.

1.5 Sections of the MRP

Part 2: Concepts establishes the conceptual foundations for my study by articulating an "Inclusive User Experience" design position. I define user experience design and inclusive design respectively, and then propose that designers adjust their thinking about the field of UX to reflect more explicitly the values of inclusive design, values which I show form part of the core of UX as well. I introduce three models that help define UX including Marc Hassenzahl's model, which is useful at drawing parallels between UX and inclusive design. I then mention accessible UX, an existing effort already underway in the accessibility field, and discuss mobile UX as the next 'inclusive frontier.' Finally, I focus on older adults with cognitive decline and explain why they represent a vital 'edge case' for UX designers and how designing for this population triggers an important 'curb cut.' Along the way, I touch on the business case for inclusive design and debunk some false notions about older adults with cognitive decline (for example that they are uninterested in technology).

Part 3: Developing the Preliminary List moves from concepts to the actual task of designing a comprehensive and inclusive list of UX design considerations. Part 3 focuses on the literature and includes in-depth content

analysis of themes/design considerations from existing guidelines, principles, and checklists from various design fields (visual design, interaction design, information architecture, mobile, web design etc). Part 3 concludes with a preliminary list of UX design considerations derived from an overview of the literature.

Part 4: Refining the Preliminary List examines the results (both quantitative and qualitative) from the first round of my survey with experts (n=12) including designers, inclusive design advocates, healthcare professionals, policy professionals and academics. The experts were asked questions relating to the literature in Part 3 and invited to critique the preliminary list. In analyzing their feedback, I also discuss the implications of ranking on inclusive research methods and why my survey is an 'inclusive survey.'

Part 5: Towards the Complete List of UX Design Considerations gathers feedback from the second round of my inclusive survey with experts (n=8). This includes feedback on the refined list of UX design considerations (based on the first round feedback in Part 4).

Part 6: Design Artifact presents the main deliverable: the inclusive user experience design considerations for UX designers designing mobile applications for older adults with cognitive decline. As suggested by the experts, I present the list in two versions: a short version for quick reference that lists the eleven design considerations and an expanded version that provides details on each. I also discuss ways to present the list so that it is most useful to the target audience: UX designers.

I conclude this MRP with a short research and design summary and a discussion of how to further the present study. I discuss the role of inclusive research methods and the implications of ongoing feedback and refinement vis. the complete list of design considerations being a "living document" for UX designers.

2 Concepts

2.1 User Experience Design

2.1.1 More Than Usability

The field of User Experience (UX) is a relatively new field and as such somewhat hard to define; however, a general consensus of definitions of UX is that UX:

1. **involves users** (as opposed to design thinking innovations of the genius kind)
2. **is *more* than usability**. UX incorporates concerns about usability found in fields such as human-computer interaction (HCI) but ultimately goes beyond usability and into the realm of emotion, creating rapport and storytelling

Usability.gov (n.d.) calls UX a "growing field" that encompasses the principles of human-computer interaction but also "goes further" to include the following disciplines: project management, user research, usability evaluation, information architecture, user interface design, interaction design, visual design, content strategy, accessibility and web analytics. According to Fredheim (2012, p.19), "whereas HCI is concerned with task solution, final goals and achievements, UX goes beyond these. UX takes other aspects into consideration as well, such as emotional, hedonic, aesthetic, affective and experiential variables. Usability in general can be measured, but many of the other variables integral to UX are not as easy to measure."[6] The end result of UX design should be usable and compelling experiences that meet – and exceed – user expectations (p.30).

[6] Compare also Morville (2004) writing about UX design for web: "Ease of use remains vital, and yet the interface-centered methods and perspectives of human-computer interaction do not address all dimensions of web design. In short, usability is necessary but not sufficient."

2.1.2 The UX Design 'Process'

The UX design 'process' is an iterative methodology grounded in user research that moves from broad ideation through successive rounds of refinement, fine-tuning and analysis/learning from users. It usually involves a combination of the following techniques: research, ethnography, personas, user testing, card sorting, flow diagrams, sketching, storyboards, user testing (again), wireframes, prototypes and more user testing. In this way, UX adopts a *holistic* approach ranging from ethnographic techniques, user interface design strategies and information architecture strategies through to the full gamut of user testing and evaluation strategies. UX designers often speak of the difficulty of any one designer doing it all (becoming a so-called 'UX Unicorn') and instead advocate for the combined (inclusive) abilities of UX teams to meet the challenge of good UX. Being a team player, therefore, is a must in UX.

2.2 UX Designers

UX can be thought of as "an umbrella term for the sets of considerations required to research, design and develop digital products and services" (Bacon, n.d.). UX teams have diverse skill sets ranging from design research and usability to visual, information and industrial design. Many UX designers have human factors training, marketing or management experience. Often, UX professionals embody a dynamic mix of fields (for example, interaction design, user research and human factors). This makes each UX professional – and each UX team – unique. Some UX designers are familiar with accessibility requirements such as the AODA and WCAG. Some take an academic/research-based approach and keep current on social sciences and human-computer interaction literature.

Bacon (n.d.) suggests a self assessment for UX designers based on the following fields: human factors, usability engineering, design research, information architecture, interaction design, industrial design, service design, information design, visual design, branding, technical communication and content management.

2.2.1 Three Models of UX

Given the diverse skills, methods and fields involved in UX, design thinkers have come up with various models to describe UX as a whole. In my view, the following three models capture the depth and breadth of UX, and resist easy over-identification of the user experience field with usability, HCI or visual interface design.[7] As these models show, UX not only encompasses usability, intuitiveness, branding and consistency, but also aims at such 'softer' design goals as "friendliness," "subtle hints" and "delight" (Fredheim, 2012).

1. Garrett's Elements of User Experience (Garrett, 2000 & 2011)

The now classic conceptual framework for UX was developed by Garrett within the context of web design and helped define the discipline of UX design; however, like all three models presented here it is equally applicable to mobile. Garrett outlines the layers and "underlying relationships" that make up UX. The base layer is formed from user needs and goals "identified through user research." Additional layers – interaction design, information architecture, interface design (encompassing the usability concerns of "traditional HCI") and visual design (the "'look' in 'look-and-feel'") – are built on top of this singular focus on user needs. For a visualization of the model, see Garrett (2000).

2. Morville's "User Experience Honeycomb" (Morville, 2004)

Peter Morville is an information architect with a self-professed passion for "findability."[8] Morville wrote specifically about websites but his insights into UX apply to mobile as well. Morville's UX Honeycomb emphasizes how UX extends

[7] Fishman (2014) points out the "Achilles heel of UX," referring to the "Near universal co-opting by profiteers and visual interface designers to the point where enterprises devalue the research, strategy and much of the design activities which results in the practice becoming indistinguishable from basic interactive design." His article distinguishes between CX, UX, Service Design and DevOps, and ultimately draws similarities between UX and DevOps: "DevOps, much like Design Thinking, puts an additional focus on the person working through the problem, and their associated mindset, as opposed to the end that the worker is striving for." I would argue UX puts this person front and centre too. For more on the differences between UX, CX and other related fields, see my colleague John Willis' MRP titled *AccessMakers: An Inclusive Innovation Platform* (OCAD U MRP, forthcoming 2015).

[8] At the time of writing, much of his writings can be found at his (now retired) blog: http://findability.org

beyond 'just' usability. He identifies eight aspects that products or services should have to facilitate a good user experience. They should be:

- **Useful**: content should be original and fulfill a need
- **Usable**: website must be easy to use
- **Desirable**: image, identity, brand and other design elements are used to evoke emotion and appreciation[9]
- **Accessible**: content needs to be accessible to people with disabilities
- **Findable**: content needs to be navigable and locatable onsite and offsite
- **Credible**: users must trust and believe what you tell them[10]
- **Valuable**

According to Morville (2004), "Each facet of the user experience honeycomb can serve as a singular looking glass, transforming how we see what we do, and enabling us to explore beyond conventional boundaries."

3. Hassenzahl's Model of UX: Hedonic and Pragmatic Attributes (Hassenzahl, 2003; Fredheim, 2012)

Finally, Marc Hassenzahl's model of UX (Hassenzahl, 2003) distinguishes between the designer's and user's perspectives and highlights the important role played by *context* and *user-assigned attributes* in the overall experience of products. Because of this it is particularly relevant to a discussion of inclusive design and is therefore a powerful model of UX for our purposes. According to Fredheim,

> Several models of UX have been suggested, some of which are based on Hassenzahl's model. This model assumes that each user assigns some attributes to a product or service when using it. As we will see, these attributes are different for each individual user*. UX is the consequences of these attributes plus the situation in which the product is used.* (Fredheim, 2012, p.20; emphasis added)

[9] Note the difference between user experience (UX) and customer experience (CX). The ethos of CX is that "businesses exist to serve a customer and the business that delights its customers the most will be the most successful" (Fishman 2014). Fishman subsumes CX under UX.
[10] For more on credibility, see Fogg (2002) and usability.gov (n.d.)

The attributes in question fall under four main categories – manipulation, identification, stimulation and evocation – and are designated “pragmatic” and “hedonic.”

> **Pragmatic** attributes refer to practical usage and function. They are typically related to usability. Their consequence is satisfaction:
>
> - **Manipulation** corresponding to the usability/ HCI part of UX: “Examples of [pragmatic] attributes that are typically assigned to websites (and software in general) are ‘supporting,’ ‘useful,’ ‘clear’ and ‘controllable.’ The purpose of a product should be clear, and the user should understand how to use it. To this end, manipulation is often considered the most important attribute that contributes to the UX” (Fredheim, 2012, p.22).
>
> **Hedonic** attributes relate to user’s psychological wellbeing:
>
> - **Evocation** “We enjoy talking and thinking about the good old days… and we want objects to help us with this” (Fredheim, 2012, p.25).
>
> - **Stimulation** Well-used instances of stimulation can cause a deeper connection between product and user. Even rarely-used functions like Gmail’s query about whether a user meant to send an attachment in their email can “give them a surprise and positive user experience” causing them to “love it even more” (p.23).
>
> - **Identification** How your use of the product communicates your identity to others; therefore “objects need to enable users to express themselves” (p.22) For example, Facebook.

Morville’s UX honeycomb (above) fits within Hassenzahl’s model. According to Fredheim (2012, p.29-30), “useful, usable, findable and accessible could all be considered as pragmatic (i.e. utilitarian and usability-related)

qualities, while desirable, credible and valuable would qualify as hedonic (well-being-related) qualities."

This section examined the diversity of methods and backgrounds of UX designers and identified UX as a growing field that considers the pragmatic and hedonic attributes users bring to products and services. I now turn to a brief look at inclusive design.

2.3 Inclusive Design

Inclusive design is design that is "inclusive of the full range of human diversity with respect to ability, language, culture, gender, age and other forms of human difference" (Inclusive Design Institute, n.d.). This emphasis on inclusion applies to both design *artifacts* (inclusive products and services) and design *processes* (inclusive processes and tools).

The Inclusive Design Research Centre (2013) lists three dimensions of inclusive design:

1. Recognizing the diversity and uniqueness of each individual
2. Using Inclusive Processes and tools
3. Being aware of the broader socially beneficial impacts of a design

2.3.1 The Value of Edge Cases and the "Curb Cut" effect

Inclusive design resists generalizations about 'average' users and instead puts the diverse needs of users first. A key approach in inclusive design is to consider the statistically less significant, or 'edge case' users, in order to identify challenges and affordances that can make better overall experiences for everybody (Treviranus, 2014b). Using edge cases to affect a better experience for everyone is known as the 'curb-cut effect.' This term takes its name from the lowered portions of roadside curbs put in place to help wheelchair users cross the road. After considerable debate, the practice was popularized in the 1960s and soon became a benefit to the wider population as a whole, who used what

was originally intended only as an aid to wheelchairs to more easily navigate urban areas with baby strollers, shopping carts and bicycles.

Building on this socially conscious aspect, inclusive design aims to "trigger a virtuous cycle of inclusion, leverage the 'curb-cut effect' and recognize the interconnectedness of users and systems. To realize this broader positive impact requires the integration of inclusive design into design in general" (Inclusive Design Research Centre, 2013).

2.3.2 Reframing Disability & Accessibility

Crucially, inclusive design "reframes disability within the design context," away from negative medical connotations that suggest permanent shortcomings or afflictions and towards the idea of a context- (and time-) based "mismatch between the needs of the individual and the design of the product, system or service" (Inclusive Design Research Centre, 2013). This corresponds to a social model of disability (Oliver and Sapey, 2006) where context/environment helps shape user needs. Such a view also includes temporary, accidental or one-off mismatches between users and products/services – equally 'disabilities' (for example, navigating a website in a foreign language or trying to open a door with an armful of groceries). The World Health Organization has acknowledged the role of context in medical definitions of disability as well. According to the WHO, "every human being can experience a decrement in health and thereby experience some degree of disability. Disability is not something that happens to a minority of humanity" (World Health Organization, 2014).

Inclusive designers, therefore, resist the dyad 'disabled/non-disabled' and instead approach the task of designing from the point of view of taking into consideration, as broadly as possible, *the mismatch between users and their contexts/environments* – a vital consideration in user experience design too, especially according to Hassenzhal's model (above). Inclusive designers recognize that individuals are "multi-faceted and the constraints or design needs they have may arise from a number of factors and characteristics" (Inclusive Design Research Centre, 2013). Such a view universalizes and at the same time

personalizes the notion of access as well. Accessibility from an inclusive design perspective thus becomes "the *ability of the design or system to match the requirements of the individual*" – be they one-off requirements or requirements of a more recurring nature (Inclusive Design Research Centre, 2013).

2.3.3 "One Size Fits One" Experiences

A key trend in inclusive design that speaks to its preoccupation with context and personalized approaches to access is the trend towards 'one size fits one' digital user experiences. Unlike the better-known approach of universal design, to which inclusive design is often compared, inclusive design of information communications technology resists a universal, one-size-fits-*all* approach in favour of a more flexible, individually tailored one-size-fits-*one* approach. This rejects the idea of design for the 'average:'

> Most individuals stray from the average in some facet of their needs or goals. This means that a mass solution does not work well. Optimal inclusive design is best achieved through one-size-fit-one configurations. Flexible or adaptable systems such as digital systems are most amenable to this but the emergence of 3D printers and other mechanisms of bespoke manufacturing and component-based architectures can also achieve diversity-supportive design. (Inclusive Design Research Centre, 2013)

Customizability, then, is an important consideration in inclusive design. Users are encouraged to "treat the UI as their own space. Thus a critical… design challenge is to design a user experience and user experience components that entice, encourage and make users comfortable with 'fiddling with' or customizing their application UI" (Treviranus, 2009, p.5).[11]

Clearly a major concern is *overcoming reluctance* on the part of users to adjust the UI of their devices. Microsoft cites numerous unintentionally reconfigured interfaces as a design risk (in Treviranus 2009). According to

[11] Cf. Treviranus, 2009, p.3: "Consider the highly personalized and specific arrangements of an artist's palette, a carpenter's workbench, a writer's desktop or a teacher's classroom, each of which is no more critical to the work or profession they support. *In contrast the computer desktop and applications have become contested real estate*, controlled by a number of interests other than the interests of the users of the tools or inhabitants of the virtual environments" (emphasis added).

Treviranus, "to prevent this unwanted situation, any adjustment must have an easy way of resetting or undoing the requested changes. Users must also be able to preview the full effect of their configuration choices before committing to them" (2009, p.5).[12]

For more about customization challenges in the context of older adults with cognitive decline, see Practical Design Considerations in Part 4, below.

2.3.4 The Core Aspects of Inclusive Design

To summarize, the core aspects of inclusive design are (Inclusive Design Research Centre, 2013):

1. **'one-size-fits-*one*' solutions** that integrate well with each other. This differs from the one size fits *all* ethos of universal design, and is perhaps most achievable in the digital realm, where designers can design flexible interfaces and experiences that adapt to different contexts[13]
2. despite this emphasis on personalization, however, **avoiding segregated or over-specialized (exclusionary) solutions** (i.e. remaining inclusive)
3. equally **avoiding adaptive systems** that make choices for the user
4. **respecting the dignity and autonomy of the user** throughout the design process, and the **importance of self-determination and self-knowledge**
5. design driven by **edge-cases and 'extreme users'**
6. working in **inclusive teams** (as varied as possible) via **inclusive processes** and **accessible tools**[14]

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[12] A proposed solution has been "intelligent inferences that adapt the interface for the user;" however, studies show users do not trust these if they are not completely accurate. Thus, such an "'intelligent' adaptation must therefore be done sparingly, carefully and with full transparency and reversibility" (Treviranus 2009, p.5)

[13] According to the Inclusive Design Research Centre (2013), "the flexibility of the digital gives us the luxury and freedom to take a one-size-fits-one personalized design approach to inclusion."

[14] For more about the power of diverse teams, see Page (2007) who shows that "a group that includes diverse perspectives, especially perspectives from the margins, trumps a group of the 'best and brightest,' in decision-making, accurate prediction and innovation" (quoted in Inclusive Design Research Centre, 2013). Inclusive design teams "should be as diverse as possible and include individuals who have a lived experience of the 'extreme users' (as coined by Rich Donovan) the designs are intended for. This also respects the edict 'nothing about us without us' without

7. **socially-conscious and responsible design**. Inclusive designers must be aware of the context and broader impact of any design and strive to affect a beneficial impact beyond the intended beneficiary of the design.
8. Inclusive design is not limited to just accessible design; however, in cases where inclusive design considers disability (as in edge cases involving users who happen to be disabled), it **reframes disability and accessibility along a social model of disability.** Such a social model of disability sees disability as a context-based mismatch between the needs of the individual and the design of the product, system or service. Accessibility in an inclusive design context thus becomes the *ability of the design or system to match the requirements of the individual*.

The sum total of these eight aspects is that *inclusive design results in a better user experience*, something I discuss at length in the next section. Indeed, for inclusive design to be effective, a commitment to inclusion must run through the entire design process, from earliest ideation through to the final implementation (sales and marketing) of a product or service. The aim of inclusive design is to trigger a "virtuous cycle" that not only has moral momentum but spurs concrete design innovation that leads to business innovation and commercial success (Treviranus, 2014). Inclusion and diversity, therefore, "are not only values or rights to be protected, but also catalysts for new ideas, design principles that lead to better design, business strategies that make good business sense and potential economic drivers with ubiquitous social benefits" (Inclusive Design Institute, n.d.).

Having thus defined inclusive design and listed its core aspects, I now compare inclusive design to UX and consider why 'inclusive UX design' results in better user experiences.

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relegating people with disabilities to the role of subjects of research or token participants in design exercises" (Inclusive Design Research Centre, 2013).

2.4 Inclusive User Experience Design

As we have seen, both inclusive design and UX acknowledge that users are complex and have multi-faceted needs, wants and predilections. Both inclusive design and UX respect and ultimately seek to empower users. Both inclusive design and UX also highlight the important role that context plays in determining user experiences (see Hassenzahl's model of UX, above).

Hassenzahl (in Law et al, 2009, p.719) identifies UX as "dynamic, context-dependent, and subjective" as well as "something individual (instead of social) that emerges from interacting with a product, system, service or an object." The implication of Hassenzahl's model for inclusive user experience design is significant. Like inclusive designers, UX designers must remember that individual needs and individual contexts change the way information communication technology is perceived, felt and thought about, even from one moment to the next. For example, as Fredheim (2012, p.26) notes, "on some occasions, you may find it totally cool that the MailChimp monkey tells you randomly that, 'It's five o'clock somewhere,' but in other cases it would feel entirely weird and annoying, because you are using the application in a different mode."

Fredheim does much to elucidate the relationship between inclusive design and UX even though he may not realize it. According to Fredheim, a major consequence of Hassenzahl's model is the realization that designers "cannot design the user" and "cannot design the situation" (Fredheim, 2012, p.25). This leads Fredheim to conclude that UX cannot be designed per se – only that designers "can design *for* UX" (p.27):

> It has been suggested, for instance, that UX is the sum of certain factors, such as fun, emotion, usability, motivation, co-experience, user involvement and user engagement … In turn, we must address some of these factors when we design for UX, depending on how we want our product to be perceived. If we want an application to be fun, then we need to add some features that will entertain; a joke, a challenging quiz, a funny video, a competitive

> aspect or something else. We should keep in mind, however, that, as designers, we can never really predict that the application will be perceived as fun by the user. Users have different standards, and sometimes they aren't even willing to be entertained. (Fredheim, 2012, p.28)[15]

It goes without saying, then, that the wider and more comprehensive understanding designers have of their users – including users at the extremes – the better they can design *for* UX – that is, for the interaction of digital products and users' specific environments, and the attributes (both pragmatic and hedonic) that users bring to this interaction. This includes instances of 'disability' (temporary or recurring). Inclusive design processes also enrich designers' understanding of users by leveraging the innovative capacities of diverse teams.

In adopting a social model of disability and a universal, personalized approach to access based on user needs, inclusive design closely aligns itself with user experience (UX) design. Indeed, the two terms start to mean the same thing. Early efforts at an accessible user experience manifesto by Sloan et al (see Accessible UX section, below) hint at "the benefits that inclusive design can contribute to product usability and desirability" (Sloan et al, 2014). To an extent, this is self-evident to many designers. "Designing inclusively makes better experiences for everyone" (Inclusive Design Institute, n.d.) simply because "it is not possible to determine whether something is accessible unless you know the user, the context and the goal" (Inclusive Design Research Centre, 2013).

Hassenzahl's model of UX helps us understand the intimate relationship of user experience to the user. Since "UX depends not only on the product itself but on the user and the situation in which they use the product … you cannot design the user [and] you cannot design the situation" (Fredheim, 2012, p.27). Solutions therefore cannot be one-size-fits-all approaches but instead depend on the particular and specific context of individual users' needs. UX cannot be

[15] Unsurprisingly, the inclusive panel of experts in my study (Part 4, below) highlights this aspect of UX (the diversity of users and situations) as particularly important when designing for older adults with cognitive decline.

designed but "we can design *for* UX" (Fredheim, 2012, p.27). That is why returning to users at each iteration of the design cycle via user research, user testing and participatory techniques is so important. Hassenzahl's model of UX emphasizes the role context plays for users and products/services. In this way UX again shows strong affinities with inclusive design's one-size-fits-*one* approach and at once universal but highly personalized view of access.

2.4.1 Same Goals

Inclusive design and UX share the same goals: to try and understand the user, the user's context, and to design for a good user experience at the interface of user, product/service and context. Treviranus[16] gives a real world example to illustrate how inclusive design strengthens both the usability aspect of UX and the emotional/holistic aspect of UX. She says think about a friend you know well:

> Your experiences with your friend have honed your perspective so that it is honest, candid and free of sentimentalization. What you do attend to now and what embodies your sense of your friend are the practical and habitual ways in which day to day tasks are approached and what strategies you have worked out to accomplish daily tasks, but more importantly you are cognizant of the things that bring them joy, their fears, the things they are sensitive to and the things that motivate them, what they are passionate about and their aspirations and all the little and big steps that make those aspirations achievable. These are the things that take centre stage. This is the view of the user that we want for our inclusive design.

The example of a good friend illustrates the deeper, holistic dimensions that inclusive design aspires towards. These are identical with the goals of UX as described by Hassenzahl (evocation, identification) and Morville (desirability, credibility, value).

2.4.2 Value of Edge Cases

According to Treviranus,[17]

[16] Jutta Treviranus, Personal Correspondence to INCD 6B06 class, OCAD University. Nov 26, 2014
[17] Jutta Treviranus, Personal Correspondence to INCD 6B06 class, OCAD University. Nov 26, 2014

> As designers we employ use cases to inspire, ground, verify and guide our designs. As inclusive designers we employ edge cases or boundary cases to make sure our design stretches to address the many dimensions of the user's requirements. In doing this it is important that the description of our user captures the perspectives we aspire to, that we can see beyond conventional stereotypes, generalizations and assumptions.

Recall that an important consideration for UX is not merely to meet expectations but to *exceed* them. According to Fredheim (2012, p.30), "give users what they want — and a little more. In addition to enabling users to use your service effectively and efficiently, make them also think, 'Wow, this application is genius.' Exceed their expectations desirably. If you do so, they will use your website or app not because they have to but because they want to." The practice of designing for (and with) edge case users using inclusive methods gives designers the best chance to design for user experiences that exceed expectations (that delight, are easy to manipulate, foster stimulation as well as evocation and identification).[18]

Crosskey (2014, p.4-6) reports numerous positive effects of adopting inclusive methods with edge case users in the context of a typical UX design cycle. She worked with older adults with mild cognitive impairment and dementia, exploring participatory design methods, co-design approaches and generative research techniques. According to Crosskey, "the invaluable benefits of adopting a co-creative perspective to collaborate with people with memory loss include the democratization of the design process, empowering the participants, developing empathy and trust, and shifting the design focus to the needs of the user" (2014, p.5).

[18] Cf. James Young's advice to UX designers: "The next time you face a design problem and you're wondering how to do solve it, resist the urge to consult a gallery for examples of similar products, because the similarities will mostly be superficial. Learning to look beyond galleries takes a while, but don't forget that you are ultimately designing for people, so drawing your inspiration from them by observing and engaging with them only makes sense" (Young, 2014, p.33).

2.5 Accessible UX

Accessibility, as we have seen, is one of the core aspects of inclusive design. As such, "accessibility and UX are part of the same objective" as well (Sloan et al, 2014). The BBC's mobile user experience guidelines state: "Accessibility originates during UX. Accessibility requirements should be considered, clarified and communicated before the first line of code is written. Often when something is broken or hard to make accessible it is because the UX doesn't quite work for all users and has a knock on affect of breaking content for disabled users" (BBC, 2014).

David Sloan, Léonie Watson and Sarah Horton at the Paciello Group are developing a manifesto for Accessible UX (AUX) in order to encourage a "paradigm shift" in the UX industry "from technical accessibility towards accessible user experience" (Sloan et al, 2014). Such a shift is premised on "the benefits that inclusive design can contribute to product usability and desirability" (Sloan et al, 2014). Described as "a small set of common statements and beliefs that UX professionals can use to describe what we mean by Accessible UX," the manifesto aims to "move thinking of accessibility from technical checkpoint testing towards a mature approach of full integration into UX activity" (Sloan et al, 2014). Echoing the emphasis on inclusive processes in inclusive design, Sloan et al's manifesto aims to improve processes, advocate for and help implement AUX.[19]

The project is ongoing at the time of this writing. Key takeaways from the project so far include the following:

- most UX designers who participated in the early stage feedback towards the creation of the Manifesto agreed that the major challenge is project execution – "getting accessibility in the process" – with project planning a distant second. Nobody felt that project management was a challenge

[19] The manifesto is meant as a "simple tool to help us develop a mutual understanding of what we're trying to achieve, to help organisations integrate accessibility into practice and create genuinely inclusive high-quality digital experiences for everyone, regardless of disability or age" (Sloan et al, 2014).

- Sloan et al's early findings suggest an even split between lack of knowledge and lack of practical guidance as obstacles to AUX
- Some noted that accessibility guidelines made a "good starting point/contributing factor of good AUX" but did not capture the whole of it (reflecting our discussion above about the holistic aspects and wider scope of UX)
- The study revealed most UX professionals who participated felt that there is a "lack of accessibility capacity on project teams"

Reflecting UX design's user-focused, holistic approach, the key words from designers in a survey asking the question "What does Accessible UX mean to you" were: *people, users, WCAG, everyone* and *disabilities*. Interestingly, words such as compliant, compliance, literacy and guideline were less commonly used to describe AUX.

2.6 Mobile: The Next Inclusive UX Frontier

Mobile design in particular can benefit from an 'inclusive UX' approach. Jutta Treviranus, director of the Inclusive Design Research Centre and professor at OCAD University, emphasizes that "we need to act on mobile accessibility now because conventions and habits have not yet formed."[20] Also, mobile platforms like iOS and devices like the iPad attract a wide range of users from all age groups including older adults (Wild, 2014). Many of these users have disabilities including cognitive decline.

Perhaps most importantly, mobile is still challenging for users – especially older adults. According to Henny Swann, Senior Accessibility Specialist at the BBC, "mobile, by definition, is disabling. Poor light, small keyboards, glare, touch, etc" (quoted in Forbes, 2013). Other challenges especially relevant to older adults with cognitive decline include a high likelihood of mistakes due to hidden or confusing interactions and a high degree of technical complexity from competing operating systems and devices (especially on Google Android). These factors make clear, engaging and consistent user experiences difficult for all users, but especially ones at the margins.

[20] personal correspondence

Although universal design principles such as equitable use, flexibility, simple and intuitive, perceptible information and tolerance for error apply to mobile interfaces, as do parts of the WCAG 2.0 (Forbes, 2013), there is still no inclusive set of UX design considerations for mobile. Such a set of design considerations needs to reflect a comprehensive inclusive UX position that focuses on more than usability concerns. It must leverage the diverse perspectives of edge-case users to emphasize the more holistic, human-connected realities of mobile platforms. This includes design considerations around mobile-enabled community networks including networks of human help and support.[21]

As Forbes (2011) emphasizes, the key in the varied mobile landscape is to "design for the human capabilities, not the device." UX designers must be careful not to mistake device and operating system diversity for real (human) inclusion. This is especially important when designing for older adults. Studies show that older adults need a more holistic approach to technology than accessibility guidelines offer at present (Milne et al., 2005).[22]

2.7 Older Adults with Cognitive Decline – A Vital Edge Case

The previous sections outlined the key concepts relevant to our study: inclusive design, user experience design and inclusive user experience design (the intersection of the two). I also touched on some of the challenges of designing for mobile. In this section, I elaborate on why older adults with cognitive decline constitute a vital 'edge case' for user experience designers working in mobile. Understanding this will help designers understand the need to design mobile experiences for older adults with cognitive decline, and will anticipate my analysis of existing strategies in Part 3 (literature review) followed by the proposed set of UX design considerations in Part 4.

[21] New realities such as the internet of things also present fresh opportunities and challenges. With the rise of mobile devices that increasingly connect to our physical reality as well as new technologies for interactions via haptics (Apple Watch) and alternative/voice interfaces (Google Glass and others), the mobile field continues to change fast and UX designers need to adapt.
[22] The authors refer to web accessibility guidelines but the same applies to mobile. For more, see Forbes (2011, 2013) in the Literature Review in Part 3.

2.7.1 *Who are Older Adults with Cognitive Decline?*

In this MRP, I follow Nielsen (2013) and Smith (2014) in the common practice of defining 'older adults' as adults aged 65 or over. I use the terms "older adult" and "senior" synonymously in the MRP but prefer the former because it is less discriminatory and affords fewer assumptions for designers.

As I explain below, 'cognitive decline' is an umbrella term for a range of issues from mild lapses in memory and language skills as a consequence of 'healthy' ageing through to clinically diagnosable mild cognitive impairment – usually characterized as being one step above normal age-related cognitive decline and one step below clinically diagnosable dementia such as Alzheimer's (see Fig. 1). So-called *amnestic* MCI affects memory. *Nonamnestic* MCI affects thinking skills other than memory including (but not limited to) "the ability to make sound decision, judge the time or sequence of steps need to complete a task, or visual perception" (Alzheimer's Association, n.d.).[23]

Unfortunately, the term cognitive decline suggests a deficiency ("decline") from the norm. This is a byproduct of its history in the medical literature; however, since it is an established term I use it throughout this MRP.

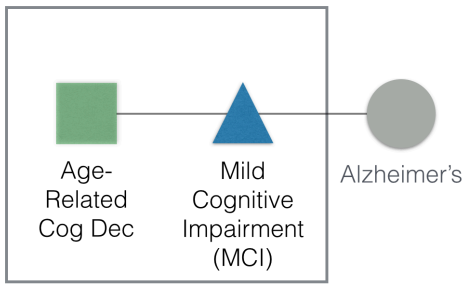

Figure 1: Cognitive Decline Definition

[23] For more information about MCI, see the Focus on MCI section, below

2.7.2 A Vital Edge Case

As Finn (2013) writes, "the number of older people throughout the world is surging. The general characteristics of older adults … merit particular consideration when designing the user interfaces that they will use." In Canada, 15.7% of the population (about one in six Canadians) was aged 65 and older in 2014. This is up from 10% thirty years ago (Statistics Canada, 2014). The rise in numbers of older adults has been accelerating especially since 2011, when the first baby boomers began to turn 65. According to Statistics Canada (2014), "by the year 2016, the number of seniors aged 65 and older [will] be greater than the number of children under the age of 15. Furthermore, seniors [will] account for between 24% and 28% of the population by the year 2063."[24]

Many older adults experience some kind of disability in their day-to-day life. In 2011 (the year the first wave of baby boomers turned 65), 747,000 Canadians were living with cognitive impairment including dementia – that is 14.9 per cent of Canadians 65 and older. If nothing changes in Canada, this figure is projected to increase to 1.4 million by 2031 (Alzheimer's Society of Canada, 2015). Lifestyle factors such as stress and nutrition increase the risk of developing cognitive decline and mild cognitive impairment.

In the context of our earlier discussion about inclusive design (above), older adults with cognitive decline thus represent a vital 'edge case' that is significant statistically – and projected to be even more so in the near future. Population numbers of older adults around the world are surging and many will develop cognitive decline in the coming years. Designing for older adults with cognitive decline thus represents an important 'curb cut' – namely, UX design considerations for older adults with cognitive decline apply to a wide range of older adults and to younger adults as well. Future-proofing the design of technology should be a strong incentive for designers because we are all getting older.

[24] In the US the picture is similar: 13.7% of the population (42 million people) were 65 or older in 2010, and 34.4% (122 million people) were aged 45–64. "In other words, nearly 50% of the entire US population was age 45 or older in 2010" (Howden & Meyer, 2010).

2.7.3 Older Adults are Interested in New Technology

Contrary to stereotypes, older adults in general, including older adults with cognitive decline, are curious about new technology and want to engage with it. More than half of the world's older adults are now online (Zickuhr & Madden, 2012; Smith, 2014). Seniors regularly use computers and mobile devices such as the iPad for a wide variety of tasks ranging from online shopping to keeping in touch with family. Nielsen (2013) identifies health, travel, hobbies, news, finance, shopping and social as the main activities older adults do online.

Older adults are quite open to new technologies provided their expectations are met (Rogers and Fisk, 2006). Goddard and Nicolle (2012) point out that seniors often enjoy a challenge and exhibit pride at figuring out new technology. Additionally, as more baby boomers near retirement age, they are reshaping the 'seniors market' with new levels of competence and familiarity with ICT (Jar Creative, 2013).

In her list "Ten Myths About Not Needing to Make User Interfaces Friendly to Older Adults," Finn (2013) highlights various false notions designers and managers have including that "older people don't use the web or mobile devices," that "general accessibility and usability guidelines are already good enough" and that, hubristically, "our designers already know what they're doing."

2.7.4 The Rise of Mobile Use Among Older Adults

Older adults increasingly use mobile technology, especially tablets. Tablets are much more popular among older adults than smartphones. In the US, "Some 27% of seniors own a tablet, an e-book reader, or both, while 18% own a smartphone" (Smith, 2014). This represents an inverse trend compared to younger adults, who own more smartphones than tablets.

In general, mobile technologies are enjoying large uptake levels across the spectrum of users (both older and younger). According to data from Comescore Inc, mobile internet usage in the US in 2014 has for the first time exceeded desktop internet usage (Wild, 2014). Mobile is fast on the rise among

people who use assistive technology too: the percentage of screen reader users on mobile increased significantly from 12% in 2009 to 82% in January 2014 (Wild, 2014).

As far back as 2007 (even before the widespread adoption of touchscreens on mobile devices), studies showed that seniors were interested in using and exploring mobile technology. In a study of older adults out of the University of Toronto, Massimi et al (2007, p.155) conclude that "sheer numbers indicate the importance of designing better mobile phones [and other mobile devices] for seniors." The authors point out that seniors engaged with mobile technology and, "contrary to common misconceptions, seniors desired a variety of applications beyond simply placing phone calls" (Massimi et al, 2007, p.157). They also reinforce that the results of the study apply to a wide range of mobile devices, not just mobile phones (Massimi et al, 2007, p.156), and that mobile design for seniors must encompass the wider scope of insights from User Experience design, not just usability concerns (p.161).

2.7.5 The Business Case

Unsurprisingly, designing with the needs of older adults in mind is not only the right thing to do (both for current and future generations) but makes good business sense as well. According to David Weigelt, President of Immersion Active, "Adults age 50 plus make up the Web's largest constituency and outspend younger consumers online 2:1 on a per capita basis." (cited in Finn, 2013). The "disability market" as a whole (of which older adults with cognitive decline form a large part) has been called "the next big consumer segment—comprised of more than one billion people and $1 trillion in annual disposable income" (Donovan, 2014). Today, the combined direct (medical) and indirect (lost earnings) costs of cognitive impairment and dementia total $33 billion per year. If nothing changes, this number will climb to $293 billion a year by 2040 (Alzheimer's Society of Canada, 2015).

The impact of care on the Canadian economy is significant as well: currently, one in five Canadians aged 45 and older provides some form of care to seniors living with long-term health problems (a quarter of all family caregivers are seniors themselves). In 2011, family caregivers spent in excess of 444 million unpaid hours looking after someone with cognitive impairment, including dementia. This figure represents $11 billion in lost income and 227,760 full-time equivalent employees in the workforce (all figures are from the Alzheimer's Society of Canada, 2015).

2.7.6 Older Adults Can Handle Complexity and Value UX as Much as Anyone

As we have seen (above), the problem is that UX designers tend to pursue 'average' users who are usually young like they are. They often forget about the needs and activities of older adults, with or without cognitive decline, and design for user experiences accordingly. This is especially so in the relatively new area of mobile ICT. As Massimi et al (2007, p.155) point out, "mobile phones can be great tools for older people, but are usually designed with younger people in mind" (Massimi et al, 2007, p.155).

Massimi et al (2007) analyze the shortcomings of mobile phone technology for older adults and present the results of a small workshop that co-designed and tested a mobile address book application with a small group of older adults in Toronto. They report that "while considerable barriers existed, motivated seniors were not overwhelmed by the phone software. Seniors surprised themselves with their ability to use the phone." (Massimi et al, 2007, p.155). The authors acknowledge the applicability of their study to wider range of mobile devices as well:

> While this study examined a mobile PDA phone, many aspects of mobile phone design can be applied to a wider range of mobile devices because of similar form factors, carrying considerations, and hardware components (*e.g.,* screens). The class of devices which can benefit from insight into mobile phone design includes personal digital assistants (PDAs), handheld entertainment systems, tablet PCs, and ultra-mobile PCs. (Massimi et al, 2007, p.156)

At the close of their paper Massimi et al conclude that "attitudes about mobile phones could be shaped by many sources, not simply usability concerns" (p.161). This echoes our discussion about user experience design, above. Their full list is worth transcribing:

- software complexity can be handled [by older adults]; in fact, seniors desired multiple application domains and worked well with the camera and voice recorder functions.
- However, we found usability problems due to hardware and operating system design choices, thus creating faulty mental models.
- We also found that attitudes about mobile phones could be shaped by many sources, not simply usability concerns. For example, the problem may be due to a lack of critical-mass adoption, a lack of technical support, or fears of health risks from radiation. (Massimi et al, 2007, p.161)[25]

Massimi et al also created a list of design guidelines for older adults, which I discuss in the literature review in Part 3.

2.7.7 Focus: What is MCI?

As mentioned above, Mild Cognitive Impairment (MCI) is usually characterized as being one step above normal age-related cognitive decline and one step below clinically diagnosable dementia such as Alzheimer's (see Fig. 1, above). MCI "does not significantly impair cognitive function" (BC Guidelines, 2014) but is nevertheless noticeable and diagnosable with a degree of professional judgment.[26]

A person with MCI has "subtle problems" with one or more of the following (Alzheimer's Society, n.d.):

[25] Their method consisted of participatory design activities comprised of user testing preceded by three software design activities (needs analysis, requirements engineering, paper prototyping) followed by two rounds of user testing (observation; assigning tasks) 30 and 60 days after the end of design activities. Data from questionnaires consisting of 7-point Likert scale items and interviews probing personal narratives collected throughout the design process. They also allotted time to "build trust, teach seniors about current mobile technology, and socialize" (Massimi et al, 2007, p.156). Participants were recruited by distributing flyers to community centres and hospitals in Toronto with seniors outreach programs. "Interestingly only women volunteered" (p.156). For a fuller analysis, see Massimi et al (2007, p.155).

[26] A doctor considers the results of a neurological exam and laboratory tests alongside the patient's medical history, input from their family and friends, assessment (including self-assessment) of mental status and overall evaluation of mood (Alzheimer's Association, n.d.).

- day to day memory
- planning
- language
- attention
- visuo-spatial skills, "which give a person the ability to interpret objects and shapes"

Any decline in these areas "will be greater than the gradual decline that many people experience as part of normal, healthy ageing. There may be minor problems with more demanding tasks, but generally not problems in everyday living. If there is a significant impact on everyday abilities, this may suggest dementia" (Alzheimer's Society, n.d.).

MCI is therefore not dementia; however, persons with MCI are at an increased risk of developing dementia – about three to five times the risk of someone without MCI (Alzheimer's Society, n.d.).[27] In a small number of cases, people with MCI improve and no longer have symptoms (Alzheimer's Society, n.d.). Studies suggest that, "between 5 and 20 percent of older people have MCI of some form at any one time" (Alzheimer's Society, n.d.). According to the UCSF Memory and Aging Center (2013), MCI may vary from mild (barely impacting daily functioning) to severe, with "cognitive deficits and functional impairment consistent with Alzheimer's disease;"[28] however, unlike Alzheimer's, "where cognitive abilities gradually decline, the memory deficits in MCI may remain stable for years."

However, MCI not only affects memory; it can also affect a range of cognitive abilities including memory, attention, language and visuo-spatial skills (Cambridge Cognition, 2014). There are two main types (Alzheimer's Association, n.d.):

[27] "In studies carried out in memory clinics, 10-15 per cent of people with MCI went on to develop dementia in each year that the research results were followed up" (Alzheimer's Society, n.d.). I believe these studies were in the UK.
[28] "Whether MCI is a disorder distinct from AD or a very early phase of AD is a topic of continuing investigation" (UCSF Memory and Aging Center, 2013).

1. **Amnestic MCI – primarily affecting memory**
   A person may forget important information that he or she would previously have recalled such as appointments, conversations or recent events.
2. **Nonamnestic MCI – affecting thinking skills other than memory such as visual perception, discrimination and language**
   A person may be unable to make sound decisions, judge the time or sequence of steps needed to complete a complex task, or have errors with visual perception.

People with Amnestic MCI make up about two-thirds of all cases of MCI (Alzheimer's Society, n.d.).

Treatments for MCI emphasize holistic approaches including an integrated regimen of healthy eating, exercise (increased blood flow to the brain), controlling cardiovascular risk factors such as smoking, and engaging in cognitively challenging/memory stimulating activities which help sustain brain function (Cambridge Cognition, 2014).

2.7.8 MCI as an Edge Case Triggering the Curb Cut Effect

As with age-related cognitive decline, MCI represents an 'edge case' that is nevertheless statistically significant (and projected to be even more so in the near future). As such, MCI represents an important 'curb cut' as well – namely, UX design guidelines for MCI will be applicable to the wide range of older adults with normal or 'healthy' age-related cognitive decline.

2.7.9 Usability Issues: Symptoms of MCI

The symptoms of MCI are usually mild or subtle, and vary from person to person. Most people are able to do everyday things, but they may find certain things are more difficult than usual. Common symptoms include (Macmillan Cancer Support, 2012 and Alzheimer's Association, 2015):

- being unusually disorganized or having noticeable trouble planning
- difficulty concentrating and not being able to focus on what you're doing

- noticeable problems finding the right word or name
- being unable to finish sentences
- trouble remembering facts you would usually remember (names, dates)
- extreme tiredness (fatigue)
- mental 'fogginess'
- difficulty doing more than one thing at the same time (multitasking)
- having noticeably greater difficulty performing tasks in social or work settings
- taking longer than usual to complete simple tasks
- difficulty learning new skills
- forgetting material that one has just read
- losing or misplacing a valuable object

Older adults with MCI often feel as if they are having lapses in memory, forgetting familiar words or the locations of objects, to the extent that family and friends notice. At the same time, they can hide their symptoms by relying on coping strategies such as keeping a notebook, making reminder lists, etc.

2.7.10 Lifestyle Factors and 'Embodied' Cognition

The medical literature (Albert 2012; Gutierrez & Isaacson, 2013) confirms that lifestyle factors can modify and slow the progress of age-related cognitive decline as well as MCI (Albert 2012). Design is a lifestyle factor and thus can mitigate age-related issues such as memory loss. This is consistent with the findings of designers who show that communication experiences for people with intellectual disabilities can be improved with proper tools designed with simplicity and cognitive accessibility in mind. Examples include software and communication platforms described in Keskinen et al (2012), Stock et al (2008), Biswas and Langdon (2011) and Sohlberg et al (2005).

A few recent studies have explored the beneficial effects of therapy based on embodied cognition (allowing users to "work through" rather than just "think through" actions) to prevent and rehabilitate cognitive decline. See for example

Otake et al (2012) and Gutierrez (2014) in the domain of music therapy and Klemmer et al (2006) and Buxton (2007) in the area of interaction design.

2.8 Conceptual Framework

This report targets the intersection of five areas where there are strong opportunities to inculcate inclusive practices (Fig. 2). Together, these target areas for the MRP form a conceptual framework that helped guide the design of my list of inclusive UX design considerations (see Parts 3 and 4, below).

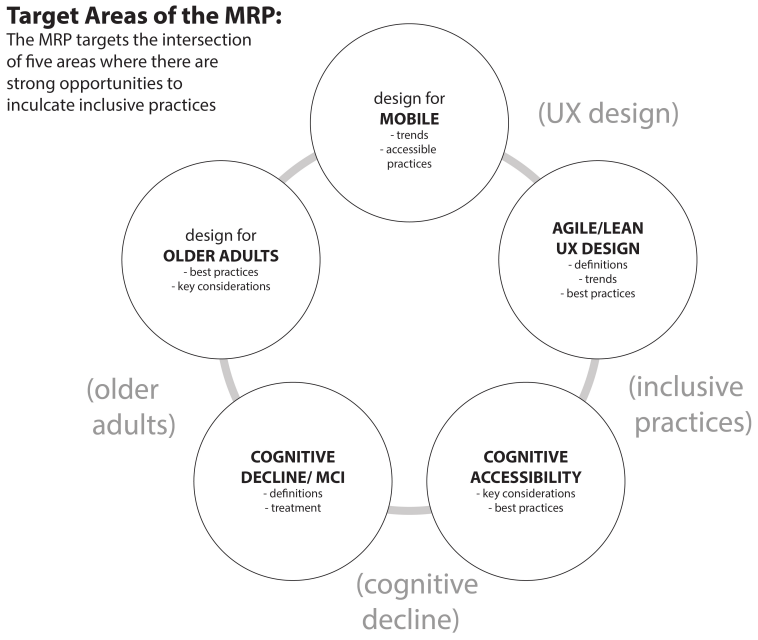

Figure 2: Conceptual Framework

Having thus established a conceptual framework of inclusive user experience design and discussed how older adults with cognitive decline (age-related cognitive decline and MCI) represent a vital edge case for user experience designers, I now turn from conceptual concerns and discuss the

actual process of designing the set of inclusive design considerations for UX designers working on mobile applications for older adults with cognitive decline.

3 Developing the Preliminary List

Parts 3 and 4 of the MRP describe my research and discuss the development of the list of inclusive design considerations for UX designers designing mobile experiences for older adults with cognitive decline.

3.1 Note on the Method (Content Analysis)

My method for both the literature review and the two-part survey with experts consists of data collection and content analysis, which includes both implicit and explicit analysis (Berg, 2001). Qualitative content analysis is defined as “a research method for the subjective interpretation of the content of text data through the systematic classification process of coding and identifying themes or patterns” (Hsieh & Shannon, 2005, p.1278) and more broadly (relevant to survey data) “any qualitative data reduction and sense-making effort that takes a volume of qualitative material and attempts to identify core consistencies and meanings” (Patton, 2002, p.453 in Zhang & Wildemuth, 2009, p.1).

3.2 Literature Review: Establishing the Initial Criteria

The following is an overview of literature from the fields of human computer interaction (HCI), psychology and design, as well as a brief look at some products and current best practices encompassing design for mobile, design for seniors, design for cognitive, and gaps in each.

As I show, the literature outlines various design considerations for older adults, users with cognitive decline, and design for mobile; however, there is as yet no comprehensive list of inclusive UX design considerations for older adults with cognitive decline that takes into account all the factors we discussed in Part 2. A quick summary of these factors includes: the role of context and user-specified pragmatic/hedonic attributes (as explained by Hassenzahl’s model of UX); the need to design *for* UX rather than design UX itself (an outcome of the model); the value of edge cases, curb cuts and inclusive teams (central

considerations in inclusive design); and the specific symptoms of cognitive decline including MCI.

One reason for the gaps in the literature may be because many designers still feel that cognitive accessibility cannot be tested objectively and cheaply, or simply that more user testing is required (Cognitive Considerations, 2013). There is also a general lack of understanding about cognitive disabilities. As mentioned in the introduction, cognitive accessibility is "an area with little definitive research and few concrete recommendations" (WebAIM, 2013c). This is even more pronounced in mobile.[29]

3.2.1 Gaps in Design Considerations for Older Adults with Cognitive Decline

As mentioned, due to the strong influence of HCI in the literature, the sources listed below tend to privilege pragmatic (usability) concerns such as simplifying interfaces and providing help functions more than hedonic attributes related to psychological wellbeing (stimulation, evocation and identification). To begin, Jokisuu et al. (2011) introduce a model of cognitive disabilities specifically for human-computer interaction designers that includes "degenerative diseases and ageing;" however, their design guidance focuses on more severe, easier to define medical conditions such as schizophrenia, traumatic brain injury, autistic spectrum disorders and learning disability. Despite this, Jokisuu et al's framework does predict that users suffering from age-related cognitive decline will most likely show a decrease in perception, attention, memory, learning and psychomotor functions. In accordance with this, general principles of universal design such as equitable use, flexibility, simple and intuitive use, perceivability, tolerance for error, and low physical effort apply to these users (NCSU, 1997).

Goddard and Nicolle (2012), Nielsen (2013), Jar Creative (2013) and Goldhaber et al. (2012) each identify a series of design principles specifically related to age-related cognitive decline. These guidelines apply mostly to web

[29] For more about the challenges with evaluating usability and accessibility for users with more advanced cognitive decline, see Lewis (2005); Sutcliffe et al. (2003); Lepisto and Ovaska (2004). For more about the challenges in involving users with cognitive disabilities in the design process, see Fischer and Sullivan (2002); Newell and Gregor (2000); Moffat et al. (2006).

design; however, I have compiled a 'best of' list that applies to mobile as well. The consensus among these sources is that older users tend to value:

- a balance of aesthetics and usability
- readability, clickability (for mobile read: tapability). Make selectable areas clear and not too small
- friendly, simple elements that don't talk down to users or promote hesitation or discouragement (In Nielsen Norman Group's 2013 study, older adults blamed themselves 90% of the time compared to 58% of younger users (Nielsen, 2013))
- social involvement of friends and family
- the positive effect of familiarity (like most of us, seniors tend to like what they are used to)
- workarounds (seniors do not always expect to master everything and are okay with that)
- accessibility and usability; emotional engagement with the product less so

An important exception is ageing baby boomers, many of whom have already crossed the threshold of 65 years of age. Ageing boomers tend to be more demanding, less tolerant, and quicker to complain about functionality and style than their pre-boomer colleagues (Goddard & Nicolle, 2012). As Huber and Skidmore (2003) note, boomers "have two distinctive characteristic, individualism and liberalism, which are likely to affect their attitudes to products and product design." The significant impact of baby boomers on the market (Jar Creative 2013) only makes the role of accessible, intelligent and elegant design for older adults even more important in the near future.

More research is needed to study how older users solve problems. As Goddard and Nicolle (2012) point out, seniors often enjoy a challenge and exhibit pride at figuring out new technology. Naveh-Benjamin et al. (2007) study how older adults use "chunking" (combining different components of information into cohesive chunks) to assist working memory. Bailey et al. (2013) similarly examine how older adults use chunking to break things down into meaningful

events in order to aid in more accurate memory recall. They conclude that "everyday memory depends on segmenting activity into discrete events during perception" (from abstract). This also applies to the organization of the visual interface, as I mention below. Patomella et al. (2011, 244) reinforce that more complex designs affect performance among older adults.

On the whole, older people are quite open to new technologies provided their expectations are met (Rogers & Fisk, 2006). Early successes lessen the impact of later failures, especially for seniors; therefore, user interfaces should focus on creating successful initial experiences: "competence generation must be a primary focus of future UI design research" (Goldhaber et al, 2012). Older adults tend to favour positive biases in their memory retention (Mather and Carstensen, 2005). In keeping with this requirement, Langdon et al. (2012) highlight the importance of keeping to a proven and understandable design language. Unsurprisingly, previous experience with similar products is a strong predictor of usability. Sickafus (2006) similarly reinforces that solution strategies need to be simple and graphic, using familiar metaphors like lists with manageable structures and expressed generically.

As general studies on older adults and technology show, older users consider the avoidance of errors to be *the* most important usability aspect (Hawthorne, 2007). Above all older users want to avoid a feeling of "significant 'lostness' in the system when error recovery is not facilitated" (Barnard et al, 2013). Perhaps this is why seniors are much more likely to turn to search engines like Google or Bing. According to Nielsen (2013), seniors use search engines 51% more than younger users to complete tasks.

Older adults also value human help a great deal. According to Smith (2014), "Just 18% would feel comfortable learning to use a new technology device such as a smartphone or tablet on their own, while 77% indicate they would need someone to help walk them through the process." Older adults are also more methodical, and much more likely to "think through each step or click to assess an entire page before moving forward (Nielsen, 2013). This is one of

the reasons why interfaces must be as simple and easy to learn as possible, as well as supportive and forgiving. Despite pioneering research by Rogers and Fisk (2006) on cognitive support for elders through technology, more research is needed into the role of social interactions with friends and family in buying products for seniors.

3.2.2 Broader Inclusive Design Guidelines for Cognitive Disabilities

The above studies fell within a larger group of general design guidelines for cognitive disabilities (Jiwnani, 2012; Richards, 2013, WebAIM, 2015; WebAIM, 2013ab; Inclusive Learning Design Handbook (n.d.); NCSU, 1997; and W3C, 2008).

The following is a summary of guidelines for people of all ages with cognitive decline. To begin, cognition includes the following specific processes that need to be designed for (Rogers et al, 2011, p.67; Bohman & Anderson, 2005; Ellison, 2011):

- attention
- perception
- memory
- learning
- reading, speaking and listening
- problem solving, planning, reasoning, and decision making

Jiwnani (2012), Robertson and Hix (2002), Rogers et al. (2011) and Sutcliffe et al. (2003) highlight the following physical, mental and psychosocial considerations:

- simplicity
- clarity
- use of familiar, real life metaphors

- computer should be a shared activity (including caregivers, family, etc)

WebAim (2013c) adds the following principles:

- Consistent
- Multi-modal
- Error-tolerant
- Attention-focusing

Sutcliffe et al. (2003) and Rogers et al. (2011, p.81-2) present the following specific **considerations for memory**:

- simplified screen layout
- system initiatives that provide status information and remind of and help recapture task context
- promoting recognition-based rather than recall-based memory by using menus, icons and consistently placed objects
- the importance of learning by doing rather than by relying on rote memory (i.e., reading from a manual)
- designing interfaces that encourage exploration

Inputs (Jiwnani, 2012):

- sequences of actions should be simplified and available choices limited
- consistency throughout
- direct selection techniques favoured to support simple, time-independent actions
- pictographic symbols should be used to help communicate, ask questions and answer them

Outputs (Jiwnani, 2012):

- uncluttered screens with adjustable display image size
- appropriate labeling for icons

- combined use of pictures and audio prompts for navigation
- multisensory presentation of feedback information
- potential of speech also noted (Braddock et al, 2004); however may be limited by other disabilities

Other design considerations for cognitive disabilities include (Ellison, 2011):

- Help users recover from errors (self-explanatory error messages etc.)
- Allow users to control movement and timing
- Be predictable
- Calculate things like order summaries, costs etc. automatically
- Left-align. Avoid justified text with gaps of various sizes

Rogers et al (2011) emphasize the importance of “how information is interpreted” in order to help retrieve it from memory (p.72). Context plays an important role in memory recall (p.73-4). Finally, interface elements that capitalize on “recognition-based” memory are better than ones that rely on “recall-based” memory (p.75) because “people are much better at recognizing things than recalling things” (Rogers et al, 2011, p.74). At the same time, systems should also be flexible to “let people use whatever memory they have” (p.75).

Finally, Yoon (2012) points out that "content simplification" can be interpreted two ways: as an alternative to the original content that is simpler through “reduction of verbosity, use of simpler diction/syntax, etc” or as “a reduction in the level of distraction from the content.” Approaches to distraction include:

- Content overview: providing a high-level view instead of the content proper (e.g., table of contents, header structures, etc.)
- Content proxies: reducing/replacing content with proxies that can be drilled-down into (e.g., content "crumbs")

- Simplicity "spectrum" slider: providing a means for the user to adjust the degree of distraction reduction, whether it is the interface, media, content sections, etc.

- Simplicity customizer: turning particular pieces of content on and off (i.e., hiding specific sections)

- Content truncation: cutting out the content itself, providing only enough to gain a sense of context

- Manual content focus: dimming all content, but allowing the user to navigating through content spaces and focusing on each individually (i.e., a spotlight on content). Not unlike iA Writer's "focus mode" for text editing.[30]

A related issue in the literature is challenges in involving users with cognitive disabilities in the design process (Fischer and Sullivan, 2002; Newell and Gregor, 2000; Moffatt et al, 2006) and related challenges with evaluating usability and accessibility (Lewis, 2005; Sutcliffe et al, 2003; Lepisto and Ovaska, 2004). Difficulties can include obtaining informed consent, the inability for users to communicate their thoughts, specialized or unknown requirements between individuals and user groups, and occasional interference from experts such as caregivers. These issues mostly apply to users with more severe forms of cognitive disability such as dementia. For a good discussion about inclusive strategies for involving older adults with cognitive decline in the design process, see Crosskey (2014).

3.2.3 Graphics/ Visualizations

The results and guidelines above are supported by literature examining best practices for graphics/visualizations.[31] Borkin et al (2013) highlight the importance of "quantifying memorability" by creating familiar and "natural" looking, human-recognizable visualizations that aid in memory recall. Similarly, Healey and Enns (2012) highlight the importance of designing visualizations that encourage locating and retaining the information that is most important to the viewer, and Hullman et al (2011) stress the importance of minimizing the

[30] The last approach has interesting implications for mobile touchscreens (for example, dimming parts of the content by tapping your finger around the screen).
[31] Thanks to my colleague Hong Zou for help in this section of the literature review

cognitive steps required to process visualizations or interfaces. Recall Bailey et al's (2013) research into "chunking" and their insight that "everyday memory depends on segmenting activity into discrete events during perception." Stone (2006) emphasizes the judicious use of colour as a powerful way to label, group, and eliminate visual clutter. She advocates making the background white and presenting supporting information in shades of grey as the most effective foundation for a colour palette.

3.2.4 Mobile

Most efforts to make mobile platforms accessible (Forbes, 2011; 2013; Wild 2014; W3C, 2009, 2015; BBC, 2013, 2014) focus on the mobile web rather than the whole device and (like many of the lists above) tend to focus on usability and accessibility concerns instead of the more holistic approach of inclusive UX, which includes designing for hedonic attributes (stimulation, evocation, identification).[32]

Forbes (2011) lists various accessibility considerations for mobile phones and tablets including vision, hearing, dexterity, speech and cognition considerations. Under cognition, she lists:

- giving the choice between audio, visual or vibrating feedback in alerts, calls, or keyboard strokes
- allowing pre-recorded voice commands to take place of popular functions
- "help menus designed to anticipate the information being sought"
- keypad shortcuts

In general, universal design principles that apply to mobile include (Forbes, 2013):

- Equitable use

[32] Milne et al. (2005) point out that, when it comes to older adults, a more holistic approach is needed than web accessibility guidelines offer at present. See also section on Mobile Use by Older Adults, above.

- Flexibility in use
- Simple and intuitive
- Perceptible information
- Tolerance for error
- Low physical effort
- Size and space for approach and use

Massimi et al. (2007, p.160-1) specify the following design considerations for mobile devices for older adults:

- Eliminate buttons on the sides and rear of devices
- Avoid soft keys
- A single, consistently placed button for returning to the home state should be included
- Consider human support networks
- Include several input modalities
- Avoid modifier keys
- Orient data structures towards personal, not business, use
- Avoid slide-out keyboards
- Carefully consider program and command naming

Apple (2015) lists the following design principles for the user experience design of iOS:

- Aesthetic integrity
- Consistency
- Direct manipulation (increases engagement with tasks)
- Feedback

- Metaphors
- User Control

There exists some overlap between mobile accessibility and WCAG 2.0 (Forbes, 2011). For example, responsive design accords with an established WCAG guideline (1.3: Adaptable), as does colour (1.4 Distinguishable) and video content (1.2.2/1.2.4 Captions). Fundamental principles of perceivable, operable, understandable and robust also apply. Despite this, efforts to map mobile practices to WCAG are hampered by the ever-changing landscape of mobile and the unpredictability of updates to operating systems, especially with Google Android. Apple has demonstrated a serious commitment to accessibility; however, this is mostly in the area of vision access and dyslexia with text-to-speech (VoiceOver) and speech-to-text (Siri). Android by contrast has demonstrated a "seriously fractured approach to accessibility" with hundreds of apps across various platforms (Forbes, 2011).

3.2.5 UX Friction Linked to Cognitive Load

A key concept in user experience design testing is user experience friction (UXF). "UXF occurs whenever a device does not do what you expect it to do – or lacks a key feature that should be available" (Pfeiffer Consulting, 2013). UXF significantly compromises otherwise good UX. According to Pfeiffer, user experience friction is linked to cognitive load, which refers to the total amount of mental effort being used in the working memory (Sweller, 1994). In a design context, cognitive load means the amount of thinking users need to do to understand an app or interface, perform actions or otherwise engage with digital experiences. In his classic book about web and mobile usability, *Don't Make Me Think*, Krug (2014, p.11) emphasizes that web and mobile interfaces must be self evident to users. Users should just "get it – what it is and how to use it – without expending any effort thinking about it."[33]

[33] Krug's advice to designers and usability experts: "if you have room in your head for only one usability rule, make it this one" (Krug, 2014, p.11).

In a comparison of major mobile operating systems by platform (Apple iOS 6 and iOS 7, Google Android, Windows Phone and Blackberry), Pfeiffer Consulting (2013) found that "iOS 6 has one of the lowest UXF ratings in the industry, clearly linked to very low cognitive load and a streamlined feature set." By comparison, Google Android has a high cognitive load: "no less than 104 apps and widgets, more than 4 times more than iOS 7, and a significantly higher number of icons and user interface elements."[34]

However, Pfeiffer also found that, whereas iOS 6 has the "lowest cognitive load count of all major mobile operating systems," it "lags behind in terms of ease of use functionality" (Pfeiffer Consulting, 2013). This conflicts with Sweller's definition of cognitive load above. The reason is that cognitive load is not simply the "sum of elements you need to get familiar with in order to use the device spontaneously and intuitively," for example the number of apps, widgets, icons or other elements of the user interface and the operating system. There is another side to cognitive load that the feedback from my panel of experts highlights as well (see Part 4, below). *Oversimplifying* (for example, by greatly reducing the number of elements in an interface) also causes UXF by forcing users to think harder since more functionality is hidden and/or assumed.

Cognitive load, therefore, not only increases with an *increase* in the number of apps, widgets, and icons but also with their *decrease* (past a certain point). Complexity as well as over-simplification increases the degree to which users must think about an action or interface. As Patomella et al (2011, p.248) found in their study of older adults and everyday technologies (ETs), "the most difficult ETs … [require] the user to handle displays and other menus that are hidden in layers and are very complex." This is especially true with mobile technologies. I discuss this in more detail when examining the results of expert feedback from the inclusive survey in Part 4, below.

[34] The resulting measure of UXF by platform in the Pfeiffer study (lower is better) was: iOS 6: 32; iOS 7: 40; Windows: 40; Blackberry: 53; Google Android: 162 (Pfeiffer Consulting, 2013).

3.3 Towards a Preliminary List of Design Considerations

A list of themes begins to emerge from the literature, most notably the need for accessibility, familiarity and consistency, as well as content, layout and interaction simplification. Cognitive Considerations (2013) emphasizes *content, layout* and *interaction simplification, accessibility* (providing multimodal content, left justifying, avoiding patterned backgrounds, supporting assistive technology), *familiarity* (use familiar words), *flexible user-controlled preferences* ("make it possible for users to shape your presentation to fit them," "change the size of fonts, change the colours," "let users suppress details"), and *help* ("let users ask for definitions or explanations").

Forbes' (2011, 2013) list of Accessible Mobile Experiences (giving the choice between audio, visual or vibrating alerts for a call; help menus designed to anticipate the information being sought etc) emphasizes the following themes: *accessibility* (multimodal content), *familiarity & consistency, interaction simplification, flexible user-controlled preferences, human support network/ help.*

An analysis of Massimi et al's (2007) design considerations for mobile devices for seniors (p.160-1) and Ellison's (2011) presentation on Designing for Cognitive Disabilities reinforces the same categories as Forbes but also adds: *content/layout simplification, credibility and trust.*

An overview of the HCI literature including the theory of chunking in Miller (1956), the benefits of dynalinking to facilitate the learning of abstract material (Rogers and Scaife, 1998) and a study on mouse pointing performance among schoolchildren with intellectual disabilities (Lin et al, 2009) emphasizes the same pragmatic attributes *(content, layout, interaction simplification)* related to manipulating interfaces. Rogers et al (2011) identifies the role of context, interpreting information, encouraging exploration and recognition-based and recall-based memory, which reflects *active engagement, content, layout, interaction simplification, help and flexible user preferences and options.*

Themes from Patomella et al.'s (2011) study of factors that make technology difficult for older adults with and without cognitive decline include *content, layout, interaction simplification, active cognitive engagement elements and familiarity.*

As mentioned, most of the existing guidelines and best practices in the literature tend to emphasize usability and manipulation attributes rather than hedonic attributes. By contrast, the Stanford credibility guidelines (Fogg, 2002) emphasize *credibility and trust* and Crosskey (2014) emphasizes that designers must take into account the diverse needs of older adults including physiological (health) and safety needs, love (staying connected to friends and family), esteem needs (being able to communicate and speak, read, remain cognitively fit) and self-actualization needs (remembering who they were before the disease). Her research emphasizes the following hedonic considerations related to psychological wellbeing: *establishing credibility & trust*, the need for *familiarity, consistency,* and *active esteem and self-actualization elements.* She also reinforces the following pragmatic considerations: *content simplification* and *layout/interaction simplification.*

Due to space limitations, this section includes only a representative sample of the literature above. The preliminary list of UX design considerations in the next section presents the full list of themes from a list-by-list, guideline-by-guideline analysis from the entire literature. The list applies not only to the design but also to the research phase of UX.

Preliminary List of UX Design Considerations

Once I completed the analysis of themes in the literature, I grouped the themes according to Hassenzahl's model of pragmatic and hedonic attributes (Hassenzahl, 2003). This became my initial list of inclusive design considerations for UX designers designing mobile applications for older adults with cognitive decline. I presented this list in a shorter form (see Appendix A) to experts in the first round of the survey.

1) Pragmatic (manipulation)

- **# Content simplification** including visibility, transparency & attention-focusing elements. Avoid abstract concepts or unfamiliar metaphors. This applies to research too (Crosskey, 2014; Massimi et al, 2007)
- **# Layout simplification** including visibility, transparency & attention-focusing elements (Nielsen, 2013)[35]
- **# Interaction simplification**. Improving the efficiency with which things get done, thus combatting fatigue, inattention etc.[36]
- **# Human support network/help** Combats difficulty learning new skills and trouble making decisions. According to the literature, older users consider the avoidance of errors to be the most important usability aspect (Hawthorne, 2007) and want to avoid a feeling of "significant 'lostness' in the system when error recovery is not facilitated" (Barnard et al, 2013). Support networks may include caregivers and family, or just a human help function. As Massimi et al (2007) state, having a "human support network is more important" than paper documentation for older adult mobile users. This consideration also speaks to the issue of *credibility*, below. One way for designers to facilitate help for older adults with MCI may be through a symbiotic relationship in which they learn new design skills in the process.[37]
- **# Flexible user-controlled preferences & options**. A key consideration from inclusive design (see Inclusive Design section, above), customization is "one of the key user experience aspects of connected digital devices" (Pfeiffer Consulting, 2013). This also includes accessibility features: "Users who have difficulties reading the thin typeface of iOS 7 can switch to bold type, for instance."
- **#Accessibility**. Relates to all of the above but is also a separate category. From an inclusive design perspective accessibility centres on the multi-modal presentation of content and the ability to suppress details (Inclusive Learning Design Handbook, n.d.). The accessible design consideration in the context of older adults with cognitive decline also relates to specific memory considerations such as system initiatives that provide status information and remind of and help recapture task context (Sutcliffe et al, 2003).

[35] Recall that older adults are more methodical than younger users, and much more likely to "think through each step or click to assess an entire page before moving forward" (Nielsen, 2013). This is one of the reasons why interfaces must be as simple and easy to learn as possible, as well as supportive and forgiving.

[36] However, recall the challenge: simplicity comes at the price of efficiency and integration features: "iOS 6 is still the simplest mobile operating system, especially for very inexperienced users, but that simplicity comes at the price of efficiency and integration features that the operating system lacks" (Pfeiffer Consulting, 2013). See UX Friction Linked to Cognitive Load section, above.

[37] For a discussion of these issues, see Part 4.

2) Hedonic (evocation, stimulation, identification)

- **# Establishing credibility & trust** in new experiences. Older adults should feel that the system is built with their wants & needs in mind.[38]
- **# Familiarity & Consistency**. Helps build trust. Taking care not to take uniqueness too far; nothing new for its own sake. Reinforcing the perceived *stability* of digital platforms. Langdon et al (2012) highlight the importance of keeping to a proven and understandable design language (by minimizing the number of updates for example).
- **# Unique & evocative.** An important consideration for good UX; however, must be carefully balanced with familiarity, credibility and trust. Unlike younger users, older adults tend to value emotional engagement less, preferring accessibility and usability (Goddard and Nicolle, 2012; Nielsen, 2013; Jar Creative, 2013; Goldhaber et al, 2012). According to Pfeiffer Consulting (2013), good UX equals the sum of a unique look paired with usable, intuitive and consistent interfaces (from device to device).[39]
- **# Active relaxing elements**. Ease stress and help improve memory and focus. For example, negative space can "impart a sense of calm and tranquility, and it can make an app look more focused and efficient" (Apple iOS Human Interface Guidelines). However, designers must keep in mind that a shift in context can quickly turn a relaxing user experience into an annoying one; for this reason as well as to conform to accessibility standards, easy on/off functions are required.
- **# Active cognitive engagement elements** to inspire, involve and motivate. As Goddard and Nicolle (2012) point out, seniors often enjoy a challenge and exhibit pride at figuring out new technology. *Gamification techniques* and *embodied cognition techniques* aimed at helping users work through, not just think through, actions can lead to improved memory and responsiveness (brain training) and higher levels of engagement.
- **# Active esteem & self-actualization elements** According to Crosskey (2014), esteem needs include being able to communicate and to speak, read, and remain cognitively fit. Self-actualization needs include remembering who older adults were before cognitive decline.[40] Also: Early successes lessen the impact of later failures, especially for seniors. Therefore UI should focus on creating successful initial experiences "Competence generation must be a primary focus of future UI design research" (Goldhaber et al, 2012, p. 111). Designs should include friendly, simple elements that don't talk down to older

[38] See Fogg (2002) and pioneering research by Rogers and Fisk (2006) on cognitive support for elders through technology.
[39] For example, writing about iOS 7 the report states that "beyond the quibbles about the new design direction, Apple has managed to create a new operating system that looks different from any other on the market, and that is immediately easy and intuitive to use – and that is identical on any iOS device the company produces" (Pfeiffer Consulting, 2013).
[40] Cf. Mather and Carstensen (2005): studies show that older adults tend to favour positive biases in their memory retention.

adults or promote hesitation or discouragement. Recall: in Nielsen Norman Group's 2013 study, seniors blamed themselves 90% of the time compared to 58% of younger users (Nielson, 2013).

4 Refining the Preliminary List

The preliminary list of design considerations in the previous section synthesizes the various checklists, guidelines and principles in the literature and attempts to fill in the gaps. It considers hedonic attributes along with pragmatic ones in an attempt to capture the wider scope of UX as per Hassenzahl's model (Hassenzahl, 2003; Fredheim, 2012). This sometimes meant I had to infer ideas from the literature. In order to test my preliminary list and to arrive at the 'complete' set of design considerations,[41] I turned to a panel of experts. By combining content analysis from the literature (including implicit and explicit analysis) with expert feedback in the form of a two-round survey, I tested my interpretation of the literature and refined my preliminary list of UX design considerations.

4.1 Survey with Experts (2 Rounds)

As mentioned in the Inclusive Design section in Part 2, the goals of inclusive design apply to design methods as much as to design deliverables. In keeping with inclusive design principles, the aim of the survey was to gather as many perspectives, viewpoints and facets as possible on older adults with cognitive decline as well as on the preliminary design considerations. Since the survey was designed to be inclusive, consensus was less important than gaining diverse perspectives. I also wanted to see how experts in the fields of design, academia, medicine and policy responded to my conceptual framework. By asking specific questions from the literature I could evaluate findings about design for mobile, design for older adults and design for cognitive decline from my literature review, as well as test Hassenzahl's model of UX.[42]

The study was administered by email in two rounds. In keeping with the aims of inclusive design, the goals of each round were:

[41] On the list being a flexible 'living document,' see Conclusion.
[42] For a list of the questions asked from the literature, see Appendix C. For an analysis of the effectiveness of the inclusive research method, see Conclusion.

Round 1: to gather as many perspectives, viewpoints and facets about older adults (65+) with cognitive decline (age-related cognitive decline and mild cognitive impairment) in anticipation of the final set of UX design considerations.

Round 2: to distil as comprehensive and inclusive a position as possible on a set of design considerations for user experience designers designing mobile apps for older adults with cognitive decline. To gather suggestions on how to present the final list so it is of use to designers and other UX professionals.

4.1.1 Experts Drawn from a Variety of Fields

The study engaged thirteen experts (seven men, six women) with experience, expertise and/or knowledge about one or more of the following areas and target groups: user experience (UX), inclusive design, older adults aged 65+, mobile design, cognitive disabilities and/or cognitive accessibility issues. The experts came from all age groups (including older adults) and represented a wide variety of fields. Six of the experts were user experience professionals working in UX as designers, researchers, project managers, design consultants and/or speakers (five of these six worked directly in accessibility or had experience with inclusive design methods). The remaining seven experts were non-designers: four academics from the fields of design, computer science and human-computer interaction; two doctors (a neurologist and a psychiatrist specializing in Alzheimer's); and one policy expert. Most had experience working with older adults with cognitive decline.

The first round of the survey engaged all the experts except one (n=12) while the second round, which gathered feedback on the refined list and asked about the best way to present the final list, mainly engaged designers (n=8) with only one expert not a designer. This distribution largely came about by chance given that not all experts had time to respond to the second round.

4.2 Round 1 Survey: Questions

The Round 1 survey included a 5- and 7-point Likert scale questionnaire based on statements or findings from the literature review (Part 3, above). Participants were asked whether they Strongly Agreed, Agreed, Neither Agreed nor Disagreed, Disagreed or Strongly Disagreed with a total of thirty-seven statements (see Table 1 below). Some statements asking about agreement/disagreement had a 7-point Likert scale for added accuracy (responses ranged from Very Much to Not at All). Most of the statements along a 7-point Likert scale reflected hedonic attributes, for example: “Older adults in general, but especially older adults with cognitive decline, care about unique and evocative user experiences.” Each question included the option for the participant to elaborate on their answer, thereby adding a qualitative dimension to the research that proved very valuable.

As mentioned above, my study targeted the intersection of five key areas, which together formed a Conceptual Framework for my research (see Fig. 2, Conceptual Framework in Part 2, above). This framework influenced the questions I asked, helped structure my study and helped guide my analysis of the results.

Of the thirty-seven questions in the survey, fifteen were about usability and UX including questions related to anthropology and social psychology needs, nine were practical/medical questions, seven were about practical design considerations, four were value-based questions, and two were specifically medical-related questions to do with biological factors around ageing and cognitive decline (see Table 1).

Table 1: Round 1 Survey Questions by Type

No. of Questions	Type	Example Question from Survey
15	Usability and UX	"Older adults tend to value emotional engagement with products less and ease of use more"
9	Practical/medical	"Mobile apps for older adults with cognitive decline should contain active relaxing elements that impart a sense of calm and tranquility"
7	Practical design	"Would help forums monitored by designers be a good way to provide help to older adults with cognitive decline?"
4	Value-based	"Should designers design for the various needs of older adults?"
2	Specifically medical	"Older adults favour positive biases in memory retention"

The final part of the questionnaire for Round 1 asked experts to examine the preliminary list of inclusive design considerations based on the literature (Appendix A) and to rank each consideration in order of importance from 1=least important to 10=most important (however see Note About Ranking, below).[43] Finally, participants were invited to suggest changes to the list, for example: should other considerations be included? Are any considerations redundant?

4.3 Round 1 Survey: Expert Feedback on Preliminary List and Criteria

4.3.1 Quantitative Data Supporting a Qualitative Analysis

In addition to gathering qualitative data (noting responses/elaborations for each question), I also graphed Likert scale data for each question and calculated standard deviation as well as mean and mode. Recognizing that the main bias of my study was the fact that the intervals are equivalent and subjective (for example, Strongly Agree may represent an agreement of 90%, 85% or 80%), I

[43] Ranking was a useful exercise because it allowed me to better understand the relative importance of each design consideration; however, ranking as a research methodology is not inclusive because it creates an 'echo chamber' (Treviranus and Hockema, 2009). For this reason, I took care not to reveal the results of the ranking to the experts in Round 2 of the survey, thereby negating the effects of an 'echo' or 'popularity' chamber. For more, see Note About Ranking, below.

calculated each answer twice: once using regular 5 and 7 point scales mapped to intervals (ex: Strongly Disagree = 1 to 1.5, Disagree = 1.6 to 2.5, Neither = 2.6 to 3.5, Agree = 3.6 to 4.5, Strongly Agree = 4.6 to 5) and then again by binarizing the data to see if the bias from the interval was reduced (ex: Disagree = -1, Neither = 0, Agree = 1).

Ultimately, given the subjective nature of the intervals and the relatively small number of participants in my study, the final analysis of survey data was *qualitative*. The quantitative data is therefore meant to support the qualitative analysis and not stand on its own.

4.3.2 General Results

In general, I found that the standard deviations were quite high, indicating a wide spread of opinion reflecting the diversity of the participants selected and the resulting inclusiveness of the study. At the same time, I observed consistency. Answers in parts 1 and 2 of the survey were on the whole accurate and consistent predictors of the final outcome of ranking design considerations in part 3 (more on this below).

The following results refer to questions asked in the Round 1 Survey Questionnaire (Appendix C). What emerges from the data is a complex picture of older adults with cognitive decline, with varying needs, abilities and predilections. While older adults do value accessibility and usability, they also value emotional engagement with products (q1). They often learn new skills and get better at using initially unfamiliar interfaces over time (q13). Depending on their personality and circumstance, they may enjoy a challenge and exhibit pride at figuring out new technology (q2) though not always.

Reflecting the comprehensive understanding of UX and inclusive design discussed in Part 2, all the experts polled either *agreed* or *strongly agreed* with the statement ‘designers must take into account the diverse needs of older adults, including physiological & safety needs, love, esteem and self-actualization needs, when designing digital experiences for older adults with cognitive decline’

(q4).[44] Nevertheless, designers cannot generalize this population with one-size-fits-all solutions nor should they attempt to 'sneak in' features that cater to cognitive decline such as gamification strategies and relaxation techniques unless these features are something that the users actively want/are seeking in an app.

The experts also *strongly agreed* that designs of apps for older adults with cognitive decline should include friendly, simple elements that do not talk down to older adults with cognitive decline or promote hesitation or discouragement (q3). Simple and clear design matters to most older adults, while visual beauty less so (q15). As one expert put it, "I have never had any older adult research participant comment specifically on the aesthetics of an interface or other design either positively or negatively," although another expert believed the triad of simplicity, clarity and pleasing aesthetics holds "true for everyone."

At the same time, designers must be careful not to oversimplify interfaces – an important consideration in mobile – since simplicity often comes at the price of efficiency and integration (q6). In this way, simplicity can increase rather than lessen cognitive load for older adults with cognitive decline – an important point discussed in the UX Friction Linked to Cognitive Load section in Part 3, above. Generally speaking, it is important for older adults with cognitive decline to encounter as few challenges as possible when using mobile interfaces (q14) while still retaining the ability to navigate intuitively and easily. Experts identified consistent (q30) as well as credible/trustworthy (q31) user experiences as being important to most older adults with cognitive decline although familiar experiences a little less so (q30, q28). Speaking about familiarity, one expert said that "familiarity may become less and less meaningful a concept for this population as time goes on."

All twelve experts *strongly agreed* that older adults with cognitive decline using technology vary in their needs and abilities (q33) and that UX designers must design for this variability (q34); however, they varied in what they

[44] One expert did not answer the question.

considered acceptable design strategies (more on this below). Most *agreed* (echoing the literature) that designers of information communications technology need to recognize the degree to which individual context shapes the user experience of older adults with cognitive decline (q36). As mentioned above, this position reflects both insights from inclusive design (one-size-fits-one experiences) and Fredheim's (2012, p.27) statement that, rather than designing UX, designers can only design *for* UX (see discussion in Part 2).

Experts *agreed* that early successes can lessen the impact of later failures (q9) and that overcoming challenges can motivate older adults with cognitive decline and help reinforce a sense of self-esteem (q8), especially when the challenge is related to completing a real-world task (although perhaps less so if the challenge involves simply figuring out a piece of technology). Designers should therefore focus on creating successful initial experiences and then decide on balancing ease of use with a small, manageable degree of cognitive challenge.

There was some discrepancy among the experts as to whether older adults in general were more methodical than younger users (q5) and also whether they tended to blame themselves for mistakes more than younger users do (q7). One expert even said that in her opinion "older adults are more willing to try new things than younger people where interface design is concerned" (q30); however, another brought up the risk of running against low self-esteem and self-efficacy in older adults with cognitive decline, something I discuss in more detail below.

Experts also pointed out that the avoidance of errors and a feeling of 'lostness' in the system is one of the most important usability aspects for older adults (q11); however, they were hesitant to call it *the* most important one (as the literature does), citing other important factors for usability such as actually getting a desired task done as well as a "combination of factors that work together to be key to the experience" such as colour, font size, layout and content.

Experts generally recognized the value added by active (as opposed to passive) hedonic design elements aimed at mitigating the effects of cognitive decline. Examples include: actively relaxing elements that impart a sense of calm; active cognitive engagement elements that involve and motivate users; active esteem elements that ensure older adults are able to communicate, speak and remain cognitively fit; and self-actualization elements that help older adults remember who they were before their condition. However, they pointed out limitations and cautioned about the appropriateness of their use depending on context. Experts were particularly unsure about 'active relaxing elements that impart a sense of calm and tranquility' (q20) such as white space and calm music with an easy on/off function, stating that it "depends on the goal of the app, as well as other elements of its tone" and cautioning that "well-intentioned efforts could end up being distracting or confusing." According to one expert, the concept of actively relaxing elements "does not acknowledge the diversity of this population and is overly simplistic." Another considered relaxing elements redundant, pointing out that "engagement need not be relaxing, being unrelaxed need not be seen as negative." Some experts preferred a passive approach to relaxation rather than an active one (q25), for example avoiding distractions such as background noise or moving elements as opposed to actively trying to relax through the use of calming colours or music. A few said that music is a bad idea. Still others said that "it doesn't have to be one or the other," pointing out that "it would depend upon the tone of the goal, the complexity of the task, and the skill of the designer." Unsurprisingly, "Active Relaxing Elements" was rated third lowest out of a list of 10 proposed UX design considerations, ahead only of "Active Esteem Elements" and "Unique and Evocative Experiences" (for more on ranking the list of preliminary design considerations, see Preliminary Design Considerations Ranked, below).

On the other hand, experts *agreed* that mobile apps for older adults with cognitive decline should contain active cognitive engagement elements that involve and motivate users (q21) as well as low to moderate cognitive challenges that do not impact overall user experience (q22). Examples might include

gamification techniques, badges, brain training elements and embodied cognition techniques (to help users work through, not just think through, actions) so as to train memory, attention and language skills and also reinforce a sense of self-esteem and autonomy. They ranked “Active Cognitive Engagement Elements” among the two most important UX design considerations for older adults with cognitive decline (just behind “Help and human support networks”). Despite this, many experts cautioned that such elements need to be carefully thought through and designed for, mindful of context, in order to be implement well “so as not to seem incongruous with the task the interface is intended to support.” They should not be “smuggled in” to unsuspecting users “for their own good.”

There was a fair amount of discussion about gamification (q21, q37), a popular topic among designers and HCI professionals. One expert, an HCI researcher and a self-professed skeptic about gamification, badges and brain training, called gamification “good for things needing a lot of otherwise boring practice, but *not* for other things. And people have to be motivated to want to spend time on whatever it is, for example touch-typing. I don't know how many apps there would be for people with cognitive decline that would meet these requirements.” As another expert, a prominent designer and accessibility expert, put it, “one should always be able to complete the task without the gamification … and the gamification notifications should *never* arbitrarily appear during the task process. For example, I am astounded that Waze presents an audio queue in the middle of giving complex driving directions to tell me that I have just earned some sort of rewards points.”

One expert (a researcher) took a slightly different position on gamification, stating that “the evidence for effects on memory, attention etc is far from clear from my readings but I think gamification can play an important social role and is rarely a bad thing for older adults who enjoy being challenged.” Experts suggested other cognitive engagement strategies to replace gamification and brain training including graded tutorials of increasing complexity and “straightforward, simple tools that provide the functions people want.” Embodied

cognition and brain training techniques that promote working through, not just thinking through actions (q38) were similarly seen as good in many cases (helping improve memory, attention and language-retention); however, one expert again warned against “smuggling in” such features unless users explicitly want to engage with them, for example in a brain training app. Another expert stated she favours embodied cognition over brain training.

On the other end of the spectrum, experts generally *disagreed* that older adults in general, but especially older adults with cognitive decline, care about unique and evocative user experiences (q29). As one expert put it, “while it is nice to create a unique and evocative user experience, at the end of the day an older person is highly likely to have a task that they’re trying to complete easily.” Reflecting this negative view, out of the preliminary list of ten UX design considerations for older adults with cognitive decline, the experts ranked unique and evocative UX at the very bottom of the list in importance. At the same time, there was quite a spread of opinion on this question, perhaps due to the way it was worded. As one expert put it, “uniqueness and evocativeness are two quite distinct characteristics in my view, and grouping them together in this question makes it harder to objectively answer.”

The issue of self-esteem and self-actualization similarly drew mixed responses. Generally experts *agreed* that older adults with cognitive decline care about experiences that reinforce esteem and self-actualization needs (q32); however, there was a very wide degree of deviation in their responses. Only nine of the twelve experts answered this question, the survey’s lowest response rate (tied with q23, also about esteem elements, and q38, about incorporating embodied cognition and brain training techniques in designs). One expert who did not answer felt the question was outside his expertise; another said that nobody “cares about this explicitly, but almost everyone does implicitly.” Implementing esteem elements (q23) “is a huge challenge” said another expert. Another cautioned that “if people choose to invest in such activities, fine, but I do not think they should be smuggled into apps for other purposes.” Following

closely on these statements about active esteem elements, the experts were similarly ambiguous about active self-actualization elements whose aim is to help older adults remember who they were before their condition (q24). They *agreed* that "for some people" such elements are a good idea in principle but cautioned that this would need "very careful management." It may be "important for some, distressing for others. It also depends on the stage of the decline. Those for whom it is important early on may be distressed or irritated by this later on."[45] Reflecting this ambiguity of positions, "Active Self Esteem and Self Actualization Elements" ranked second lowest in importance among ten UX design considerations, ahead only of "Unique and Evocative."

The issue of help was considered very important. "Help and Human Support Networks" came first in the ranking of design considerations, just ahead of "Active Cognitive Engagement Elements;" however, various experts questioned how to implement help successfully. One said she felt the definition of help was unclear, and that "help/human support networks seems to be potentially two or many different things." A suggestion to implement online help forums for older adults with cognitive decline (q16) drew the largest amount of negative responses in the survey, although with a fairly large degree of variance, perhaps reflecting the fact that not all experts felt comfortable with the 'technical' nature of the question. Experts generally *disagreed* that a good way for designers to facilitate help for older adults with cognitive decline is through online help forums in which older users ask questions and designers contribute answers. As one expert put it, "I think it is a relatively poor way, because this audience is less likely to engage with the complexity of online forums, including having to register and one more password etc." Similarly, another expert (who *strongly disagreed*) reported that "the older adults I've worked with have told me very early on that using online forums even when they are having severe problems with technology e.g. mobile devices is not something they'd consider doing. I think it's unlikely that many of them would engage in this way willingly or even unwillingly."

[45] Recall what Fredheim (2012, p.26) writes about MailChimp's It's 5 o'clock somewhere. See User Experience Design section in Part 2, above.

Another said: “Other strategies to engage end users need to be developed,” while another said he has limited experience with this and worries “that this kind of support can't make up for problems in the design itself… people would just tune out.”

4.3.3 Practical Design Considerations

As mentioned above, while all experts agreed that older adults with cognitive decline vary widely in their needs, wants and abilities, the issue of how to design for this variability drew a wide range of responses. Generally, experts stressed the need to avoid easy, one-size-fits-all solutions. Instead, what came out of my research with experts is that *UX designers must address individual users almost on a case-by-case basis* – a view that reflects both the general position of inclusive design (one-size-fits-one experiences) as well as Fredheim’s view that UX cannot be designed; rather, designers must design *for* UX.

1. Customization and user-controlled preferences

Recall from our discussion above (Inclusive Design section in Part 2) that customization via user-controlled preferences is a good way to design for inclusion; however, implementing customizable preferences is also a key inclusive design challenge. While most experts *agreed* or *strongly agreed* in principle with the statement ‘older adults with cognitive decline should have access to user-controlled preferences and setting in order to adapt the interface to their individual needs’ (q17), and also *agreed* that customizable interfaces are a good way to design for the various needs of older adults with cognitive decline (q35), many questioned how to actually achieve this given the added cognitive load involved in accessing user-controlled preferences. They hesitated to call customizable interfaces “a *key* user experience design consideration when designing mobile applications for older adults with cognitive decline” (q27). Two of the twelve experts *strongly disagreed* with this statement while two others *strongly agreed*. The majority *neither agreed nor disagreed*.

One expert suggested that, while “customization is important,” in some cases it would be “more appropriate” for caregivers or family to control these preferences rather than older adults themselves. Another warned that customization becomes less and less feasible in more advanced stages of cognitive decline, while another stated that “the customization task itself is a complication and potential distraction, and may result in abandonment.” Designers should not “devolve responsibility to the user to work out their preferences before the system becomes usable to them.”

In response to these “customization pitfalls,” some experts suggested using “smart defaults” or a “locked-down customization set by a facilitator or a wizard interface” because ultimately “customization requires an investment of time and effort, which may be worthwhile, depending upon the context of the app.” Given this spread of opinion and the general uncertainty about how to implement customizable user-controlled preferences and settings in the context of older adults with cognitive decline, it is not surprising that “Flexible Preferences” ranked on the low side (7th out of 10) of UX design considerations. This suggests more work needs to be done to examine ways to implement customizable preferences in inclusive user experience design.

2. Suppressing details of the user interface

Experts generally *strongly agreed* (albeit with a farily large degree of deviation) that older adults with cognitive decline should have the option to suppress details of the user interface that distract from the main content (q18), stating that this should be a design consideration for “everyone,” not just older adults with cognitive decline. It “could be useful for anybody” although “onscreen ‘noise’ definitely seems to be a bigger issue as we age.” Interestingly, one expert (a psychologist who works with Alzheimer patients) disagreed with this statement, reflecting perhaps a reluctance to increase cognitive load by taxing memory.

A similar concern arose with the question of providing status information and other system initiatives that remind/ help recapture task content (q19). Again experts generally *strongly agreed* with a fairly large degree of deviation; however, some questioned the effectiveness of this approach with older adults with cognitive decline. “A good idea in intent,” wrote one, “but implementation could be disastrous (distracting, confusing) and worse than doing nothing.” Another said that it is “a good idea in theory, but I don’t know of effective ways to do it.”

3. Negative space

Experts were less sure about the usefulness of a user interface with lots of negative space for older adults with cognitive decline (q26). There was a very large spread of opinion as to whether negative space is a positive. Two experts *strongly disagreed*. One expert reported they are not sure what is meant by the term “negative space;” another said it is outside her expertise. One expert warned against user interfaces with lots of negative space, stating that “older adults are more likely to have partial vision conditions where excessive whitespace will increase the chance they will miss the existence of user interface elements, especially when using magnifying assistive technology.”[46]

4.3.4 Preliminary Design Considerations (ranked)

As mentioned above, the final part of the Round 1 questionnaire asked the experts to rank the ten proposed mobile UX design considerations for older adults with cognitive decline (1=least important; 10=most important). The data showed that the list as a whole is pretty robust. This was reinforced by the fact that *each* item was ranked *most* important (=10) by at least one expert, suggesting that even ‘low’ ranked items such as Active Esteem elements and Unique and Evocative were considered fairly important design considerations according to this group of experts.

[46] This accords with a study on desktop interfaces by Lin et al (2009) that shows that the further away an element is on screen, the harder it is to mouse over to it for persons with severe cognitive disabilities. Bigger icons aid in efficient mouse motion towards the target.

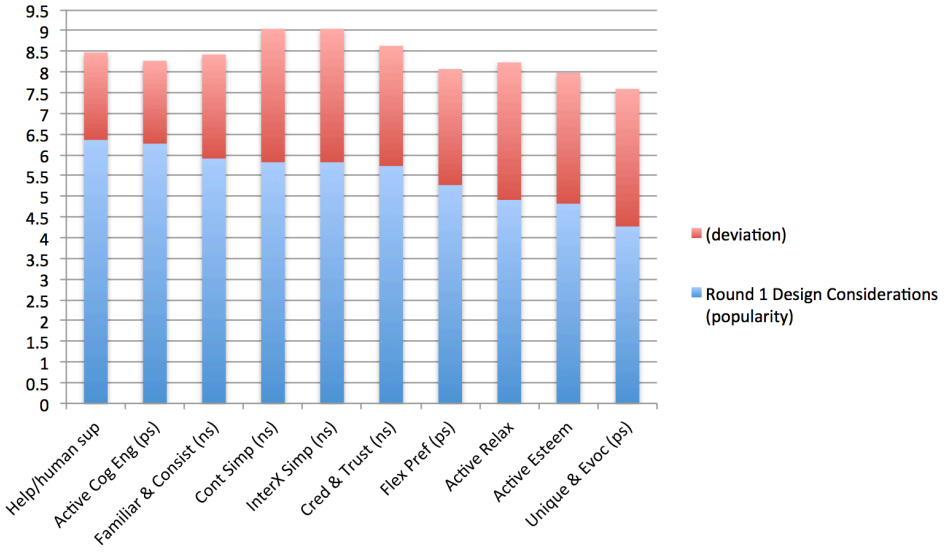

Figure 3: Preliminary UX Design Considerations (ranked).
ps = positively skewed; ns = negatively skewed

Standard deviation in this part of the survey was quite high, which further suggests that experts did not always have particularly strong feelings about any one of the considerations over another. Nevertheless, it is worth noting that the three highest ranked considerations (Help/human support, Active cognitive engagement elements and Familiar and consistent experiences) also had the lowest degrees of deviation. This suggests that experts felt most comfortable with these as top picks, although one expert noted that she thinks familiarity and consistency should be two different categories. This reinforces previous discussion around the fact that consistent user experiences are more relevant to older adults with cognitive decline than familiar ones.

Content simplification and Interaction simplification are the only considerations tied in popularity. This as well as their place near the middle of the rankings reinforces the view that these two can be conflated to one consideration. As one expert put it, “interaction simplification seems like it is made up of the other considerations such as content and layout simplification. Efficiency can be improved by simplifying content and layout, therefore simplifying the interaction.”

4.4 A Note on Ranking

Ranking creates a popularity echo-chamber (Treviranus and Hockema, 2009). If participants know the results of a ranking exercise, it threatens to bias their responses in later rounds of the survey, resulting in certain considerations rising to the top while others are brought low in the ranking.

The purpose of the ranking exercise (above) was simply to aid in my qualitative analysis of the results in order to better contextualize and discuss each design consideration and to suggest pairings where rankings were close or identical (for example content simplification and interaction simplification). The experts in my study did not see the results of the ranking in the follow-up round.

As mentioned above, ranking the results showed that answers to the Likert scale questions in the Round 1 survey were on the whole accurate and consistent predictors of the final outcome of ranking design considerations, thus reinforcing a sense of consistency across the different parts of the survey.

In only one instance did the results of the ranking lead to a major change in the list for Round 2. Unique and Evocative experiences not only ranked lowest but also had the highest standard of deviation of all items (positively skewed), with a wide distribution of both very high and very low rankings.[47] Because this finding was reinforced by other data from the first part of the survey, I felt Unique and Evocative experiences was a more nuanced design consideration that was not optimally represented by the preliminary list. As a result, I removed it as a main category from the refined list (Appendix B) and inserted it as a consideration to balance other design considerations such as “design for consistency.”

It is also important to note that the ranking was relative and subjective. As mentioned above, the small size of the group (n=13) does not make it a representative sample.

[47] It actually tied for highest SD along with “Active Relaxing Elements” but ranked two spots lower.

4.4.1 Additions to the List

On the whole, the experts approved the list of ten proposed UX design considerations, calling it a "solid list;" however, they also suggested important additions. Two experts proposed adding a pragmatic design consideration to do with manipulation: the *degree of usefulness* of the device/application towards practical challenges in the daily life of older adults with cognitive decline. Usefulness for tasks users want and need to perform is not only a strong motivator that contributes to a positive user experience (as has been shown in the case of fitness bands like the fitbit for motivated weight-conscious individuals); it may also help resolve a key tension with another design consideration – flexible preferences. As described above, there exists a tension between the obvious benefit of flexible preferences/customizable experiences (that users can tailor their own experience to best suit their needs) and their main shortcoming for older adults with cognitive decline (the relatively high cognitive load). Yet, as one expert put it, making an app uniquely fitted to tasks and highly useful may "decrease the amount of effort required to provide personalized customer experience." Another way to state this new design consideration is *Relevant and Useful for specific tasks older adults with cognitive decline want and need to perform.*

Tasks need to be completed efficiently but also with a minimum of anxiety. Another design consideration suggested was *designing to minimize error versus designing for speed of task completion*. This is in effect a complement to another design consideration – help and human support. Whereas help and human support networks is an active consideration, designing to minimize error is a negative (the absence of something: error). I felt this was such a good addition to the list that I made it a standalone category in the refined list (Appendix B) along with human support, which the survey showed was more important than in-app help. I discuss this in the next section.

5 Towards the Complete List of UX Design Considerations

5.1 Round 2 Survey: Refining the Preliminary List and Questions

Overall, the feedback from experts in Round 1 of the survey (above) reinforced that my conceptual framework was on the right track. It also stressed the importance of hedonic attributes in designing for UX as described by Hassenzahl (2003) above. However, the results of the survey also made clear that my preliminary list of design considerations from the literature (Appendix A), while a "solid" start, still assumed 'average' users and consequently failed to capture the subtleties needed to design inclusive, one-size-fits-one experiences for older adults with cognitive decline. One issue that I had thus far ignored was the effect of specific design considerations, contexts and scenarios on cognitive load. For example, as various experts pointed out, too much content simplification and/or frequent customization of the interface increases cognitive load for some older adults and therefore must be controlled for in certain contexts.

In general, what emerges from the Round 1 data is a complex picture of older adults with cognitive decline:

- with varying needs, abilities, experiences, and predilections, including attitudes towards technologies
- who value accessibility and usability as well as emotional engagement
- who value self-esteem and self-actualization elements implicitly, including the right not to participate in a given activity (though may not express this explicitly) and who may not automatically value technological methods, so motivation is important
- who are able to learn new skills, although some may be able to do so only with difficulty

Give this, my aim for Round 2 of the survey was to create a more comprehensive list that better captures the nuances of designing mobile user experiences for older adults with cognitive decline. Since Round 1 yielded much useful data, and since I wished to avoid creating an 'echo-chamber' by further ranking, I decided not to do a quantitative analysis for Round 2 and focused instead on qualitative feedback based on the revised and expanded set of UX design considerations.[48] I asked the experts to review the list and then asked the following two questions:

- **Question 1)** In your opinion, does the list capture the primary design considerations you would include in creating an interface, app or otherwise planning a mobile user experience for older adults with cognitive decline?
- **Question 2)** Please provide your thoughts on the best way to present this list to UX designers. Any particular format(s) and/or strategies to enhance and maximize use of the list, engagement and inclusion strategies, etc?

The refined list as presented to the experts (Appendix B) ran just over five pages single-spaced and included general considerations for UX designers followed by a list of specific considerations grouped into eleven categories. These categories built on the categories in the preliminary list based on the literature but modified, combined and expanded some of them in line with the feedback I received.

5.2 Round 2 Survey: Expert Feedback on Refined List

The experts agreed that the refined list captures the subtle and varied needs of older adults with cognitive decline. "I think you nailed it this time," wrote one. Others wrote: "A big yes," "clearly worded, and "a great looking list with lots to think about." At the same time, the experts pointed out that it is a "long list in its current form" and "a bit of a cognitive overload itself." One expert noted the

[48] Thank you to my Principal Advisor, Jutta Treviranus, for suggesting this shift in approach at a key juncture in my research

"tentativeness in the tone, such as 'do this but don't do too much of it'" but concluded that that is "unavoidable for this user group."

Interestingly, the one non-designer in the second round, himself an older adult, found the list "greatly overstated. There is very little difference between a number of the considerations… I think you could probably reduce 70-odd design considerations to something closer to a dozen." He believed that "if the designers are at all capable, they shouldn't need such fine-tooth instruction in the detail." Another expert pointed out that most designers tend "towards being intuitive rather than methodical when it comes to the process." He suggested using more "plain, friendly, almost fun language" and proposed a gamification approach where designers could earn points "and the points also reinforced the relative importance of the aspects."

The "Active Cognitive Engagement Elements" design consideration in the preliminary list had strong support but the experts pointed out that cognitive engagement strategies like gamification can also be distracting or inappropriate in certain contexts. A key category in the revised list, therefore, became "Design to engage cognition (including memory, attention and language skills) but do it carefully and judiciously."[49]

Under General Considerations in the refined list, one expert suggested adding "Applicability of tasks to users' goals (not designer goals)." He elaborated: "I'm saying this based on my experience in senior centers, not only with people with cognitive impairments. There is some resentment about having to do things with no personal payoff, and if they can opt out, they will."

[49] Anticipating a continuation of my study, one expert had the following to say about the reference to the sub-categories (memory, attention and language skills) used in this consideration: "These sub-categories might need to be addressed separately. What we call 'cognitive functioning' is a constellation of skills applied to tasks as needed, and any given design calls upon each of those skills differently. Now, as far as I can see, experts in cognition don't seem to agree on the sub-categories themselves, so of course you are not expected to resolve all that. But for the sake of your audience, you might want to break it down for them. You may need to go into some detail on 'executive function', being effective in self-directing through a task."

As mentioned above, designing for human help was seen as a crucial design consideration for older adults with cognitive decline. “Make it a default, not Plan B,” wrote one expert. “I would even emphasize that having this one feature means you can screw everything else up completely.”

Taking this feedback into consideration, I present the ‘complete’[50] list of UX design considerations in Part 6, below.

[50] It is not quite complete. See discussion about the list being a “living document” in the Conclusion.

6 Design Artifact: Set of UX Design Considerations for Older Adults with Cognitive Decline

6.1 Preamble

Recall the following from our discussion about User Experience in Part 2:

- UX is more than usability. It takes into consideration hedonic attributes (psychological well-being) as well as pragmatic ones (usability) that are dependent on users and their context
- The end result of UX design should be usable and compelling experiences that meet – and exceed – user expectations.

Recall also the core aspects of inclusive design from our discussion about Inclusive Design in Part 2:

1. **"one-size-fits-*one*" solutions** that integrate well with each other. This differs from the one size fits *all* ethos of universal design, and is perhaps most achievable in the digital realm, where designers can design flexible interfaces and experiences that adapt to different contexts
2. despite this emphasis on personalization, however, **avoiding segregated or over-specialized (exclusionary) solutions**
3. equally **avoiding adaptive systems** that make choices for the user
4. **respecting the dignity and autonomy of the user** throughout the design process, and the "**importance of self-determination and self-knowledge**"
5. design driven by **edge-cases and "extreme users"**
6. working in **inclusive teams** (as varied as possible) via **inclusive processes** and **accessible tools**
7. **socially-conscious and responsible design**. Inclusive designers must "be aware of the context and broader impact of any design and strive to effect a beneficial impact beyond the intended beneficiary of the design."
8. Inclusive design is not limited to just accessible design. In cases where inclusive design considers disability (as in edge cases involving users who happen to be disabled), it ***reframes disability and accessibility along a social model of disability*.** Such a social model of disability sees disability as a context-based "mismatch between the needs of the individual and the design of the product, system or service." Accessibility in an inclusive design context thus becomes the *ability of the design or system to match the requirements of the individual*

6.2 The Long List

Designing Mobile Applications for Older Adults with Cognitive Decline: Inclusive Design Considerations for User Experience Designers

- **older adults** are defined as adults over 65 years of age
- **cognitive decline** is defined as age-related cognitive decline and mild cognitive impairment (MCI). It does not include Alzheimer's or other forms of dementia

Studies reveal a complex picture of older adults with cognitive decline:

- with varying needs, abilities, experiences, and predilections, including attitudes towards technologies
- who value accessibility and usability as well as emotional engagement
- who value self-esteem and self-actualization elements implicitly, including the right not to participate in a given activity (though may not express this explicitly) and who may not automatically value technological methods, so motivation is important
- who are able to learn new skills, although some may be able to do so only with difficulty

General Considerations for UX Designers

1. Design for the diverse needs of older adults with cognitive decline, including physiological and safety needs, love, esteem and self-actualization needs
2. Design for individual context as much as possible: keep context-specific tasks in mind
3. Avoid one-size-fits-all solutions
4. Balance cognitive engagement with designs that reduce cognitive load (the total amount of mental effort being used in the working memory)
5. Put user's goals first. Make sure any task you want the user to perform is clearly connected to the *user's* goal (rather than the designer's goal). If there is no user goal, you have a problem!
6. Avoid features such as gamification, relaxation techniques or elements designed to reinforce a sense of self-esteem unless those features are something that users are expecting and actually seeking. Avoid "sneaking in" features for users' "own good" (don't condescend)
7. Consider that some older adults with cognitive decline:
    a. are more methodical than younger users; some are not
    b. blame themselves more than younger users do; some do not

c. are more willing to try new things; others are not
d. suffer from self-esteem issues; others do not
e. wish to be reminded of who they were before their decline (self-actualization elements); others do not

Specific Considerations

6.2.1 Design to reduce error rather than for speed of task completion; include human help as a default

1.1. Designing to reduce error is more important than designing for speed of task completion. Older adults are often used to taking a little more time on certain tasks
1.2. Design for human help as the *default*, not Plan B. Include options for human support including support by other older adults, caregivers and family (adds to the trust and credibility of the experience, combats difficulty learning new skills, inability to make decisions, etc)
1.3. Also include in-app help (implemented clearly and unobtrusively)
1.4. Avoid online help forums. Older adults often find them complex and tedious to use
1.5. Make it easy to recover from interruption
1.6. Avoid distractions to help focus on tasks and reduce anxiety (see also design for clarity and design for consistency below)

6.2.2 Design to engage cognition (including memory, attention and language skills) but do it carefully; be mindful of appropriate degree and context

1.7. Include cognitive engagement elements and low to moderate cognitive challenges in a way that is transparent, appropriate, proportionate to the overall user experience and presented in a way that does not negatively impact the overall user experience
1.8. Be mindful of appropriate degree and context
1.9. Keep in mind that older adults with cognitive decline learn in various ways including working through, not just thinking through, actions
1.10. Be mindful not to interfere with tasks the interface is intended to support (see designing for real-world tasks below)
1.11. Overcoming challenges can motivate and reinforce self-esteem: focus on creating successful initial experiences and then decide on balancing ease of use with a small, manageable degree of cognitive challenge
1.12. Avoid over-stimulation and do not overdo the level of cognitive challenge
1.13. Use brain training, memory and gamification techniques only if users know to expect them; make sure alerts and notifications do not interfere with main functionality or arbitrarily appear during task processes

1.14. Ensure users can always complete the task without the gamification elements as well
1.15. Consider that gamification may be good for some tasks (i.e., ones needing a lot of repetitive practice) but not for other tasks. Older adults with cognitive decline often need to be motivated to spend time with gamification
1.16. Straightforward, simple tools that provide the functions people want can replace gamification strategies and motivate users in many cases
1.17. Use graded tutorials of increasing complexity if the app warrants this functionality and users expect it

6.2.3 Design for consistency

1.18. Avoid surprises
1.19. Keep functionality and design elements consistent and predictable across screens, apps and devices
1.20. Avoid new for its own sake. This helps establish trust in the experience (see designing credible and trustworthy experiences below)
1.21. Avoid unique and evocative experiences for their own sake; balance new and evocative elements with consistency and credibility
1.22. Avoid frequent updates
1.23. Keeping things familiar (keeping to a proven and understandable design language) is also good but less important than keeping things consistent

6.2.4 Design for clarity and straightforwardness rather than simplicity

1.24. Designing for clarity and straightforwardness is more important than designing for simplicity because oversimplifying increases cognitive load (see below). For example, too much whitespace can cause some older adults with cognitive decline to miss navigational cues, especially if they use magnifying assistive technology, causing confusion and making them think harder. Similarly, too much semantic simplification (acronyms, unfamiliar metaphors) or interaction simplification (hidden gestures) strains memory
1.25. Clarity includes efficiency/convenience and integration features
1.26. Keep interactions clear and understandable. This includes making content and layout visible, transparent and attention-focusing
1.27. Design clear, accurate and succinct text (labeling/copy/link text). Avoid abstract concepts or unfamiliar metaphors. If the text is for a link, make sure it describes the link and indicates what will happen/where user will go if the link is activated
1.28. Avoid justified text
1.29. Use terms and images/icons consistently
1.30. Link abstract representations such as diagrams with more concrete illustrations of what they stand for (“dynalinking” – for example, show fish swimming next to a diagram explaining a pond’s food chain)

1.31. General rules for colour contrast and text size apply (see design for accessibility, below)

6.2.5 Decrease cognitive load wherever possible

1.32. Design to decrease cognitive load (the total amount of mental effort in the user's working memory)
1.33. Design to minimize challenges
1.34. Simplify, but don't simplify too much. Design for clarity and straightforwardness instead of too much simplification (see design for clarity above)
1.35. Use whitespace, but not too much. Older adults may have partial vision conditions where excessive whitespace may increase the chance of missing elements of the user interface (especially if they are using assistive technology such as screen magnifiers)
1.36. Design with accessibility in mind but do not add to cognitive load, for example with too many multisensory/multimodal content alternatives (see accessibility below)
1.37. Give older adults with cognitive decline the option to suppress details of the user interface that distract from the main content but be mindful of taxing memory and increasing cognitive load with too much choice
1.38. Keep things clear and minimize the potential for error (see design for clarity and design to reduce error above)
1.39. Minimize distractions. Reduce system updates, status information and other system initiatives to a minimum. System initiatives that remind or help recapture task content are a good idea in principle but must be implemented carefully so as to minimize potential confusion
1.40. Use inference to simplify both the interface and the entire session where possible, and where accuracy is high. Allow for override
1.41. Design interfaces that promote recognition rather than recall by using menus, icons and consistently placed objects

6.2.6 Design for real-world task completion and practical challenges; always put user's goals ahead of designer's goals

1.42. Make sure the design helps older adults with cognitive decline perform actual tasks they want and need to complete. This also helps establish credibility and trust (see below)
1.43. The design should help the user perform tasks in a way that is better than the way they did it previously
1.44. Focus on creating successful initial experiences and then decide on balancing ease of use with a small, manageable degree of cognitive challenge (see engaging cognition above)

6.2.7 Design credible and trustworthy experiences; connect with communities beyond the interface to reinforce credibility and trust

1.45. Consider how the sum total of design decisions can help reinforce credibility and trust in the overall experience
1.46. Consider how communities beyond the app (ex: friends and family) can help reinforce credibility and trust in the digital experience (as well as help balance cognitive engagement with reduced cognitive load)
1.47. New and evocative elements can help motivate and cognitively stimulate but be mindful of context and degree

6.2.8 Implement customizable preferences with care to minimize cognitive load; allow users to import their preferences if possible

1.48. Customizable flexible preferences can be a good way to design for the diverse needs of older adults with cognitive decline but the customization process can also increase cognitive load (see decrease cognitive load above)
1.49. Do not give too much responsibility to the user for establishing the usability of the system as this may be confusing and cause them to 'tune out'
1.50. Allow users to import their preferences if possible
1.51. Consider designing a set of smart defaults, a 'wizard interface' and/or letting family/caregivers control and lock down preferences
1.52. Consider how making an app uniquely fitted to tasks, consistent, useful and connected to people (help etc) may decrease the amount of effort required to provide a personalized user experience
1.53. Consider also how the sum total of engagement with and connection to friends and family, consistent, familiar metaphors and sometimes gamification techniques can help motivate users, manage cognitive load and decrease the amount of effort required to establish personalized user experiences

6.2.9 Keep users engaged, motivated and at ease. Don't "sneak in" cognitive, relaxation or self-esteem elements for user's "own good"

1.54. Keep things conversational and light (mindful of context and purpose of the app)
1.55. Clear and straightforward tools and functions that people want will achieve cognitive engagement, relaxation and esteem better than active attempts to "sneak these" elements in
1.56. Avoid distractions to help focus on tasks and reduce anxiety
1.57. Avoiding distractions (visual, auditory, etc) is better than trying to include active relaxation elements that impart calm and tranquility such as whitespace or music. Include active relaxation elements only if they conform with the goal(s) of the particular app being designed
1.58. The end result will allow older adults with cognitive decline to communicate, speak, read and remain cognitively fit, ease their stress, improve memory and focus, inspire and motivate. It may also help them

remember who they were before the condition (self-actualization) if this is something they want to do

6.2.10 Design for accessibility but manage the number of choices

1.59. A key factor in cognitive accessibility is that an interface/app is compatible with assistive technology and across platforms/browsers

1.60. Use multisensory and multimodal feedback (ex: audio, visual and vibrating alerts) judiciously. Too much multisensory and/or multimodal content or multitasking increases cognitive load (see also cognitive load)

1.61. Too many distractions from system initiatives/updates that provide status information and help recapture task content increases cognitive load (see also cognitive load)

1.62. Include easy ways to adjust colour contrast and text size so that the interface is customizable and so that minimum accessibility requirements are met (minimum 70% contrast and 12 point font). Implement customization carefully so as not to overwhelm users (see customization preferences above).

6.2.11 Design for dignity, autonomy and connectedness

1.63. Include friendly simple elements that do not talk down to older adults with cognitive decline or promote hesitation or discouragement

1.64. Early successes can lessen the impact of later failures: focus on creating successful initial experiences and then decide on balancing ease of use with a small, manageable degree of cognitive challenge (see design to engage cognition above)

1.65. Include and engage community, peers, caregivers and family, both for their assistance in engaging and helping the user (see human help above), and as an important part of the mobile experience for older adults with cognitive decline (e.g., communication, sharing, social participation, civic engagement, etc.)

1.66. Wherever possible, reinforce self-esteem and self-efficacy (without being patronizing or drawing attention to these elements explicitly) by motivating, engaging and enabling older adults with cognitive decline. Do not “smuggle” these qualities in to apps for users’ own good (see keep users engaged above)

1.67. Self-esteem and autonomy can also be strengthened by reinforcing memory, attention and language skills (via design with a cognitive engagement element)

1.68. Keep in mind that too much emphasis on self-esteem and self-actualization elements might be welcome initially but later cause irritation

6.3 The Short List

The short list of design considerations is meant as a quick reference for UX designers on the go. It repeats only the main category headings of the long list with the option to choose any heading and expand it.

Designing Mobile Applications for Older Adults with Cognitive Decline: Inclusive Design Considerations for User Experience Designers

- **older adults** are defined as adults over 65 years of age
- **cognitive decline** is defined as age-related cognitive decline and mild cognitive impairment (MCI). It does not include Alzheimer's or other forms of dementia

Studies reveal a complex picture of older adults with cognitive decline:

- with varying needs, abilities, experiences, and predilections, including attitudes towards technologies
- who value accessibility and usability as well as emotional engagement
- who value self-esteem and self-actualization elements implicitly, including the right not to participate in a given activity (though may not express this explicitly) and who may not automatically value technological methods, so motivation is important
- who are able to learn new skills, although some may be able to do so only with difficulty

General Considerations for UX Designers

1. Design for the diverse needs of older adults with cognitive decline, including physiological and safety needs, love, esteem and self-actualization needs
2. Design for individual context as much as possible: keep context-specific tasks in mind
3. Avoid one-size-fits-all solutions
4. Balance cognitive engagement with designs that reduce cognitive load (the total amount of mental effort being used in the working memory)
5. Put user's goals first. Make sure any task you want the user to perform is clearly connected to the *user's* goal (rather than the designer's goal). If there is no user goal, you have a problem!
6. Avoid features such as gamification, relaxation techniques or elements designed to reinforce a sense of self-esteem unless those features are

something that users are expecting and actually seeking. Avoid “sneaking in” features for users’ “own good” (don’t condescend)

7. Consider that some older adults with cognitive decline:
    a. are more methodical than younger users; some are not
    b. blame themselves more than younger users do; some do not
    c. are more willing to try new things; others are not
    d. suffer from self-esteem issues; others do not
    e. wish to be reminded of who they were before their decline (self-actualization elements); others do not

Specific Considerations

(choose any consideration to see more details)

1. **Design to reduce error** rather than for speed of task completion; include human help as a default
2. **Design to engage cognition** (including memory, attention and language skills) but do it carefully; be mindful of appropriate degree and context
3. **Design for consistency**
4. **Design for clarity** and straightforwardness rather than simplicity
5. **Decrease cognitive load** wherever possible
6. **Design for real-world task completion** and practical challenges; always put user’s goals ahead of designer’s goals
7. **Design credible and trustworthy experiences**; connect with communities beyond the interface to reinforce credibility and trust
8. **Implement customizable preferences with care** to minimize cognitive load; allow users to import their preferences if possible
9. **Keep users engaged, motivated and at ease**. Don’t attempt to “sneak in” cognitive engagement, relaxation or self-esteem elements for user’s “own good”
10. **Design for accessibility** but manage the number of choices
11. **Design for dignity, autonomy and connectedness**

6.4 Presenting the List to UX Designers

The previous two sections presented long and short versions of the list of inclusive design considerations for UX designers designing mobile applications for older adults with cognitive decline. This list came about from a summary of the main design considerations from the literature (Part 3) and a refinement of these considerations after feedback from an inclusive panel of experts in a two-part survey (Part 4 and 5). In this final section of the MRP, I consider ways that the list can be presented to UX designers so that it is most useful and effective to UX design teams.

As discussed in the User Experience Design section in Part 2, UX professionals vary widely in their skills, expertise and backgrounds. According to Sloan et al. (2014), a major challenge of accessible UX is “getting accessibility in the process” and meeting the “lack of accessibility capacity on project teams.” Most designers felt that once accessibility was inserted into the UX process, project management came fairly easily. Sloan et al.’s early findings suggest an even split between lack of knowledge and lack of practical guidance as obstacles to accessible UX.

Given this, it is important to present the list to UX designers in a way that fulfills the practical and pedagogical aims of this MRP: to be useful and to help raise awareness among designers about inclusive UX design and older adults with cognitive decline. Experts in Round 2 of the survey suggested the following ways to present the list to UX designers.

6.4.1 Integrate the List in the Daily Workflow

All the designers suggested that the list needs to be integrated in the daily workflow of UX design teams. Jim Tobias of Inclusive Technologies, who helped edit the final list of design considerations, wrote the following:

> I would encourage you to integrate this material wherever possible into general usability resources, rather than present them separately. In fact, you could position this material as the 'acid

> test' of general cognitive usability: "Here are some real challenges in the form of users who are often ignored. If you can meet their needs, you will probably have served all the other users you have in mind." Another way to structure this integration is to take general usability statements in a given resource and interpret them in terms of these users: "We know that many users prefer X. For older people with cognitive limitations, this may mean Y."

Because UX professionals vary so much in their skills and backgrounds, a common suggestion was to present the list on the internet with examples and diagrams, possibly as an infographic (see next point).

6.4.2 Make it Accessible and Engaging to the Target Users (UX Designers)

Most experts thought the 5 page list should be made more accessible to UX designers, presented in an easy to read format, and available as an interactive list online with the option to be printed out in PDF or Word format. One expert pointed out that the long version of the list (an expanded "opt-in doc" with all details, specifics and nuances intact) can also offer "points for further consideration" such as the fact that many of the design considerations also apply to design for children.

Another expert suggested the list could be "mind-mapped or flowcharted." A few suggested interactive visual presentations such as infographics similar to WebAim's Web Accessibility infographic,[51] Prezi/animated powerpoints on Slideshare and YouTube videos. One expert suggested using tags that tied in to the categories in the preliminary list of design considerations from the literature (see Part 3) and also introduced a few extra categories: for example, "'avoid new for its own sake' can be categorised under 'consistency' as well as 'trust.' Other categories could include areas like 'navigation' and 'error handling'." One expert suggested building an "interactive learning tool" out of a current interface or app "with callouts on what considerations are being referred to."

Despite discussion about whether or not to include gamification elements in the list of design considerations for older adults with cognitive decline (see Part

[51] http://webaim.org/resources/designers/

4), two experts suggested a gamification approach for UX designers. One idea was a system where designers could earn points that reinforced the relative importance of the aspects while another suggested a game-like possibility with the list of considerations that begin with the words “Consider that some older adults…” and end with “and some do not.” As she put it, “that feels like a point of opportunity for presenting things in a thoughtful way that maybe pricks your brain without trying to ‘solve’ for something.”

6.4.3 Increase Legitimacy

Experts suggested various ways to make the list appear more legitimate to design professionals. One suggestion was to call the list a “handbook” in order to “increase the idea of legitimacy and the idea of it being a key reference guide.” Another expert suggested that the online list include “links to other standards, guidelines and online resources” such as WCAG 2.0 to “make it a comprehensive learning material for designers with varied profiles.”

6.4.4 Include Examples from Designers that Reinforce the List

In order to be most effective and inclusive, the list should include examples and illustrations (wireframes, screenshots and prototypes) based on specific categories, items or sub-items in the list. An example of this approach is the screenshots page on the UI Patterns website (http://ui-patterns.com/explore). In this way, the list could form part of a vibrant online interactive community of designers with contributions, examples, and discussions moderated by an administrator (see Next Steps in the Conclusion, below).

7 Conclusion

The research above represents a small contribution to the wider "paradigm shift … from technical accessibility towards accessible user experience" (Sloan et al, 2014). Sloan et al (2014) identify a lack of knowledge and lack of practical guidance among UX designers as the main obstacles to accessible UX. The design challenge of this MRP was to assemble a comprehensive set of research-based inclusive design considerations for UX designers so that they can design mobile user experiences to meet the needs of older adults with cognitive decline (age-related cognitive decline and mild cognitive impairment) – something UX designers do not have now.

As discussed in Part 2, an inclusive set of UX design considerations for mobile needs to reflect a comprehensive and holistic UX position that focuses not only on usability concerns but also on fostering stimulation, evocation and identification. It should leverage the diverse perspectives of older adults with cognitive decline as a vital edge-case to emphasize the more holistic, human-connected realities of mobile platforms. This includes design considerations around mobile-enabled community networks including networks of human help and support.

The list (in two versions) in Part 6 is by no means the final word on the matter but rather represents the beginning of what I hope will become a rich dialogue between designers, experts, and users of all ages – but especially older adults with cognitive decline – about designing cognitively accessible mobile applications and experiences. Along the way, designers and non-designers alike are invited to read through the guidelines and present ideas, suggestions and sketches, to involve others in helping create inclusive mobile UX and in the process to help raise awareness about cognitive decline.

In addition to the actual list of inclusive UX design considerations in Part 6, I hope the rest of the MRP is useful to designers, scholars and inclusive design students as a learning tool about cognitive accessibility and designing for

older adults, as well as an example of inclusive UX research (see Contributions of the Inclusive Research Method, below).

7.1.1 Next Steps: Ongoing Feedback via a "Living Document"

Recognizing the need to adapt to changing contexts, a key aim of the literature review and the survey was to come up with a list that is flexible for the future. My hope is that the list becomes a "living document" for UX designers. The inclusive panel of thirteen experts from design, academia, medicine and policy who participated in my study helped guide the design of the list and offered excellent suggestions to ensure the list remains accessible, legitimate, engaging, integrated with daily UX workflows and open to ongoing feedback.

The logical next step is to put the list online and encourage the growth of an 'inclusive community' around it in order to provide input and suggest ways to make the list even better. UX designers could post examples (sketches, wireframes, screenshots, prototypes, user scenarios, journey maps) as well as the results of interviews, questionnaires and actual user tests with older adults with cognitive decline in order to supplement, reinforce and modify the UX design considerations in the list above. They could create infographics and captioned videos to help communicate the design considerations. A website or mobile app for designers could even present future iterations of the list as an interactive "experience" in itself, for example by introducing designers to the core concepts and then taking them through screenshots and case studies and finally to full-fledged examples of existing apps with user testimonials showing the design considerations in action.

Sharing the list and inviting feedback from the wider community has strong social implications in line with the goals of inclusive design. This is especially true if the list is opened up to non-designers. Leveraging the power of diverse digitally-connected teams, designers together with non-designers (including older adults with cognitive decline) can co-create easy to use applications that also inspire, evoke memories, reinforce a sense of trust, motivate, stimulate and ultimately help adults of all ages to identify with digital

products and services, exceeding expectation and creating meaningful experiences. This is the spirit of inclusive design and inclusive user experience design in particular.

As a final point, the list above is still fairly broad. As the mobile landscape continues to change in new ways, feedback from the wider UX design community will be needed to keep the list current and help tailor it to specific scenarios and challenges. Along the way, the list will need to keep focused on pragmatic attributes (usability) as well as hedonic attributes (psychological well-being) in order to address the challenges of designing *for* UX as described above.

7.1.2 Contributions of the Inclusive Research Method

In closing, I wish to highlight the contributions of the inclusive research method to this MRP. As noted in Part 2, inclusive design applies not only to deliverables but to methods as well. In my analysis of the results from my two-part survey with experts (Part 4, above), I suggest that an inclusively designed survey that seeks diverse views rather than a 'consensus' approach can result in a nuanced, multi-faceted and yet consistent position on a given topic. This was indeed the case.

Comparing the quantitative results from the first part of the survey with the results of the ranking exercise in the second part reinforced an overall consistency in expert views. This consistency was important for the development of the final design deliverable in Part 6. Despite the wide range of perspectives the experts brought to the survey, and despite the fact that none of the experts knew their fellow respondents' positions (thus eliminating the danger of an echo-chamber), I observed consistency in general trends about topics. Trends observed by aggregating the Likert scale data in the first part of the Round 1 survey carried over to – and were consistent with – the separate aggregated ranking of design considerations in part two. Not only that, as a whole the results showed that all experts generally agreed that the preliminary list of design considerations was a good start (*each* of the individual considerations was ranked "most important" (score = 10) by at least one expert). At the same time,

the responses suggested that the list can be improved as well. In general the ranking indicated a wide spread in the data – for example, only “credibility and trust” had more than one perfect 10-point score while four items (“unique and evocative,” “active relaxing elements,” “active esteem elements” and “content/layout simplification”) had the highest number of 1-point scores. The standard deviation increased as the design considerations fell lower in popularity ranking, suggesting increased uncertainty about the way those design considerations were worded or presented. This corresponded to qualitative feedback that pointed out instances where those considerations needed caveats or amendments (for instance, flexible preferences, active relaxation and esteem elements, and unique and evocative experiences).

This attention to detail and the steady shift in focus away from generalizable, “one size fits all” solutions (characteristic of the preliminary list) to a wider acknowledgement of the role context and individual predispositions play is unsurprising given the rich diversity of backgrounds and experiences my expert participants brought to my study. I believe this is precisely the greatest contribution of inclusive design research methods, which by definition seek as varied and specific positions as possible that, when brought together, at once become comprehensive and applicable to the widest range of users. The feedback from experts showed that, in order to truly form an inclusive list of UX considerations that can be used by designers, the list needs to better account for the various abilities and individual predilections of older adults with cognitive decline – and to remind UX designers of this fact wherever possible.

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Appendix A: Preliminary List from Literature Review for Round 1 Survey

Inclusive UX Design Considerations for UX Designers Working on Mobile Applications for Older Adults with Cognitive Decline

1) Pragmatic (manipulation)

- **# Content simplification** including visibility, transparency & attention-focusing elements. Avoid abstract concepts or unfamiliar metaphors. This applies to research too (Crosskey 2014; Massimi et al 2007)
- **# Layout simplification** including visibility, transparency & attention-focusing elements (Nielsen Norman Group 2013)
- **# Interaction simplification**. Improving the efficiency with which things get done, thus combatting fatigue, inattention etc
- **# Human support network/help** Combats difficulty learning new skills and trouble making decisions. Support networks may include caregivers and family, or just a human help function. As Massimi et al (2007) state, having a "human support network is more important" than paper documentation for older adult mobile users (also reinforced in Crosskey 2014: "It's not just for individuals, but for family, community, caregivers, and clinicians"). This consideration also speaks to the issue of *credibility*, below. One way for designers to facilitate help for older adults with MCI may be through a symbiotic relationship in which they learn new design skills in the process.
- **# Flexible user-controlled preferences & options**. A key consideration from inclusive design (see Inclusive Design section, above), customization is "one of the key user experience aspects of connected digital devices" (Pfeiffer 2013). This also includes accessibility features: "Users who have difficulties reading the thin typeface of iOS 7 can switch to bold type, for instance."
- **#Accessibility**. Relates to all of the above but is also a separate category. From an inclusive design perspective accessibility centres on the multi-modal presentation of content and the ability to suppress details (Inclusive Learning Design Handbook). The accessible design consideration in the context of older adults with cognitive decline also relates to specific memory considerations such as system initiatives that provide status information and remind of and help recapture task context (Sutcliffe et al, 2003).

2) Hedonic (evocation, stimulation, identification)

- **# Establishing credibility & trust** in new experiences. Older adults should feel that the system is built with their wants & needs in mind.
- **# Familiarity & Consistency**. Helps build trust. Taking care not to take uniqueness too far; nothing new for its own sake. Reinforcing the perceived *stability* of digital platforms. Langdon et al (2012) highlight the importance of keeping to a proven and understandable design language (by minimizing the number of updates for example).
- **# Unique & evocative.** An important consideration for good UX; however, must be carefully balanced with familiarity, credibility and trust. Unlike younger users, older adults tend to value emotional engagement less, preferring accessibility and usability (Goddard and Nicolle (2012), Nielsen Norman Group (2013), Jar Creative (2013), and Goldhaber et al (2012)). According to Pfeiffer (2013), good UX equals the sum of a unique look paired with usable, intuitive and consistent interfaces (from device to device).
- **# Active relaxing elements**. Ease stress and help improve memory and focus. For example, negative space can "impart a sense of calm and tranquility, and it can make an app look more focused and efficient" (Apple iOS Human Interface Guidelines). However, designers must keep in mind that a shift in context can quickly turn a relaxing user experience into an annoying one; for this reason as well as to conform to accessibility standards, easy on/off functions are required.
- **# Active cognitive engagement elements** to inspire, involve and motivate. As Goddard and Nicolle (2012) point out, seniors often enjoy a challenge and exhibit pride at figuring out new technology. *Gamification techniques* and *embodied cognition techniques* aimed at helping users work through, not just think through, actions can lead to improved memory and responsiveness (brain training) and higher levels of engagement.
- **# Active esteem & self-actualization elements** According to Crosskey (2014), esteem needs include being able to communicate and speak, read, and remain cognitively fit. Self-actualization needs include remembering who older adults were before cognitive decline Designs should therefore include friendly, simple elements that don't talk down to older adults or promote hesitation or discouragement (recall: in Nielsen Norman Group's 2013 study, seniors blamed themselves 90% of the time compared to 58% of younger users).

Appendix B: Refined List for Round 2 Survey

Design to reduce error

1. Designing to reduce error is more important than designing for speed of task completion. Older adults are often used to taking a little more time on certain tasks
2. include in-app help (implemented clearly and unobtrusively)
3. include options for human support where possible including support by other older adults, caregivers and family (adds to the trust and credibility of the experience, combats difficulty learning new skills, inability to make decisions, etc)
4. Avoid online help forums. Older adults often find them complex and tedious to use
5. Make it easy to recover from interruption
6. Avoid distractions to help focus on tasks and reduce anxiety (see below)
9. (See also clarity and consistency)

Design to engage cognition (including memory, attention and language skills) but do it carefully and judiciously

1. Include cognitive engagement elements & low to moderate cognitive challenges in a way that is transparent, appropriate, proportionate to the overall user experience and presented in a way that does not negatively impact the overall user experience
2. Be mindful of appropriate degree and context
3. Keep in mind that older adults with cognitive decline learn in various ways including embodied cognition (working through, not just thinking through, actions)
4. Be mindful not to interfere with tasks the interface is intended to support (see designing for real-world tasks below)
5. Overcoming challenges can motivate and reinforce self-esteem: focus on creating successful initial experiences and then decide on balancing ease of use with a small, manageable degree of cognitive challenge
6. Avoid over-stimulation and do not overdo the level of cognitive challenge
7. Use brain training, memory and gamification techniques only if users know to expect them; make sure alerts and notifications do not interfere with main functionality or arbitrarily appear during task processes
8. Ensure users can always complete the task without the gamification elements as well
9. Consider that gamification may be good for some tasks (i.e., ones needing a lot of repetitive practice) but not for other tasks. Older adults with cognitive decline often need to be motivated to spend time with gamification
10. Straightforward, simple tools that provide the functions people want can replace gamification strategies and motivate users in many cases

11. Use graded tutorials of increasing complexity if the app warrants this functionality and users expect it

Design for consistency

1. Avoid surprises
2. Keep functionality and design elements predictable across screens, apps and devices
3. Avoid new for its own sake. This helps establish trust in the experience (see below)
4. Avoid frequent updates
5. Keeping things familiar (keeping to a proven and understandable design language) is also good but less important

Design for real-world task completion and practical challenges

1. Make sure the design is relevant to actual tasks older adults with cognitive decline want and need to complete, a key component in establishing credibility and trust (see below)
2. Focus on creating successful initial experiences and then decide on balancing ease of use with a small, manageable degree of cognitive challenge (see engaging cognition above)

Decrease cognitive load wherever possible

1. Design to decrease cognitive load
2. Design to minimize challenges
3. Keep in mind that at some point most 'positive' considerations can become problematic
4. Simplify, but don't simplify too much. Design for clarity and straightforwardness instead of too much simplification (see below)
5. Use whitespace, but not too much. Older adults may have partial vision conditions where excessive whitespace may increase the chance of missing important elements of the user interface (especially if they are using assistive technology such as screen magnifiers)
6. Design with accessibility in mind but do not add to cognitive load, for example with too many distracting multisensory/multimodal content alternatives (see accessibility below)
7. Give older adults with cognitive decline the option to suppress details of the user interface that distract from the main content but be mindful of taxing memory or increasing cognitive load with too much choice (see below)
8. Keep things clear and minimize the potential for error (see clarity below)
9. Minimize distractions. Reduce system updates, status information and other system initiatives to a minimum. System initiatives that remind or help recapture task content are a good idea in principle but must be implemented carefully so as to minimize potential confusion

Design for clarity & straightforwardness rather than simplicity

1. Designing for clarity and straightforwardness is more important than designing for simplicity because oversimplifying increases cognitive load
2. Clarity includes efficiency/convenience and integration features
3. Keep interactions clear and understandable. This includes making content and layout visible, transparent and attention-focusing
4. Design clear, accurate and succinct text (labeling/copy/link text). Avoid abstract concepts or unfamiliar metaphors. If the text is for a link, make sure it describes the link and indicates what will happen/where user will go if the link is activated. Make headings explicit; avoid referencing tech metaphors that may not be understood easily by users. For example, change “suggestion for you” (suggestions about *what*? *Who* is making these suggestions?) to the simpler to understand “some categories you might like”.

Design credible and trustworthy experiences

1. Consider how the sum total of design decisions can help reinforce credibility and trust in the overall experience
2. Consider how communities beyond the app (ex: friends and family) can help reinforce credibility and trust in the digital experience (as well as help balance cognitive engagement with reduced cognitive load)
3. Avoid unique and evocative experiences for their own sake; balance new and evocative elements with consistency and credibility. Keep to a proven and understandable design language (see consistency above)
4. New and evocative elements can help motivate and cognitively stimulate but be mindful of context and degree

Implement customizable preferences with care

1. Customizable flexible preferences can be a good way to design for the diverse needs of older adults with cognitive decline but can also increase cognitive load (see above)
2. Do not give too much responsibility to the user for establishing the usability of the system as this may be confusing and cause them to ‘tune out’
3. Consider designing a set of smart defaults, a ‘wizard interface’ and/or letting family/caregivers control and lock down preferences
4. Consider how making an app uniquely fitted to tasks, consistent, useful and connected to people (help etc) may decrease the amount of effort required to provide a personalized user experience.
5. Consider also how the sum total of engagement with and connection to friends and family, consistent, familiar metaphors and sometimes gamification techniques can help motivate users, manage cognitive load and decrease the amount of effort required to establish personalized user experiences

Keep users engaged, motivated and relatively at ease. Don't attempt to "sneak in" cognitive engagement, relaxation or self-esteem elements

1. Keep things conversational and light (mindful of context and purpose of the app)
2. Clear and straightforward tools and functions that people want will achieve cognitive engagement, relaxation and esteem better than active attempts to "sneak these" in.
3. Avoid distractions to help focus on tasks and reduce anxiety
4. Avoiding distractions (visual, auditory, etc) is better than trying to include active relaxation elements that impart calm and tranquility such as white space or music. Include active relaxation elements only if they conform with the goal(s) of the particular app being designed
5. The end result will allow older adults with cognitive decline to communicate, speak, read and remain cognitively fit, ease stress and improve memory and focus, inspire and motivate. It may also help them remember who they were before the condition (self-actualization) if this is something they want to do

Design for accessibility but manage the number of choices

1. A key factor in cognitive accessibility is that an interface/app is adaptive with assistive technology and across platforms/browsers
2. Too much multisensory and/or multimodal content or choice increases cognitive load
3. Too many distractions from system initiatives/updates that provide status information and help recapture task content increases cognitive load (See also cognitive load)

Design for dignity and autonomy

1. Include friendly simple elements that do not talk down to older adults with cognitive decline or promote hesitation or discouragement
2. Early successes can lessen the impact of later failures: focus on creating successful initial experiences and then decide on balancing ease of use with a small, manageable degree of cognitive challenge (see above)
3. Include and engage community, caregivers and family
4. Wherever possible, reinforce self-esteem and self-efficacy (without being patronizing or drawing attention to these elements explicitly) by motivating, engaging and enabling older adults with cognitive decline. Do not "smuggle" these qualities in to apps for users' own good (see above)
5. Self-esteem and autonomy can also be strengthened by reinforcing memory, attention and language skills (via design with a cognitive engagement element)

6. Keep in mind that too much emphasis on self-esteem and self-actualization elements might be welcome initially but later cause irritation
7. Consider that some older adults with cognitive decline are more methodical than younger users; some are not.
8. Consider that some older adults with cognitive decline blame themselves more than younger users do; some do not.
9. Consider that some older adults with cognitive decline are more willing to try new things; others are not
10. Consider that some older adults with cognitive decline suffer from self-esteem issues; others do not
11. Consider that some older adults with cognitive decline wish to be reminded of who they were before their decline (self-actualization elements); others do not

Appendix C: List of Questions for Experts in Round 1 Survey

(note: this is a list of the questions in the Round 1 survey – not the actual survey as presented to experts. This list omits Likert scales and fields below each question to expand on answers. It also omits explanatory footnotes for terms such as gamification and embodied cognition, etc.)

Do you Strongly Agree, Agree, Neither Agree nor Disagree, Disagree or Strongly Disagree with the following statements?

1. Unlike younger users, older adults 65+ with cognitive decline tend to value emotional engagement with products *less* and tend to value accessibility and usability needs *more*.

2. Older adults 65+ with cognitive decline often enjoy a challenge and exhibit pride at figuring out new technology.

3. Design should include friendly, simple elements that don't talk down to older adults with cognitive decline or promote hesitation or discouragement.

4. Designers must take into account the diverse needs of older adults, including physiological & safety needs, love, esteem and self-actualization needs, when designing digital experiences for older adults with cognitive decline.

5. In general, older adults are more methodical than younger users, and much more likely to think through each step or click to assess an entire page before moving forward.

6. Simplicity of user interfaces can sometimes come at the price of efficiency and integration features. For example, "iOS 6 is still the simplest mobile operating system, especially for very inexperienced users, but that simplicity comes at the price of efficiency and integration features that the operating system lacks" (Pfeiffer Consulting, 2013).

7. Older adults blame themselves for mistakes with tech more than younger users do.

8. Overcoming challenges can motivate older adults with cognitive decline and help reinforce a sense of self-esteem.

9. Early successes can lessen the impact of later failures, especially for older adults. Therefore designers should focus on creating successful initial experiences.

10. Older adults tend to favour positive biases in their memory retention

11. Older adults consider the avoidance of errors to be *the* most important usability aspect. Above all older adults want to avoid a feeling of significant 'lostness' in the system when error recovery is not facilitated.

12. Cognitive accessibility has been defined by the following principles:
- Simple
- Consistent
- Clear
- Multi-modal
- Error-tolerant
- Attention-focusing

Are there other principles that you would add?

13. It is possible for older adults with cognitive decline to learn new skills and get better at using initially unfamiliar interfaces over time.

14. It is important for older adults with cognitive decline to encounter *as few challenges as possible* when using mobile user interfaces.

15. Simple, clear and visually beautiful design matters to most older adults.

16. A good way for designers to facilitate help for older adults with cognitive decline is through online help forums in which older users ask questions and designers contribute answers. This allows older adults to have their questions answered quickly and in the process lets designers better understand their users and refine their design skills.

17. Older adults with cognitive decline should have access to user-controlled preferences and settings in order to adapt the interface to their individual needs.

18. Older adults with cognitive decline should have the option to suppress details of the user interface that distract from the main content.

19. Older adults with cognitive decline would benefit from system initiatives that provide status information and remind / help recapture task context.

20. Mobile apps for older adults with cognitive decline should contain *actively relaxing elements that impart a sense of calm and tranquility.* Some examples may include: lots of white/negative space and calm music (with an easy on/off function).

21. Mobile apps for older adults with cognitive decline should contain *active cognitive engagement elements that involve and motivate users.* Examples might include: gamification techniques, badges, brain training elements, and embodied cognition techniques to help users work through, not just think through, actions.

22. Mobile apps for older adults with cognitive decline should contain *low to moderate cognitive challenges* that do not impact overall user experience. This is so that older adults with cognitive impairment can "train" their memory, attention and language skills etc. (and also enforce a sense of self-esteem and autonomy)

23. Do you believe that *active esteem elements that ensure older adults are able to communicate, speak, read and remain cognitively fit* are important design considerations when designing mobile applications for older adults with cognitive decline?

24. Do you believe that designs containing *self-actualization elements that help older adults remember who they were before their disease* are important for older adults with cognitive decline?

25. When designing mobile apps for older adults with cognitive decline, a *passive approach to relaxation is better than an active approach*. For example: avoiding distractions such as background noise or moving elements as opposed to actively trying to relax through use of calming colours or music etc.

26. A user interface with lots of negative space is best for older adults with cognitive decline.

27. Making an interface customizable should be a key user experience design consideration when designing mobile applications for older adults with cognitive decline.

28. Designers should err on the side of familiarity as opposed to uniqueness when designing mobile apps for older adults with cognitive decline.

On a scale of 1 to 7 where 1= not at all and 7 = very much, please rate the following:

29. Older adults in general, but especially older adults with cognitive decline, care about *unique and evocative* user experiences.

30. Older adults in general, but especially older adults with cognitive decline, care about *familiar and consistent* user experiences.

31. Older adults in general, but especially older adults with cognitive decline, care about digital experiences that are *credible and trust-worthy*.

32. Older adults in general, but especially older adults with cognitive decline, care about experiences that reinforce their *esteem and self-actualization*. Esteem needs include being able to communicate and speak, read, and remain cognitively fit. Self-actualization needs include remembering who they were before the disease.

33. Older adults with cognitive decline using technology vary in their needs and abilities.

34. Designers need to recognize the degree of variability that exists among older adults with cognitive decline and design for that variability.

35. Customizable interfaces are a good way to design for the various needs and abilities of older adults.

36. Designers of information technology need to recognize the degree to which individual context shapes the user experience of older adults with cognitive decline.

37. Can *gamification techniques* that use game thinking and game mechanics in non-game contexts to engage users in solving problems and increase users' self contributions work with older adults with cognitive decline to improve memory, attention and language-retention?

38. Can *embodied cognition* & brain training techniques that promote *working* through – not just thinking through – actions work with older adults with cognitive decline to improve memory, attention and language-retention in the context of mobile applications?

Please examine the following considerations for designing inclusive user experiences for older adults with cognitive decline

1) Pragmatic attributes (manipulation)

- # Content simplification (including visibility, transparency & attention-focusing elements. Avoiding abstract concepts or unfamiliar metaphors)
- # Layout simplification (including visibility, transparency & attention-focusing elements)
- # Interaction simplification (improving efficiency with which things get done; combats fatigue, inattention etc)
- # Human support network/help (aids in learning new skills, combats inability to make decisions etc; may include caregivers and family, designers, or just a human help function)
- # Flexible user-controlled preferences & options
- #Accessibility (relates to all of the above but also separate; includes multi-modal presentation of content, option to suppress details, and system initiatives that provide status information and remind of and help recapture task context)

2) Hedonic attributes (evocation, stimulation, identification)

- # Establishing credibility & trust (in new experiences) so that older adult users feel apps are designed with their wants & needs in mind
- # Familiarity & Consistency (closely related to trust) Keeping to a proven and understandable design language – not new for its own sake; avoiding frequent updates: increasing the perceived *stability* of the platform
- # Unique & evocative (important for good UX; however, must be carefully balanced with familiarity, credibility and trust)
- # Active relaxing elements (eases stress & helps improve memory & focus). Ex: some images, sounds and/or negative space can impart a sense of calm and tranquility. Design with mindfulness. Since context & accessibility are important considerations here, provide an easy on/off function

- # Active cognitive engagement elements (to inspire, involve, motivate). Ex: gamification techniques aimed to maximize a state of 'flow.' Embodied cognition: help users work through, not just think through, actions in order to improve memory (Brain Training)

- # Active esteem & self-actualization elements (Esteem needs include being able to communicate and speak, read, and remain cognitively fit. Self-actualization needs include remembering who they were before the disease)

39. Given the list of possible design considerations above, please rank the items in order of importance from 1= least important to 10= most important by numbering the boxes below.

[ ] Content and layout simplification
[ ] Interaction simplification
[ ] Help/human support networks
[ ] Flexible user-controlled preferences
[ ] Establishing credibility and trust in the overall experience
[ ] Familiarity and consistency in the overall experience
[ ] Uniqueness & evocativeness of the experience
[ ] Active relaxing elements in the interface and/or experience
[ ] Active cognitive engagement elements in the interface and/or experience
[ ] Active esteem & self-actualization elements in the interface and/or experience

40. Are there other considerations you feel should be included? What are they?

41. Are any of the above considerations unimportant or redundant? Which one(s)? Please explain.

42. Would you combine or reconfigure the list above? If so, how?

If you would like to elaborate on any of the topics covered in this questionnaire, the questionnaire itself, or the survey process, please use the space below. Thank you for your participation in Round 1.