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RESEARCH NOTE

# Assessing the Design Choices for Online Recommendation Agents for Older Adults: Older Does Not Always Mean Simpler Information Technology[1]

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*Grounded in the aging and complexity literature, this experimental study investigated the moderating role of individuals' cognitive age on the impact of recommendation agent (RA) comprehensiveness (i.e., amount of detail involved in using an RA) on users' perceptions regarding RA complexity and RA usefulness. An experiment involving 140 online shoppers was conducted to understand the experiences of cognitively younger and older adults while using low or high comprehensiveness RAs designed for this study. Results reveal the tension that exists for older adults when using highly comprehensive RAs, as they perceive them to be more complex but also more useful in providing recommended products. The finding that cognitively older adults perceive high comprehensiveness RAs to be more useful compared to low comprehensiveness RAs provides a novel insight to the information systems literature, as it is contrary to the prevalent belief that "the older the user, the simpler the information technology should be." Theoretically, this study improves our understanding of how increasing levels of RA comprehensiveness differentially affects the perceptions of RA complexity and RA usefulness of users of different cognitive ages. For practitioners, the results provide important guidelines about the kind of RA that is appropriate for consumers with different cognitive ages.*

**Keywords**: Recommendation agents (RAs), interface design, cognitive age, RA comprehensiveness, perceived RA complexity, perceived RA usefulness

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## Introduction

Recommendation agents (RAs) are software tools that support online shoppers by eliciting their preferences in products and consequently making appropriate recommendations that meet those preferences (Ansari et al. 2000; Xiao and Benbasat 2007; Xu et al. 2014). RAs play a critical role in reducing consumers' information overload perceptions and supporting them in making better online shopping decisions (Xu et al. 2014). Specifically, evidence from several studies shows that online RAs could help consumers examine, evaluate, and compare products (e.g., Komiak and Benbasat 2006; Wang and Benbasat 2009; Zhu et al. 2016).

Properly designed RAs are considered critical success factors for online vendors who are confronted with increasingly competitive pressures (Kamis and Stohr 2006; Palanivel and Sivakumar 2010; Xu et al. 2014). A poorly designed RA, on the other hand, could result in frustrated consumers (Gretzel and Fesenmaier 2006; Leavitt 2006), ultimately leading them to experience lower satisfaction with their online shopping experiences or to seek alternative channels to satisfy their needs (e.g., shopping offline) (Gourville and Soman 2005). This is especially the case for older adults, as they have limitations in their physical and cognitive abilities associated with the natural aging process (Kuo et al. 2012; Loiacono and Djamasbi 2013), and thus may face and perceive additional difficulties in using inappropriately designed online RAs (Carpenter and Yoon 2011; Ghasemaghaei et al. 2014; Kuo et al. 2012).

Consequently, the main objective of this study is to understand the differences in the perceptions of older and younger adults in terms of the usefulness and complexity of RAs when using RAs of different designs, namely, in the amount of detail provided by RAs in their interaction with users. Although this question has not yet been studied, the prevalent belief that one might have based on the commonly offered views in the literature on aging and information technology (IT) use is likely to be "the older the person, the simpler the IT should be" (Charness and Boot 2009, p. 2014; see also Selwyn et al. 2003; Worden et al. 1997). However, in this study, we leverage aging, cognitive complexity, and effort–accuracy theories, to advance an alternative view asserting that *older adults might in some cases find more complex IT to be more useful*. Our empirical study explores the tension that exists for older adults when using highly comprehensive RAs as they perceive them to be more complex but also more useful.

The study of the above objective is a novel one since most studies involving RAs and their design have focused on younger populations (e.g., university students) leading to a lack of understanding of the older adults' experience with using these important online decision aids (Kuo et al. 2012). The older adult population is rapidly increasing. According to a United Nations report, whereas only 5.2% of the population was over 65 in the year 1950, this percentage is projected to rise to 15.9% by 2050, and to 27.5% by 2150 (Baecker et al. 2012). Older adults are also the fastest growing segment of Internet users and they have a strong interest in making purchases online (Lian and Yen 2014). According to a Pew Research Center report (2015), while only 13% of older Americans (> 65 years) used the Internet in 2000, this percentage increased to 38% in 2008 and 58% in 2015 and will continue to increase significantly in the years to come. Thus, older adults are an important population segment for both Information Systems (IS) researchers and online retailers to consider. However, older adults have been neglected for years by online retailers (Lian and Yen 2014). As such, many older consumers are not satisfied with their online shopping experiences and they often give up before completing their purchasing transactions (Kuo et al. 2012). Studies have found that the main reason for this lack of satisfaction is frustration caused by difficulties encountered when using shopping websites. According to a recent report, only 28% of older adults click to purchase online products (Wallace 2017), while about 90% of younger adults purchase online products (Kerr and Castel 2016). Moreover, a recent report shows that only 26% of older adults are very confident in using computers to do their online shopping (Monica et al. 2017). Based on the Internet consumer behavioral model for the elderly (O'Keefe and McEachern 1998), Kuo et al. (2007) found that older consumers have serious difficulties in examining products and evaluating and comparing them to make online shopping decisions. Hence, a decision aid with an appropriate design could facilitate older adults' online shopping experiences (Kuo et al. 2012). In the IS literature, although it is found that such tools could indeed help younger consumers to examine, evaluate, and compare products, the support of these tools and the appropriate design for older consumers are still unknown (Kuo et al. 2012).

Given the quickly rising population of older adults and their strong interest in shopping online, they are highly likely to encounter and consider the use of the RAs offered on online shopping sites. Considering the high potential benefits associated with RA utilization to both users and to online stores, it is in the best interest of e-commerce websites that older adults adopt the use of RAs. However, due to the almost nonexistent research on this issue, how to design RAs to best suit older adults' needs is an unexplored question. This study is an attempt to address this "unknown" in the IS literature.

RAs vary in the amount of detail (or *comprehensiveness*) they provide in eliciting consumers' preferences and in presenting them with recommendations based on their preferences (Ghasemaghaei 2016; Xiao and Benbasat 2007). Compared to younger adults, older adults may perceive difficulties due to the increased complexity associated with using highly comprehensive RAs. This could be due to age-related changes in cognition and motor functioning in older adults, which may lead them to experience difficulties in using new technologies compared to their younger counterparts (Charness and Boot 2009). From that perspective, a poorly designed (e.g., overly complex) RA could end up exacerbating the problems of older adults in online environments. On the other hand, consumers may perceive highly comprehensive RAs to be more useful than low comprehensiveness RAs as the use of the former could help them find products that better match their detailed preferences (Xiao and Benbasat 2007). This could be especially true in the case of older adults, given their lower versatility in leveraging online resources to search for products and services that match their preferences on their own (Eastman and Iyer 2004). Therefore, although older users are likely to find the high comprehensiveness RA to be more complex compared to the low comprehensiveness RA, that complexity-usefulness trade-off could be worthwhile as the RA handles a lot of the additional mental processing involved.

In the IS literature, usually age has been measured as the number of years from birth (i.e., chronological age) without much attention to individuals' self-perceptions about their age (Hong et al. 2013). However, according to Sherman et al. (2001), "age is revealing itself to be more a state of mind than a physical state" (p. 188). Hong et al. (2013) found the self-perception of individuals' own age (i.e., cognitive age) to be a better predictor of their perceptions and behaviors toward using technology than their chronological age. For example, elderly people who perceive themselves to be younger are more likely to use the Internet (Eastman and Iyer 2004), tend to seek more information online, have lower anxiety toward new technology, and use more high-tech products (Chang 2008) compared to their counterparts who perceive themselves to be older (Ghasemaghaei 2016).

Further, in the online environment, many vendors ask consumers to provide their demographic data (e.g., age). However, previous studies argue that consumers often withhold their personal data or provide false data over privacy concerns (Dwyer et al. 2007; Feng and Xie 2014; Hoffman et al. 1999). This is because consumers consider such data to be sensitive information and that it could result in more unsolicited marketing (Xu et al. 2014). A recent report by Chahal (2015) found that 60% of consumers intentionally provide incorrect personal information online and that birth dates are the most commonly falsified data that consumers provide. Along the same lines, Jiang et al. (2013) argue that in the online environment, consumers may manipulate their anonymity status by concealing their demographic data (e.g., age) or by providing false data to maintain a sense of immunity and to lower their privacy concerns. The cognitive age measure, on the other hand, is less threatening to customers from a privacy perspective as it asks individuals to answer four simple questions related to their perceptions about their looks, feelings, actions, and interests relative to different age groups (Barak and Gould 1985; Barak and Schiffman 1981), as opposed to a specific question about their exact age or birth date. Therefore, (1) as many consumers provide inaccurate data about their chronological age in the online environment, (2) as cognitive age questions do not reveal consumers identity, and (3) as cognitive age is a better predictor of individuals' perceptions and behaviors, we utilize the cognitive age of users rather than their chronological age in this study.

In summary, this study investigates the yet unanswered question of evaluating the perceptions of cognitively older adults toward RA designs of different levels of comprehensiveness. The empirical findings of this study provide online RA designers with important guidelines that should be considered when designing RAs for different age groups.

## Theoretical Background

### *RA Comprehensiveness*

Xiao and Benbasat (2007) argue that RAs vary in the amount of detail (or comprehensiveness). In this study, we define RA comprehensiveness as the number of required product attributes elicited from users in the initial stage of using the RA, and the number of recommendations and associated product attributes presented to them in the final stage of using it. RAs with low levels of comprehensiveness ask consumers to provide only a few product attributes to understand their preferences and suggest a short list of recommended products with an associated small number of attributes for customers to compare simultaneously. On the other hand, RAs with high levels of comprehensiveness ask consumers to provide a higher number of product attributes to better understand their preferences and suggest a long list of recommended products with an associated larger number of attributes for customers to compare (Ghasemaghaei et al. 2014).

### *Aging and IT Use*

According to theories of psychological aging, older adults face limitations in their cognitive abilities (Kooij et al. 2008). Such limitations may cause older adults to experience difficulties when interacting with online interfaces and in making high quality decisions while using IT applications, including decisions made in online environments (Becker 2004). Below we examine three relevant aging theories: the resources, speed, and inhibition theories (Cabeza 2002).

First, the notion of reduced processing resources, which sometimes is referred to as attentional capacity, refers to the limited number of cognitive resources available for allocation to a given cognitive task (Balota et al. 2000; Kahneman 1973). Studies show that reduced attentional resources decrease older adults' ability to engage in more complex and cognitively demanding tasks (e.g., Craik and Byrd 1982; Salthouse 1982). Second, according to the processing speed theory, aging is associated with a decline in the speed with which information processing can be performed, and this decrease in speed leads to impairments in cognitive functioning (e.g., Birren et al. 1980; Cerella 1985; Salthouse 1996). Therefore, cognitive performance is degraded when information processing is slow because of declines in memory, whereby products of early processing stages might no longer be available in memory in later processing stages. Studies show that older adults take much longer than younger adults to accomplish different tasks (Brinley 1965). Third, age-related deficits in cognitive performance may also arise from a reduced efficiency in the ability to filter irrelevant information when focusing on the current task demands (e.g., Balota et al. 2000; Hartman and Hasher 1991; Hasher et al. 1991). Zacks (1989) suggests that older adults are more distracted by irrelevant information.

Because of age-related changes in cognition and in motor functioning, older adults often experience difficulty in using new technologies compared with their younger counterparts, and thus the use of new technologies becomes more challenging for this segment (Charness and Boot 2009). Page (2014) found that older adults remain slow at adapting to technologies, as they often feel anxiety in using them. Hence, more efforts should be directed toward making technologies simpler and easier for this age group (Czaja et al. 2006). Likewise, Chang (2013) found that compared to younger adults, older adults are more likely to have difficulties in recognizing and selecting wanted functions from different information displayed on screens of multifunctional devices (e.g., smartphones). Similarly, Kurniawan (2008) found that as older adults experience difficulty in different stages of interaction when using new technology, they often have to involve other people to help them to use such technologies. Hawley-Hague et al. (2014) also found that older adults have issues related to the use of information and communication technologies. Particularly, they found that technology needs to be simple to use, reliable, and tailored to older adults' needs; such findings have also been supported by many previous studies (e.g., Demiris et al. 2008; Demiris et al. 2004; Steele et al. 2009). Hence, based on the extant literature, it is generally believed that the older the user, the simpler the IT should be. Given this prevalent view, in this study, we wanted to explore whether this is also true in the case of online RAs.

## Measurement of Age

Chronological age and self-perceived age are two main approaches to measuring age (Hong et al. 2013). Chronological age (i.e., the number of years since birth) is a commonly used age measure, although no longer considered a good predictor of factors such as mental outlook and cognitive ability (Pesonen et al. 2015). Thus, despite its popularity in the IS literature, its use is problematic, especially for research focused on understanding the impacts of age on behavioral patterns of individuals (Hong et al. 2013).

Aging research suggests that most adults tend to feel younger than their chronological age, and such tendencies become more pronounced as they get older (Kastenbaum et al. 1972); this is supported by many studies (e.g., Barak and Gould 1985; Clark et al. 1999; Czaja et al. 2001). Lindberg et al. (2006) suggest that predictions regarding computer user performance should not be based solely on chronological age. As such, some research has focused on the subjective perception of how old a person feels as a measure of age (Barak 2009; Guido et al. 2014). Likewise, Barak and Schiffman (1981) suggest that individuals' behaviors may be based on perceived or felt age rather than their chronological age. C*ognitive age*, which refers to how old individuals are based on their self-perceptions regarding their looks, feelings, actions, and interests (Barak and Gould 1985; Barak and Schiffman 1981), has been the most commonly used self-perceived age measurement in consumer research (e.g., Hong et al. 2013; Hong et al. 2008; Underhill and Cadwell 1984; Wilkes 1992) and has been found to correlate well with chronological age (Sudbury-Riley et al. 2015; Wenzke 2014). Schwall et al. (2012) suggest that there are three subcategories of individual aging: biological, social, and psychological. They noted that cognitive age is a type of subjective age that considers all of these subcategories in computing one's age. Research has also shown that cognitive age has a good predictive validity as it can be more effective in (1) capturing older adults' lifestyles (Iyer et al. 2008), (2) explaining their choices (Ying and Yao 2010), and (3) predicting their purchases (Myers and Lumbers 2008) than other widely used variables such as education, income, and health (Guido et al. 2014). Further, recent findings suggest cognitive age is a better predictor of people's beliefs, attitudes, and behavior than chronological age (Teller et al. 2013). For example, Sudbury-Riley et al. (2015) argue that cognitive age may be more useful than chronological age when studying older adults' behavior and perceptions because aging does not occur in the same way for everyone. Further, Teller et al. (2013) argue that cognitive age is "a more accurate reflection of changes related to age and aging than chronological age" (p. 317). Therefore, cognitive age is arguably a more accurate predictor of people's beliefs, attitudes, and behavior than chronological age, since it reflects this nonconstant rate of aging more accurately (Moschis and Mathur 2006; Sherman et al. 2001). In the context of IT, studies suggest cognitive age is a better measure of age, compared to chronological age, for understanding consumers' behavior toward new IT (Chang 2008; Eastman and Iyer 2004; Ghasemaghaei 2016; Ghasemaghaei et al. 2014; Hong et al. 2013). Wenzke (2014) argues that those who feel cognitively young are more willing to test new things and are more likely to show innovative behavior.

Previous studies argue that individuals' perceptions about themselves have an impact on their attitudes and behaviors. For example, it is well established in the IS literature that self-efficacy (a self-perceived construct) has an impact on users' perceptions regarding their attitude toward and intention to use specific information technologies. Woodward and Wallston (1987) investigated the impact of individuals' age on their perceived self-efficacy and found self-efficacy perceptions were lower for individuals over 60 years of age. Along these lines and considering cognitive age, Bergland et al. (2014) found that individuals with lower cognitive age perceive higher self-efficacy in accomplishing their tasks compared to individuals with higher cognitive age. Likewise, Boehmer (2007) found that individuals with younger age identities (which is self-perceived age) reported higher levels of perceived self-efficacy compared to individuals with older age identities; this result is consistent with other previous studies (e.g., Infurna et al. 2010; Schafer and Shippee 2009; Stephan et al. 2012). In addition, Schafer and Shippee (2009) found that those individuals who perceive their age to be younger than their chronological age are more optimistic about their ability to maintain memory and other aspects of cognitive ability (e.g., memory performance).

*Cognitive age* is also found to be a better predictor than chronological age of one's declining *cognitive abilities*. Previous studies argue that individuals' cognition and cognitive abilities do not erode at a constant rate for all consumers as chronological age increases (Cole et al. 2008; Teller et al. 2013; Zeithaml and Gilly 1987). According to Teller et al. (2013), *chronological age* does not accurately reflect the changes in individuals' bodily systems that result in declines in physical and cognitive abilities with age. Cognitive age, on the other hand, takes into account such changes that occur over time to a more accurate degree (Moschis 2012; Teller et al. 2013). Previous studies found that individuals' cognitive age is a significant predictor of their cognitive ability, with cognitively younger age being predictive of better cognitive functioning (Kerr and Castel 2016; Kotter-Grühn et al. 2009). Particularly, studies argue that cognitively younger adults have better mental and physical functioning (Barak and Stern 1986; Barrett 2003; Geraci et al. 2017; Kotter-Grühn et al. 2009; Stephan et al. 2012) compared to those who report older cognitive ages. Stephan et al. (2014) found that older adults who report feeling relatively young show superior executive functioning and long-term memory performance compared to older adults who report feeling relatively older. In their study, they found that even after controlling for chronological age and levels of physical activity, individuals' cognitive age remained a significant predictor of executive functioning and memory performance. Similarly, Stephan et al. (2015) found that younger cognitive age is positively associated with superior immediate and delayed recall and superior memory performance, even after accounting for demographic and health variables. Stephan et al. (2014) argue that there are reasons to expect that individuals' cognitive age may be related to their cognition, given that it has been related to behavioral, psychosocial, and health-related processes that influence the rate of cognitive decline. Previous studies found a positive relationship between a younger cognitive age and memory self-efficacy (Stephan et al. 2012; Stephan et al. 2015). Moreover, health and lifestyle patterns are another argument in favor of the impact of individuals' cognitive age on their cognitive abilities. Particularly, individuals who feel younger than their chronological age are generally healthier and are less likely to suffer from chronic conditions, such as diabetes and hypertension (Demakakos et al. 2007). Therefore, these individuals with a younger cognitive age are more likely to engage in health-promoting behaviors, such as physical activity (Caudroit et al. 2012). Individuals with more active lifestyles generally perform better on cognitive ability testing, including memory and executive functioning (Kramer et al. 2006; Weuve et al. 2004).

To summarize, in this study we use cognitive age as a more appropriate measure to understand how age impacts consumers' experiences while using online RAs, rather than their chronological age, because, as mentioned above, many previous studies identified it as a better predictor of individuals' attitudes and behavior. It reflects an individuals' assessment of their own cognitive abilities, which in turn has an impact on their perceptions in relation to other perceived constructs used in this study (e.g., complexity, PU). Moreover, most consumers commonly provide falsified data for chronological age in the online environment (Chahal 2015), undermining the reliability of this age measure. Further, cognitive age correlates well with chronological age and *has been shown as a better predictor of declines in cognitive abilities* and associated changes in attitude.

### Effort–Accuracy Framework

According to the effort–accuracy framework proposed by Payne (1982), the main objectives of a decision maker are to minimize the cognitive effort and maximize the accuracy of decision making. As these objectives often conflict, this theory postulates that a consumer's decision-making process is often influenced by a trade-off between the effort required to make a decision and the accuracy of that decision whereby more accurate decisions come at the expense of more effort (Payne et al. 1993). The empirical research on the effort–accuracy framework suggests that people focus more on effort reduction rather than on accuracy improvement due to their cognitive limitations (Punj 2011). Todd and Benbasat (1991, 1992, 1999, 2000) conducted a series of studies investigating the choice behavior of decision makers when they use computer-based decision aids. They found that individuals use decision-aiding tools to maintain a low level of effort expenditure in their decision making. Particularly, they found that since online decision-aiding tools reduce some of the effort associated with applying decision strategies, decision makers are able to use more normative strategies that lead to more accurate decisions. In addition, they argue that as decision aids reduce decision making effort, it becomes possible for designers of these tools to alter the way in which information is processed. In the context of online RAs, studies have relied on the effort–accuracy framework to investigate the beneficial impact of RAs on decreasing the cognitive effort expended by users while also increasing the accuracy of their decision making (Benbasat and Todd 1996; Gretzel and Fesenmaier 2006; Häubl and Trifts 2000; Hostler et al. 2005).

The fundamental premise on which the effort–accuracy framework is based is that individuals have finite limits to process information at any given time. Therefore, if they are provided with too much information at a given time that exceeds their processing limits, information overload occurs, which increases the complexity perception of the decision-making process (Malhotra 1982). Thus, an individual could be viewed as a limited information-processing system (Newell et al. 1972). Further, according to the effort–accuracy framework, people often focus more on effort reduction in their information processing tasks, where they try to find ways (e.g., using online RAs) to decrease their overall effort and increase the accuracy of their decision making (Creyer et al. 1990). Complexity theory is also consistent with these views (Malhotra 1982). Therefore, in the context of this study, although older users are expected to find the high comprehensiveness RA to be more complex compared to the low comprehensiveness RA, this additional complexity could be worth their while considering the higher decision accuracy expected and especially since a lot of the additional mental processing required is handled by the RA in the processing stage of its operation. Hence, cognitively older adults may perceive the higher comprehensiveness RA to be more useful as it provides more complete information about the products they are seeking to purchase, and thus they do not have to put much effort into leveraging online resources on their own to search for the products that best match their preferences.

## Hypotheses Development

### RA Complexity Perceptions

Complexity is defined as "the degree to which an innovation is perceived as relatively difficult to understand and use" (Rogers and Shoemaker 1971, p. 180). This definition, and an accompanying measure, was used by Thompson et al. (1991) to understand the impact of individuals' complexity perceptions on perceived utilization of a new technology. Accordingly, in this research, we define RA complexity as the degree to which a user perceives the RA to be relatively difficult to understand and use.

Kieras and Polson (1985) proposed a cognitive complexity theory, which considers the cognitive complexity of the interaction between a device and a user. This theory explains users' difficulty in accepting and using a new technology due to the extraneous cognitive load they experience when using such a technology (Dean 2008). Cognitive load refers to "the mental resources a person has available for solving problems or completing tasks at a given time" (Oviatt 2006, p. 873). If the amount of information processing exceeds an individual's cognitive capacity, his/her attention to the task may get diluted (Kahneman 1973).

Wood (1986) argues that information cues, which refer to the pieces of information about the stimulus that a person should process in performing a task, are central to understanding perceived complexity. They note that the complexity perceptions of a particular task are related to the number of the distinct acts that need to be performed and the number of distinct information cues that should be processed in the performance of those acts. Likewise, Alvarez and Cavanagh (2004) argue that increasing the information load per object, as well as the number of objects in a task, increases complexity perceptions as individuals have limitations in their memory capacity. This relationship would be stronger for cognitively older adults since aging is generally associated with declines in cognitive and physical functioning (Teller et al. 2013).

Studies have argued that individuals' cognitive age is an important predictor of their cognitive ability, with cognitively younger age being predictive of better cognitive functioning (Kerr and Castel 2016; Kotter-Grühn et al. 2009). In general, cognitively younger adults have better mental and physical functioning (Barak and Stern 1986; Barrett 2003; Geraci et al. 2017; Kotter-Grühn et al. 2009; Stephan et al. 2012) compared to cognitively older adults. For example, Stephan et al. (2015) found that individuals with lower cognitive age have superior memory performance and higher immediate and delayed recall when they are performing a particular task. Similarly, Stephan et al. (2014) found that cognitively younger adults have superior executive functioning and memory performance compared to cognitively older adults. Thus, in the context of online RAs, when RAs provide information consisting of large amounts of text, cognitively older adults may experience higher levels of complexity compared to their cognitively younger counterparts. This is due to the extra time and effort it would take them to (1) respond to all the questions at the initial stage of using an RA and (2) analyze/compare the higher number of recommended alternatives with their more detailed specifications at the final stage.

Further, previous studies argue that individuals' perceptions about themselves have an impact on their attitudes and behaviors. For example, Bergland et al. (2014) found that individuals with lower cognitive age perceive higher self-efficacy in accomplishing their tasks compared to individuals with higher cognitive age. Moreover, Schafer and Shippee (2009) found that those individuals who perceive their age to be younger than their chronological age are more optimistic about their ability to maintain memory and other aspects of cognitive ability (e.g., memory performance). Hence, cognitively older adults are expected to experience higher perceptions of complexity while using RAs with a high level of comprehensiveness compared to their cognitively younger counterparts. Thus we hypothesize that

> **H1**: *Cognitive age moderates the effect of RA comprehensiveness on increasing perceived RA complexity, such that the effect is stronger for cognitively older adults.*

## RA Usefulness Perceptions

Perceived usefulness, in the context of IT use, is defined as the degree to which an individual believes that using a specific system would enhance her/his task performance (Davis 1989). In the context of this study, perceived usefulness refers to the degree to which a user believes an RA to be useful for his/her online shopping task. Previous studies argue that usefulness perception of an online RA is a critical factor in consumers' intention to adopt the RA (Benbasat and Wang 2005; Kowatsch and Maass 2010; Xiao and Benbasat 2007). In IT adoption models (e.g., TAM), IT acceptance is determined by salient beliefs (e.g., usefulness) (Benbasat and Wang 2005). Moreover, Kamis et al. (2008) found that perceived usefulness of an online RA leads to consumers' intention to return to a website. In addition, Kowatsch and Maass (2010) found that the usefulness perception of an online RA impacts individuals' intention to use an RA, and their intention to purchase after using it. Therefore, as RA usefulness perception is considered a critical factor in positively impacting consumers' behavior in their online shopping behavior, in this study, we investigate the moderating impact of cognitive age on the impact of RA comprehensiveness on RA usefulness perception.

There are two competing lines of reasoning about the moderating impact of cognitive age on the effect of RA comprehensiveness on perceived usefulness. The first is that a highly comprehensive RA provides a large amount of detail in eliciting consumers' preferences and in presenting the recommendations to the users, which increases users' cognitive effort. As previously mentioned, individuals' cognitive age is a significant predictor of their cognitive ability, with cognitively younger age being predictive of better cognitive functioning (Kerr and Castel 2016; Kotter-Grühn et al. 2009). Mata et al. (2007) suggest that offering different choices, as is the case with highly comprehensive RAs, can increase information overload perceptions and cause confusion for cognitively older adults. Thus, compared to cognitively younger adults, they may not be able to process fully all the detailed information provided by highly comprehensive RAs and as a result may perceive these RAs to be less useful.

However, and importantly, according to a second and opposing line of thought, high comprehensiveness RAs are likely to provide more detailed support compared to low comprehensiveness RAs by eliciting a larger set of attributes from the users about their needs and thus providing a potentially better and larger set of advice concerning best fitting products for the user. Further, some of the additional effort that is associated with this comprehensiveness will be assumed by the RA itself, since searching the product base and determining if these products are a good match with the attribute values (needs) identified by the users will be automated by the RA. As a consequence, a more comprehensive analysis would require some effort on the part of the user, who will answer additional needs-identifying questions, but the bulk and complex part of the processing for matching products will be handled by the RA, culminating in exploring and finding more suitable (i.e., best fitting) products. To recap, this higher total effort will lead to higher accuracy as predicted by the effort–accuracy framework (Hostler et al. 2005; Payne et al. 1993; Todd and Benbasat 1991). From this perspective, while still perceiving higher complexity than their younger counterparts, cognitively older adults are more in need of, and could benefit more from using, highly comprehensive RAs compared to their cognitively younger counterparts, who would not benefit as much from the additional support given by such RAs since, based on the cognitive age literature, they have more processing ability (Stephan et al. 2014) and thus are more capable of finding the best fitting products even on their own. On the other hand, cognitively older adults may find highly comprehensive RAs to be more useful compared to less comprehensive RAs, given their lower versatility in leveraging online resources to search for products that best match their preferences and needs on their own. Thus, on the balance of the above arguments we hypothesize that

> **H2**: *Cognitive age moderates the effect of RA comprehensiveness on increasing perceived RA usefulness, such that the effect is stronger for cognitively older adults.*

## Research Methodology

### *Recommendation Agents (RAs)*

In this study, experimental RAs were designed to help participants in choosing a car to purchase. This product was selected because it has many product attributes, requires strong consumer involvement in the purchasing process, and is a product of interest to both younger and older adults (Lambert-Pandraud et al. 2005).

Based on our survey of commercial RAs used for shopping for cars online, we selected a well-known RA (www.MyProductAdvisor.com), which was used in several other research studies (e.g., Aljukhadar and Senecal 2011), to form the basis of the two RAs designed for this experimental study. The designed RAs (shown in Appendix A) were further fine-tuned through a pilot study involving 50 participants. To minimize any confounding effects due to brand or design elements, both RAs focused on the same car brand (Toyota was chosen in this case). As shown in Table 1, the RAs exhibited different levels of comprehensiveness. Miller (1956) found that people could concurrently hold 7 ± 2 chunks of information in their working memory, which formed the basis for our choice of the number of attributes for the low and high comprehensiveness treatments for the designed RAs. Thus, we expect that subjects will experience significantly different perceptions regarding RA comprehensiveness between the low and high treatments shown in Table 1.

### *Experimental Procedures, Incentives, and Participants*

Participants were general online shoppers from Canada and the United States recruited through a market research firm. Each participant had a chance to win one of the five monthly $1000 prizes that were awarded by the research firm in exchange for participation. To motivate participants to take the experimental task seriously, they were informed that 25% of them would get an additional reward from $10 to $50 based on their performance (prior to the experiment, participants were informed that they would be asked to provide justifications for their car selection decisions and their performance would be examined based on how convincing their justifications were in supporting their decisions). Participants were randomly assigned to one of the two experimental RA treatments (i.e., low or high comprehensiveness RA) and asked to use their assigned RA to complete the car-shopping task. They were then directed to respond to the cognitive age questions and complete the survey instrument.

### *Measurements of Variables*

In order to ensure content validity, previously validated instruments were used to measure constructs in this study. As shown in Appendix B,[2] perceived complexity was measured using the four-item scale from Thompson et al. (1991), and perceived usefulness was measured using the four-item scale from Hassanein and Head (2007). Scales were slightly adapted to reflect the context of this study. RA comprehensiveness was coded as a dummy variable (i.e., 1 for low and 2 for high comprehensiveness). Age was measured using a cognitive age scale based on Barak and Schiffman (1981), as shown in Table 2. Barak and Schiffman measured individuals' cognitive age as the average of the midpoint values of the four age dimensions. In that paper, the items achieved an internal consistency reliability score of 0.86. Thus we used this method to compute cognitive age. Studies have found that the four questions of the cognitive age scale are very easy for respondents to understand and answer (Stephens 1991), and they are valid, reliable, and globally usable (Kohlbacher and Chéron 2012). In this study, seven potentially relevant control variables were also included in the survey, including participant's interest in purchasing a car, participant's knowledge about cars in general, an individual's education level, user RA experience, gender, Web experience, and task complexity.

[2]The scale for perceived behavioral intention (BI) is also included in Appendix B as the impact of PU and complexity perceptions on BI is examined later in the *post hoc* analyses section. In addition, the validity and reliability of BI are also included in the construct validation section.

**Table 1. RA Design**

| | Low Comprehensiveness RA | High Comprehensiveness RA |
|---|---|---|
| Number of product attributes elicited | 8 attributes | 29 attributes |
| Number of recommendations and number of associated attributes | 5 recommendations and 8 attributes for each recommendation | 8 recommendations and 29 attributes for each recommendation |

**Table 2. Cognitive Age Scale (Barak and Schiffman 1981)**

| | 20s | 30s | 40s | 50s | 60s | 70s | 80s | 90s |
|---|---|---|---|---|---|---|---|---|
| I FEEL as though I am in my | | | | | | | | |
| I LOOK as though I am in my | | | | | | | | |
| I DO most things as though I were in my | | | | | | | | |
| My INTERESTS are mostly those of a person in his/her | | | | | | | | |

## Data Analysis and Results

### *Sample*

To ensure that we had enough cognitively younger and cognitively older adults in our sample, we initially approached 300 participants. Out of these 300 participants, 273 provided usable data. These 273 online shoppers, of which 52% were males, had an average chronological age of 54.8 and an average cognitive age of 43.8 years. The statistical distribution of cognitive age relative to chronological age is shown in Appendix C.

To support our analysis of the moderating impact of cognitive age on the relation between RA comprehensiveness and RA complexity (H1), as well as RA comprehensiveness and RA perceived usefulness (H2), participants were asked to respond to the cognitive age scale questions. Based on their responses, each participant's cognitive age was computed. For the purposes of this analysis, we focused on comparing two specific cognitive age groups. The first group consisted of cognitively younger adults ($20 \leq$ cognitive age $\leq 30$) while the second group consisted of cognitively older adults (cognitive age $\geq 60$). These two ranges of cognitive age were chosen for this analysis since, according to Tucker-Drob and Salthouse (2008), the cognitive abilities of individuals belonging to these two groups chronologically are markedly different, with the younger group exhibiting significantly higher cognitive abilities compared to the older group. These differences are expected to still be present when comparing these groups on a cognitive age basis, as the chronologically older group will still be cognitively much older than the younger group (Hong et al. 2013). Based on the responses of our sample of 273 participants to the cognitive age scale, 85 participants ended up being classified as cognitively younger adults while 55 were classified as cognitively older adults.

### *Manipulation Check*

After the experimental task was completed (using an RA with either low or high comprehensiveness), each participant was asked to respond to the following two questions using a five-point Likert scale (very low to very high):

(1) Please indicate your perceptions regarding the number of product attributes and the level of detail associated with each attribute at the stage where the RA elicited your preferences for the car attributes you are looking for.

(2) Please indicate your perceptions regarding the number of recommendations and the number of associated product attributes at the stage where the RA recommendations were presented to you.

For the first question, participants who used the low comprehensiveness RA reported a mean of 2.68 (standard deviation of 1.76), whereas participants who used the high comprehensiveness RA reported a mean of 3.51 (standard deviation of 1.68). This difference was significant (one-way ANOVA, $p < 0.001$). For the second question, participants who used the low comprehensiveness RA reported a mean of 2.64 (standard deviation of 1.77) on manipulation check question, whereas participants who used the high comprehensiveness RA reported a mean of 3.43 (standard deviation of 1.74). This difference was also significant (one-way ANOVA, $p < 0.001$). Hence, our manipulation of RA comprehensiveness was successful.

### *Construct Validation*

To evaluate the measurement item reliability, the loadings of each measurement item on its intended construct were assessed and compared with the recommended tolerance of 0.70 (Chin 1998) (see Appendix D). As Table D1 shows, all indicators loaded most highly on their own theoretically assigned construct, and at a minimum threshold of 0.70. Gefen and Straub (2005) suggest that "loadings of the measurement items on their assigned latent variables should be an order of magnitude larger than any other loading" (p. 93) and the difference should be at least 0.10. As shown in Appendix D, this criterion was also met.

As can be seen in Table 3, to demonstrate the internal consistency of the constructs, the composite reliability and Cronbach's alpha were calculated for each construct across our sample of cognitively younger and older adults ($n = 140$). As shown in Table 3, all constructs met the recommended tolerance of being higher than 0.70 (Fornell and Larcker 1981). In Table 3, the diagonal elements show the square roots of the average variance extracted (AVE) of variables, and the off-diagonal numbers represent the correlation between variables. According to Barclay et al. (1995), to have adequate discriminant validity, the square root of the AVE of a construct must be larger than the correlation between that construct and any other construct. As shown in Table 3, all variable pairs met this requirement. Table 4 shows the means and standard deviations of the variables.

## *Tests of the Moderation Hypotheses*

To test the moderating impact of cognitive age on the relation between RA comprehensiveness and RA complexity (H1), as well as RA comprehensiveness and RA perceived usefulness (H2), ANOVA analyses were conducted to understand whether any differences exist between cognitively older and younger adults' perceptions following a $2 \times 2$ factorial design (i.e., low cognitive age (between 20 and 30)/high cognitive age (above 60) × low RA comprehensiveness/high RA comprehensiveness) (Box et al. 1978). First, we conducted a multivariate analysis of variance (MANOVA) on both perceived PU and perceived complexity together. Pillai's trace test revealed a significant main effect of RA comprehensiveness ($p < 0.001$) as well as a significant interaction effect between RA comprehensiveness and cognitive age ($p < 0.001$). Then, we conducted follow-up ANOVAs to test the effects on perceived PU and perceived complexity separately. Repeated measure ANOVA on RA complexity perception as well as RA usefulness perception yields the significant effects of RA comprehensiveness, cognitive age, and the interaction between RA comprehensiveness and cognitive age (see Tables 5 and 6).

We also conducted multiple comparison analyses to assess whether different results would be obtained in individuals' RA complexity and usefulness perceptions when cognitively older and younger adults use RAs with low or high levels of comprehensiveness. The results of these analyses are shown in Figures 1 and 2. As hypothesized, cognitive age was found to moderate the relationship between RA comprehensiveness and complexity such that the effect is stronger for cognitively older adults. Therefore, H1 was supported. Interestingly, cognitive age was also found to moderate the relationship between RA comprehensiveness and perceived RA usefulness such that the relation is stronger for cognitively older adults. Therefore, H2 was also supported. For cognitively younger adults, RA comprehensiveness has no significant impact on their perceptions of RA usefulness and complexity. On the other hand, cognitively older adults perceived the high comprehensiveness RA to be significantly more complex, and interestingly more useful. Finally, results also showed that the control variables did not significantly influence the dependent variables in our study (i.e., PU and Complexity).

## *Post Hoc Analyses*

### Impact of RA Complexity and Usefulness on Behavioral Intention

We also used Smart PLS (Ringle et al. 2005) to investigate the impact of RA complexity and RA usefulness on users' intention to use the online RA in their future online shopping (BI). We found that, while the impact of RA usefulness (PU) on behavioral intention is highly significant ($\beta = 0.815$; $p < 0.001$), the impact of RA complexity on intention is marginally significant[3] ($\beta = -0.078$; $p < 0.1$). However, when we only consider the impact of perceived complexity on BI in the absence of PU, this relationship becomes significant ($\beta = -0.344$; $p < 0.001$). This is consistent with previous studies (e.g., Jiang and Benbasat 2007; Morris and Venkatesh 2000; Steelman et al. 2014), which found that PU has the dominant impact on BI.

### Comparing Cognitive Versus Chronological Age

We conducted an ANOVA analysis to assess whether different results would be obtained if *chronological age* was used instead of cognitive age in terms of the differences in individuals' overall complexity perceptions when they use RAs with low or high levels of comprehensiveness. Using similar groups to those used in our cognitive age analysis (i.e., younger adults (20–30) and older adults (60+)), results showed that the interaction between chronological age and

[3]Recent IS literature has referred to ($0.05 < p < 0.10$) as "modest" or of "marginal" significance (e.g., Dimoka et al. 2012)

| Table 3. Internal Consistency and Discriminant Validity of Constructs | | | | | | | |
|---|---|---|---|---|---|---|---|
| | CR | CA | COA | COM | PU | RC | BI |
| Cognitive Age (COA) | 0.98 | 0.98 | **0.95** | | | | |
| Complexity (COM) | 0.94 | 0.91 | 0.63 | **0.79** | | | |
| Usefulness (PU) | 0.97 | 0.96 | -0.31 | -0.28 | **0.89** | | |
| RA Comprehensiveness (RC) | 1.00 | 1.00 | -0.002 | 0.23 | 0.26 | **1.00** | |
| Behavioral Intention (BI) | 0.98 | 0.97 | -0.28 | -0.29 | 0.80 | 0.20 | **0.96** |

**Note**: Composite reliability = CR; Cronbach's alpha = CA; diagonal elements are the square root of AVE.

| Table 4. Descriptive Statistics with Means and Standard Deviations (SD) | | | | | | |
|---|---|---|---|---|---|---|
| Groups | Complexity | | Usefulness | | Behavioral Intention | |
| | Mean | SD | Mean | SD | Mean | SD |
| Low (n = 72) | 1.77 | 0.8 | 4.83 | 1.4 | 4.62 | 1.62 |
| High (n = 68) | 2.26 | 1.1 | 5.53 | 1.08 | 5.23 | 1.24 |
| Total Sample (n = 140) | 2.01 | 1.03 | 5.17 | 1.32 | 4.92 | 1.48 |

Low: RA low comprehensiveness; High: RA high comprehensiveness
**Note:** All measures were based on seven-point Likert scales ranging from "strongly disagree" (1) to "strongly agree"(7).

| Table 5. ANOVA Summary Table for Perceived RA Complexity | | | | |
|---|---|---|---|---|
| Source | df | Mean Square | F | Sig. |
| Intercept | 1 | 625.63 | 1267.00 | 0.000 |
| RA Comprehensiveness | 1 | 11.86 | 24.02 | 0.000 |
| Cognitive Age | 1 | 63.76 | 129.1 | 0.000 |
| RA Comprehensiveness × Cognitive Age | 1 | 11.24 | 22.76 | **0.000** |
| Error | 136 | 0.49 | | |
| Total | 140 | | | |

| Table 6. ANOVA Summary Table for Perceived RA Usefulness | | | | |
|---|---|---|---|---|
| Source | df | Mean Square | F | Sig. |
| Intercept | | 3447.57 | 2550.754 | 0.000 |
| RA Comprehensiveness | 1 | 24.077 | 17.814 | 0.000 |
| Cognitive Age | 1 | 28.162 | 20.836 | 0.000 |
| RA Comprehensiveness × Cognitive Age | 1 | 14.719 | 10.890 | **0.000** |
| Error | 136 | 1.35 | | |
| Total | 140 | | | |

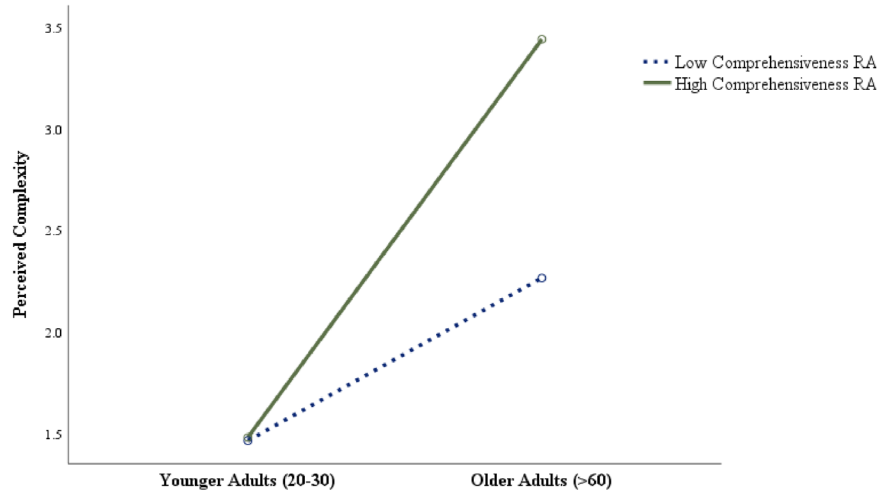


**Figure 1. Interaction Effect between Cognitive Age and RA Level of Comprehensiveness on Perceived Complexity**

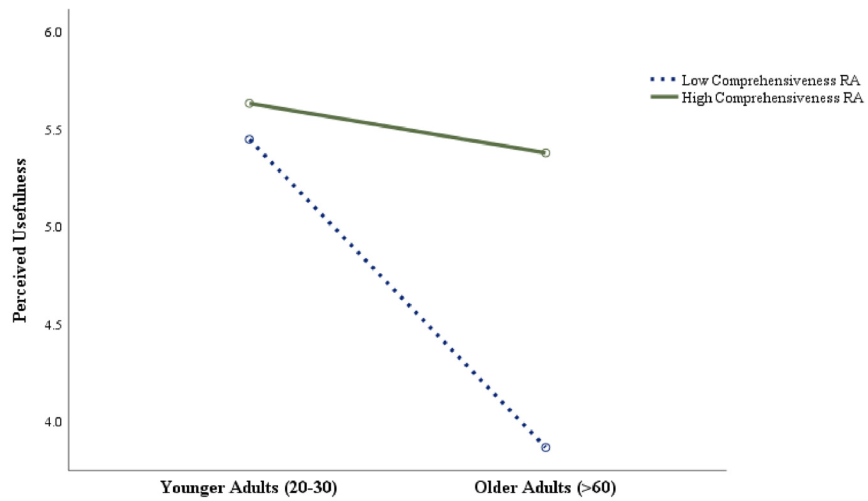


**Figure 2 Interaction Effect between Cognitive Age and RA Level of Comprehensiveness on Perceived Usefulness**

RA comprehensiveness on users' overall complexity is *not* significant ($p > 0.05$), which is contrary to the results obtained for cognitive age, which showed that cognitively older adults found the high comprehensiveness RA to be more complex than the low comprehensiveness RA, compared to cognitively younger adults. Hence, the results obtained with cognitive age are more consistent with aging theories, which assert that older adults should experience more complexity when using technology than younger adults, lending support to cognitive age being a better predictor of users' beliefs regarding RAs than their chronological age. This result is consistent with previous studies that argue that *chronological* age does not accurately reflect the changes in individuals' bodily systems that result in declines in physical and cognitive abilities with age (Teller et al. 2013). According to previous studies, cognitive age is more useful than chronological age when studying older adults' behavior and perceptions because aging does not occur in the same way for everyone (Moschis and Mathur 2006; Sudbury-Riley et al. 2015; Teller et al. 2013).

## Contributions, Limitations, and Future Research

### *Theoretical Contributions*

This study contributes to the literature by analyzing how different levels of RA comprehensiveness (low or high) influence the complexity and usefulness perceptions for users with different cognitive ages. As expected, cognitive age was found to moderate the relationship between RA comprehensiveness and complexity perceptions such that the effect is stronger for cognitively older adults. Interestingly, and importantly, contrary to the prevalent belief in the literature that the older the person, the simpler the IT should be, cognitive age was found to moderate the relationship between RA comprehensiveness and perceived RA usefulness such that the relationship is stronger for cognitively older adults. Hence, unlike cognitively younger adults, cognitively older adults perceive significantly more complexity while using high comprehensiveness RAs compared to lower comprehensiveness RAs. They also perceive RAs with higher comprehensiveness as being significantly more useful.

The higher complexity perceptions are explained by the facts that (1) individuals' cognitive age is an important predictor of their cognitive ability, with cognitively younger age being predictive of better cognitive functioning (Kerr and Castel 2016; Kotter-Grühn et al. 2009), which in turn will lower users' perceptions of RA complexity, and (2) individuals who perceive their age to be younger than their chronological age are more optimistic about their ability to maintain memory and other aspects of cognitive ability (Schafer and Shippee 2009), which will impact their perceptions of their abilities to use information technologies (e.g., RAs). This, in turn, will affect their perceptions of RA complexity. The higher usefulness perceptions arise from the greater need cognitively older adults have for RAs owing to their cognitive limitations. Therefore, although cognitively older RA users find the high comprehensiveness RA to be more complex compared to the low comprehensiveness RA, this additional complexity could be worth their while. This makes sense considering the higher decision quality they perceive in return for this complexity and especially since a lot of the additional mental processing required is handled by the RA in the processing stage of its operation.

This research also responds to Tams et al.'s (2014) call for studies examining the emerging importance of studying age-related impacts on IS phenomena. Further, recent findings suggest cognitive age is a better age measure for understanding consumers' behavior toward IT (here RAs) (Hong et al. 2013). This is also consistent with our ANOVA findings that show that the results obtained with cognitive age are more consistent with aging theories lending support to its being a better predictor of users' beliefs regarding RA complexity than the chronological age. Thus, as opposed to most IS studies focusing on the role of age in technology adoption, in this study, individuals' cognitive age was used rather than simply their chronological age.

In summary, the population of older adults is rapidly increasing, and they are the fastest growing segment of Internet users and have a strong interest in shopping online (Lian and Yen 2014). However, this user segment has difficulties in examining products and evaluating and comparing them to make effective online shopping decisions (Kuo et al. 2007). Appropriately designed decision aids, such as RAs, could facilitate older adults' online shopping experiences (Kuo et al. 2012). However, extant RA studies (e.g., Benbasat and Wang 2005; Komiak and Benbasat 2006; Xu et al. 2014) have examined RA interfaces focusing mainly on younger adults. We addressed this knowledge gap by applying aging and effort–accuracy theories to explain how users' cognitive age moderates the impact of RA comprehensiveness on their RA usefulness and complexity perceptions while they are shopping for online products. Particularly, in this study, we identified the tension that exists for older adults when using highly comprehensive RAs, as they perceive them to be more complex on the one hand, but also more useful on the other. In so doing we advance the RA literature by considering the impact of users' cognitive age on the design of the RA interface.

### *Practical Contributions*

This study also has significant implications for practitioners. Particularly, the results of this study clearly reveal that both cognitively young and old users find the more comprehensive RA to be more useful than the low comprehensive RA. In particular, the finding that cognitively older adults perceive the high comprehensiveness RA to be more useful compared to the low comprehensiveness RA provides a novel insight. Given that our *post hoc* analysis reveals that perceived usefulness is the most dominant factor affecting users' intentions to use online RAs, our recommendation to online vendors is that, as opposed to the predominant belief that they should provide older adults with the simpler IT, they should provide the more comprehensive RA on their websites, as it is the more useful option for all age groups and the one likely to lead to intention to use the RA. From a user's perspective, the use of the high comprehensive RA could help them find products that better match their detailed preferences. This could be especially important for cognitively older adults, as they have lower versatility in searching and finding appropriate online information on their own. Users who are more satisfied with the products they purchase due to making better decisions using more comprehensive RAs are likely to be more loyal and provide repeat business and positive word of mouth for their online vendors.

### Limitations and Future Research

This study was conducted in a context in which participants assessed an online RA in the pre-adoption stage. As participants become more familiar with the RA, it is possible that the perceptions of certain elements of complexity (e.g., the learning dimension) of an RA will be reduced in the post-adoption stage. Thus, research is required to further assess the importance of different factors in post-adoption perceptions toward online RAs and whether the effects of such factors differ by age. Second, in this study, we captured the impacts of diminishing physical and cognitive abilities implicitly through measuring individuals' cognitive age. Future research could explore the value of measuring individuals' actual physical and cognitive limitations through appropriate cognitive tests to objectively determine their abilities, and use that to understand their experience with RA use, instead of using cognitive age as a proxy for such abilities. However, this approach does not lend itself to a practical implementation in eCommerce settings. Third, previous research has shown affective factors (e.g., enjoyment) to impact the user experience in eCommerce environments. Studies argue that affective factors may influence online shopping decision making, as the psychological state of "flow" is a characteristic of online settings (Punj 2012). Moreover, affective factors can have a significant role in individuals' motivation and intention toward performing a task (Zhang 2013). While such factors were outside the main focus of this study, future research could explore how such factors might influence the experience of users of different cognitive ages with RAs with different comprehensiveness levels. Finally, the results of this study showed that in the context of online shopping decision making, while comprehensive RAs increase complexity perceptions, they also increase usefulness perceptions of the RAs among cognitively older users. Future studies should investigate whether the results of this study could be generalized to all information systems, or only those focused on product purchasing. Particularly, future studies could examine the associations we study here in other contexts (e.g., organizational context) using other types of decision support tools. Moreover, the task of purchasing a car is a complex task (Tsekouras and Li 2015) and, thus, consumers may find the high comprehensiveness RA to be more useful than the low comprehensiveness RA, as a lot of mental processing is handled by the RA. However, in the case of tasks with a lower level of complexity (e.g., purchasing a computer keyboard), consumers may find the low comprehensiveness RA to be equally useful to the high comprehensiveness RA, as they do not need to process a large amount of information to make their purchasing decisions. Therefore, future studies could assess whether individuals' perceptions would be different when they are involved in a shopping task having a lower level of complexity.

## Conclusions

This study addresses an important gap in the IS literature in terms of understanding the role of aging on the impact of RA comprehensiveness on users' perceived RA complexity and usefulness, a novel aspect not previously considered in RA research. The use of individual cognitive age as a measure of age sheds light on how users' self-perceived age impacts their perceptions in using online RAs. The study also explored the tension that exists for older adults when using highly comprehensive RAs, as they perceive them to be more complex but also more useful. This finding provides a novel insight in the IS literature, as it is contrary to the predominant recommendation to provide older users IT with simpler designs. These results are particularly timely and important given the fast-growing older adult segment of IT users in most developed countries.

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MIS Quarterly

RESEARCH NOTE

# ASSESSING THE DESIGN CHOICES FOR ONLINE RECOMMENDATION AGENTS FOR OLDER ADULTS: OLDER DOES NOT ALWAYS MEAN SIMPLER INFORMATION TECHNOLOGY

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# Appendix A

## Low-Comprehensiveness and High-Comprehensiveness RAs

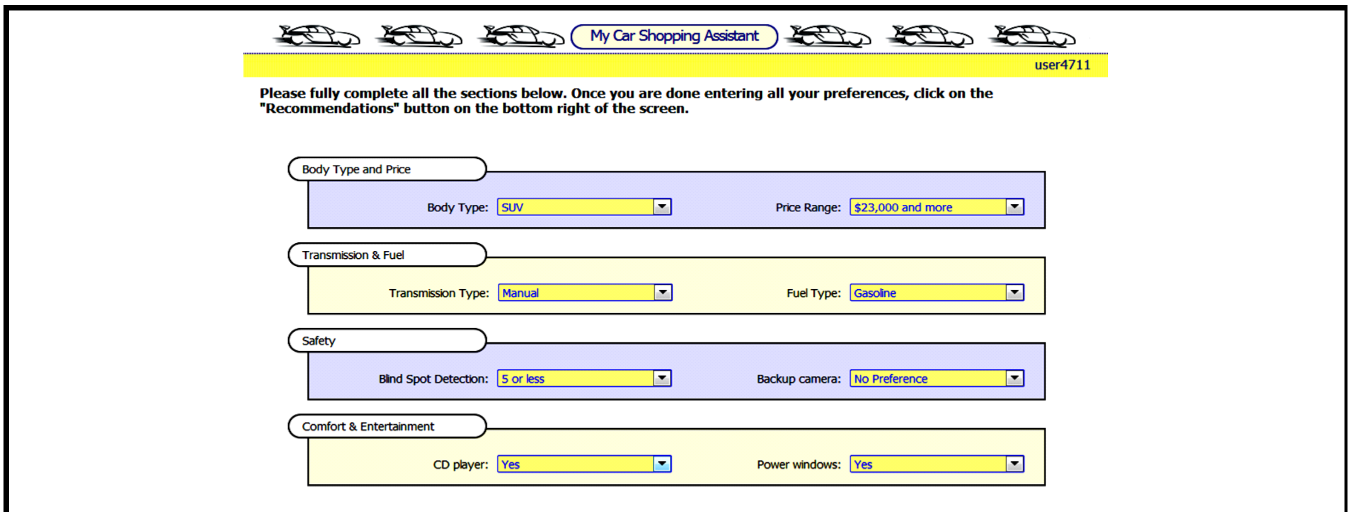



Figure A1. Screen Shot of the Low-Comprehensiveness RA in the Preferences' Gathering Stage

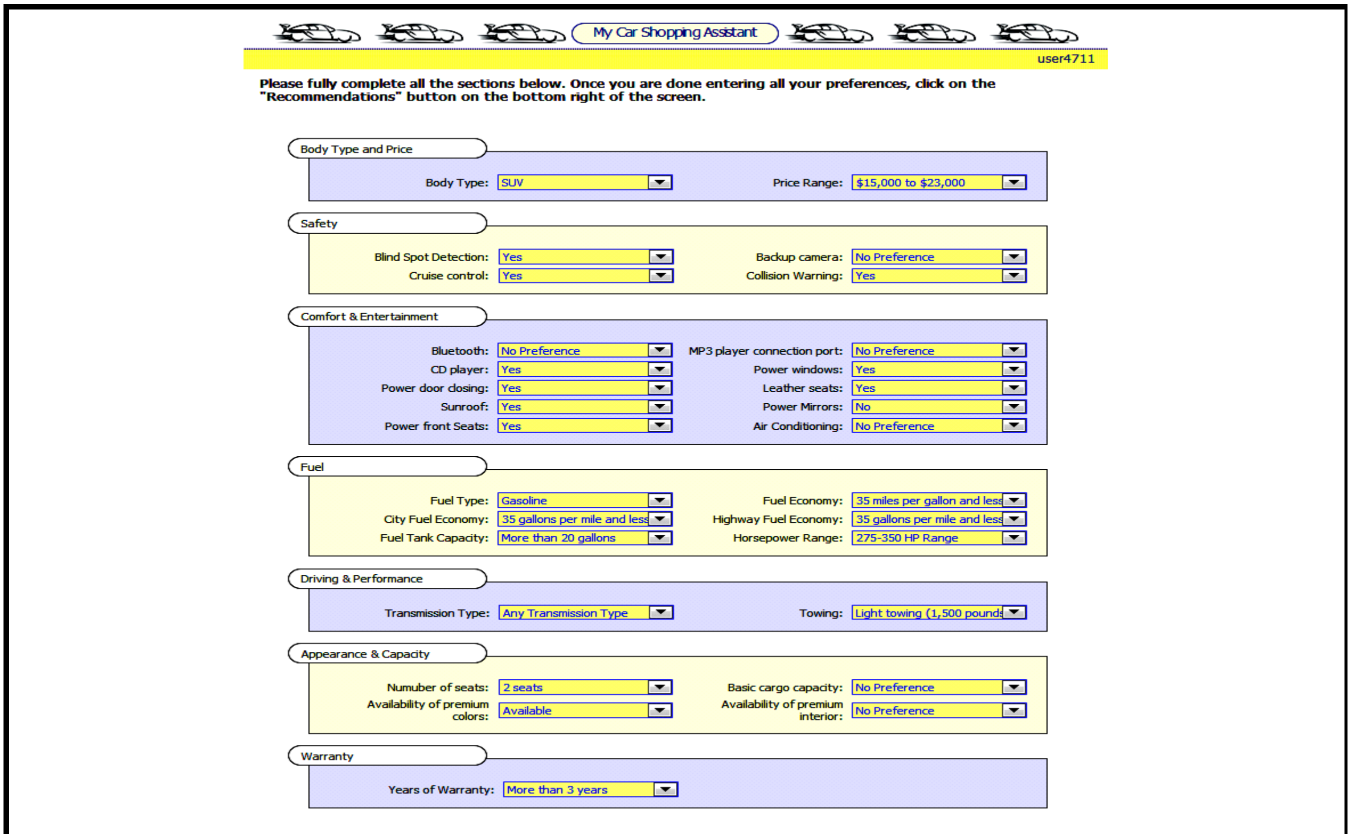



**Figure A2. Screen Shot of the High-Comprehensiveness RA in the Preferences' Gathering Stage**

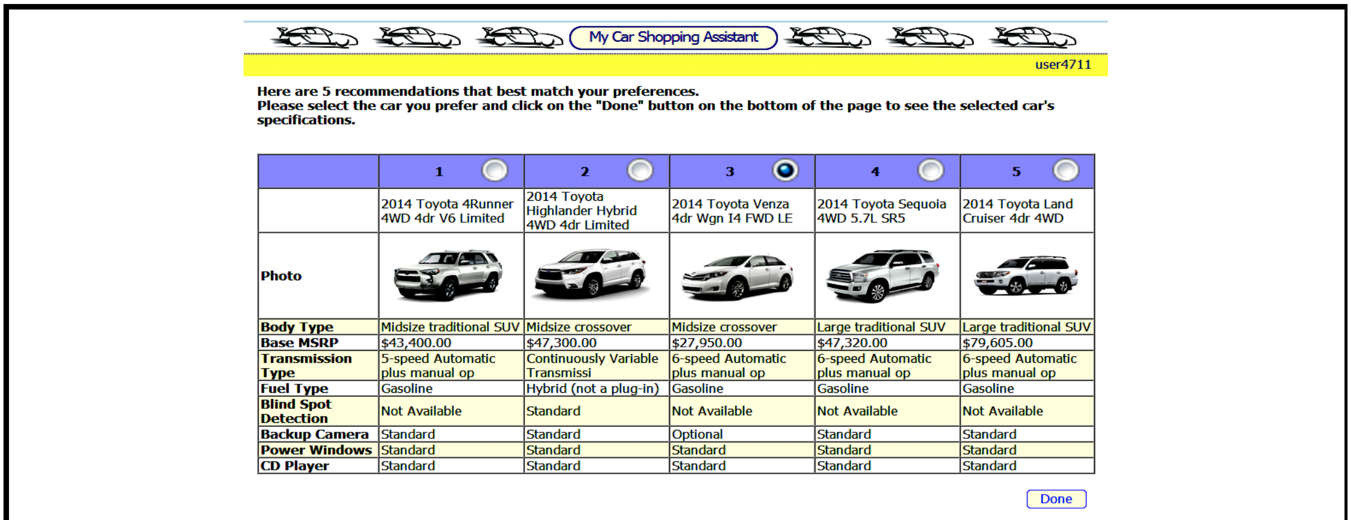
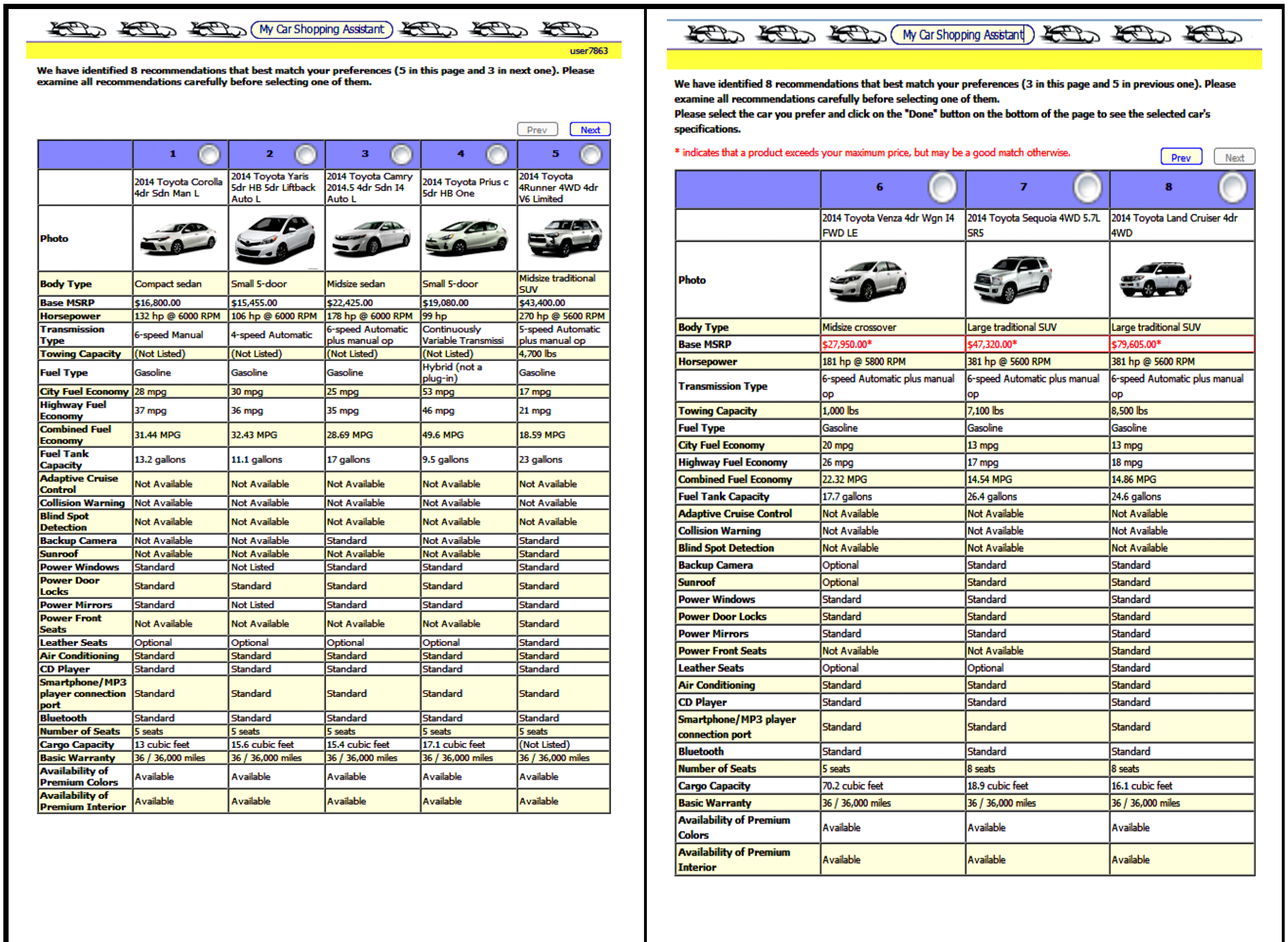



**Figure A3. Screen Shot of the Low-Comprehensiveness RA in the Recommendations Stage**



My Car Shopping Assistant

user7863

We have identified 8 recommendations that best match your preferences (5 in this page and 3 in next one). Please examine all recommendations carefully before selecting one of them.

Prev Next

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| | 2014 Toyota Corolla 4dr Sdn Man L | 2014 Toyota Yaris 5dr HB 5dr Liftback Auto L | 2014 Toyota Camry 2014.5 4dr Sdn I4 Auto L | 2014 Toyota Prius c 5dr HB One | 2014 Toyota 4Runner 4WD 4dr V6 Limited |
| **Photo** | | | | | |
| **Body Type** | Compact sedan | Small 5-door | Midsize sedan | Small 5-door | Midsize traditional SUV |
| **Base MSRP** | $16,800.00 | $15,455.00 | $22,425.00 | $19,080.00 | $43,400.00 |
| **Horsepower** | 132 hp @ 6000 RPM | 106 hp @ 6000 RPM | 178 hp @ 6000 RPM | 99 hp | 270 hp @ 5600 RPM |
| **Transmission Type** | 6-speed Manual | 4-speed Automatic | 6-speed Automatic plus manual op | Continuously Variable Transmissi | 5-speed Automatic plus manual op |
| **Towing Capacity** | (Not Listed) | (Not Listed) | (Not Listed) | (Not Listed) | 4,700 lbs |
| **Fuel Type** | Gasoline | Gasoline | Gasoline | Hybrid (not a plug-in) | Gasoline |
| **City Fuel Economy** | 28 mpg | 30 mpg | 25 mpg | 53 mpg | 17 mpg |
| **Highway Fuel Economy** | 37 mpg | 36 mpg | 35 mpg | 46 mpg | 21 mpg |
| **Combined Fuel Economy** | 31.44 MPG | 32.43 MPG | 28.69 MPG | 49.6 MPG | 18.59 MPG |
| **Fuel Tank Capacity** | 13.2 gallons | 11.1 gallons | 17 gallons | 9.5 gallons | 23 gallons |
| **Adaptive Cruise Control** | Not Available | Not Available | Not Available | Not Available | Not Available |
| **Collision Warning** | Not Available | Not Available | Not Available | Not Available | Not Available |
| **Blind Spot Detection** | Not Available | Not Available | Not Available | Not Available | Not Available |
| **Backup Camera** | Not Available | Not Available | Standard | Not Available | Standard |
| **Sunroof** | Not Available | Not Available | Not Available | Not Available | Standard |
| **Power Windows** | Standard | Not Listed | Standard | Standard | Standard |
| **Power Door Locks** | Standard | Standard | Standard | Standard | Standard |
| **Power Mirrors** | Standard | Not Listed | Standard | Standard | Standard |
| **Power Front Seats** | Not Available | Not Available | Not Available | Not Available | Standard |
| **Leather Seats** | Optional | Optional | Optional | Optional | Standard |
| **Air Conditioning** | Standard | Standard | Standard | Standard | Standard |
| **CD Player** | Standard | Standard | Standard | Standard | Standard |
| **Smartphone/MP3 player connection port** | Standard | Standard | Standard | Standard | Standard |
| **Bluetooth** | Standard | Standard | Standard | Standard | Standard |
| **Number of Seats** | 5 seats | 5 seats | 5 seats | 5 seats | 5 seats |
| **Cargo Capacity** | 13 cubic feet | 15.6 cubic feet | 15.4 cubic feet | 17.1 cubic feet | (Not Listed) |
| **Basic Warranty** | 36 / 36,000 miles | 36 / 36,000 miles | 36 / 36,000 miles | 36 / 36,000 miles | 36 / 36,000 miles |
| **Availability of Premium Colors** | Available | Available | Available | Available | Available |
| **Availability of Premium Interior** | Available | Available | Available | Available | Available |

My Car Shopping Assistant

We have identified 8 recommendations that best match your preferences (3 in this page and 5 in previous one). Please examine all recommendations carefully before selecting one of them.
Please select the car you prefer and click on the "Done" button on the bottom of the page to see the selected car's specifications.

* indicates that a product exceeds your maximum price, but may be a good match otherwise.

Prev Next

| | 6 | 7 | 8 |
|---|---|---|---|
| | 2014 Toyota Venza 4dr Wgn I4 FWD LE | 2014 Toyota Sequoia 4WD 5.7L SR5 | 2014 Toyota Land Cruiser 4dr 4WD |
| **Photo** | | | |
| **Body Type** | Midsize crossover | Large traditional SUV | Large traditional SUV |
| **Base MSRP** | $27,950.00* | $47,320.00* | $79,605.00* |
| **Horsepower** | 181 hp @ 5800 RPM | 381 hp @ 5600 RPM | 381 hp @ 5600 RPM |
| **Transmission Type** | 6-speed Automatic plus manual op | 6-speed Automatic plus manual op | 6-speed Automatic plus manual op |
| **Towing Capacity** | 1,000 lbs | 7,100 lbs | 8,500 lbs |
| **Fuel Type** | Gasoline | Gasoline | Gasoline |
| **City Fuel Economy** | 20 mpg | 13 mpg | 13 mpg |
| **Highway Fuel Economy** | 26 mpg | 17 mpg | 18 mpg |
| **Combined Fuel Economy** | 22.32 MPG | 14.54 MPG | 14.86 MPG |
| **Fuel Tank Capacity** | 17.7 gallons | 26.4 gallons | 24.6 gallons |
| **Adaptive Cruise Control** | Not Available | Not Available | Not Available |
| **Collision Warning** | Not Available | Not Available | Not Available |
| **Blind Spot Detection** | Not Available | Not Available | Not Available |
| **Backup Camera** | Optional | Standard | Standard |
| **Sunroof** | Optional | Standard | Standard |
| **Power Windows** | Standard | Standard | Standard |
| **Power Door Locks** | Standard | Standard | Standard |
| **Power Mirrors** | Standard | Standard | Standard |
| **Power Front Seats** | Not Available | Not Available | Standard |
| **Leather Seats** | Optional | Optional | Standard |
| **Air Conditioning** | Standard | Standard | Standard |
| **CD Player** | Standard | Standard | Standard |
| **Smartphone/MP3 player connection port** | Standard | Standard | Standard |
| **Bluetooth** | Standard | Standard | Standard |
| **Number of Seats** | 5 seats | 8 seats | 8 seats |
| **Cargo Capacity** | 70.2 cubic feet | 18.9 cubic feet | 16.1 cubic feet |
| **Basic Warranty** | 36 / 36,000 miles | 36 / 36,000 miles | 36 / 36,000 miles |
| **Availability of Premium Colors** | Available | Available | Available |
| **Availability of Premium Interior** | Available | Available | Available |

**Figure A4. Screen Shot of the High-Comprehensiveness RA in the Recommendations Stage**

# Appendix B

## Measurement Items of the Dependent Variables

**Table B1. Measurement Items of the Dependent Variables**

| Construct Names | Measurement Items (7-point scale) | Sources |
|---|---|---|
| Perceived Complexity | • Using this recommendation agent would take too much time.<br>• Working with this recommendation agent seems so complicated; it would be difficult to understand what is going on.<br>• Using this recommendation agent involves too much time doing mechanical operations (e.g., data input).<br>• It would take too long to learn how to use this recommendation agent to make it worth the effort. | Thompson et al. (1991) |
| Perceived Usefulness | • This recommendation agent provides good quality information for my online shopping task.<br>• This recommendation agent improves my performance in my online shopping task.<br>• This recommendation agent increases my effectiveness for shopping online.<br>• Overall, this recommendation agent is useful for online shopping. | Hassanein and Head (2007) |
| Behavioral Intention to Use an RA | • Assuming I had access to this recommendation agent while shopping online, I intend to use it.<br>• Assuming I had access to this recommendation agent while shopping online, I predict that I would use it.<br>• Assuming I had access to this recommendation agent while shopping online, I plan to use it. | Wang and Benbasat (2009) |

# Appendix C

## Group Comparisons between Cognitive Versus Chronological Age

Figure C1 shows the distribution of participants' cognitive and chronological age. In this study, the average of participants' chronological age and cognitive age was 54.8 (SD: 18) and 43.8 (SD: 15.2) years, respectively.

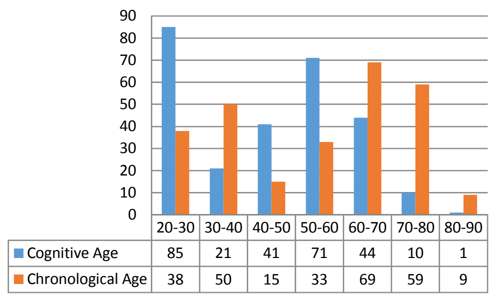



**Figure C1. Distribution of Participants' Cognitive and Chronological Age**

As can be seen in Table C1, there is a positive association between chronological and cognitive age. Further, and as expected, when individuals become older (> 60 chronological years), they tend to feel younger than their chronological age, with most individuals feeling they are 10 years younger on average than their chronological age.

**Table C1. Chronological Age Versus Cognitive Age**

| | Cognitive Age | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Chronological Age Group** | **20-30** | **30-40** | **40-50** | **50-60** | **60-70** | **70-80** | **80-90** | **Total** |
| 20-30 | 36 | 2 | | | | | | **38** |
| 30-40 | 40 | 6 | 3 | 1 | | | | **50** |
| 40-50 | 5 | 3 | 7 | | | | | **15** |
| 50-60 | 4 | 8 | 8 | 13 | | | | **33** |
| 60-70 | | 2 | 19 | 28 | 19 | 1 | | **69** |
| 70-80 | | | 3 | 28 | 23 | 5 | | **59** |
| 80-90 | | | 1 | 1 | 2 | 4 | 1 | **9** |
| **Total** | **85** | **21** | **41** | **71** | **44** | **10** | **1** | **273** |

# Appendix D

## Loading and Cross Loading of Measures

**Table D1. Loading and Cross Loading of Measures**

| | BI | COM | PU |
|---|---|---|---|
| Behavioral Intention (BI1) | **0.9621** | -0.2566 | 0.8165 |
| Behavioral Intention (BI2) | **0.9785** | -0.3042 | 0.8171 |
| Behavioral Intention (BI3) | **0.9771** | -0.3074 | 0.8168 |
| Complexity (COM1) | -0.4084 | **0.7721** | -0.3819 |
| Complexity (COM2) | -0.1665 | **0.9332** | -0.1609 |
| Complexity (COM3) | -0.232 | **0.9212** | -0.2057 |
| Complexity (COM4) | -0.2754 | **0.9255** | -0.2766 |
| Usefulness (PU1) | 0.7629 | -0.2868 | **0.9188** |
| Usefulness (PU2) | 0.7989 | -0.2765 | **0.9456** |
| Usefulness (PU3) | 0.8002 | -0.2294 | **0.9517** |
| Usefulness (PU4) | 0.8081 | -0.2726 | **0.9586** |

**Note**: As cognitive age and RA comprehensiveness are single-item measures that results in loadings of 1.000, they were not included in this analysis.

### *References*

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