

Intention to Use Recommendation Agents for Online Shopping: The Role of Cognitive Age and Agent Complexity

Research-in-Progress

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Abstract

Online recommendation agents (RAs) are increasingly being made available to consumers to facilitate their online shopping decision making. However, some customers may perceive difficulty in using online RAs if they are too complex, particularly older adults who experience limitations in their cognitive abilities. Grounded in the theory of reasoned action, and the aging and information systems adoption literatures, this study proposes a theoretical model to explore the effects of cognitive age and RA complexity on consumers' intentions to use RAs. An experimental design and research methodology are outlined to validate the proposed model and identify differences between the experiences of younger and older adults in using RAs based on their cognitive age.

Keywords: E-Commerce, cognitive age, recommendation agents, complexity, intention to use

Introduction

Older adults are the fastest growing segment of Internet users (Nam et al. 2007). They have a strong interest in making purchases; however, they have been neglected for years by vendors. The lack of attention to this rapidly growing consumer segment¹ has led to reduced purchasing opportunities for older adults, as well as decreased business revenues for online vendors (Nam et al. 2007). Theories of psychological aging emphasize that older adults face limitations due to the natural aging process (Uechi 2010). Such limitations result in difficulties for older adults in using information technologies and in making high quality decisions in the online environment (Becker 2004; Chattaraman et al. 2011). Thus, these limitations should be taken into account when designing information systems (IS) for this important segment.

Despite its importance in technology adoption and use, age has received little attention in IS research (Hong et al. 2013; Braun 2013). Hence, in this study, we will investigate how age is an important consideration in the design of consumer support technologies. More specifically, we will conduct this investigation in the context of B2C e-commerce and product recommendation agents. Online recommendation agents (RAs) are online-based software tools that support online shoppers by eliciting their preferences for products and make appropriate recommendations accordingly (Ansari et al. 2000). RAs operate in three stages: input stage (consumers' preferences are elicited); process stage (recommendations are generated); and output stage (recommendations are presented) (Xiao and Benbasat 2007). Studies show that consumers have become much more reliant on RAs to help them with their shopping decisions (Xiao & Benbasat 2007). However, some consumers may perceive difficulty in using online RAs with a high degree of complexity. This is especially the case for older adults who experience limitations in their cognitive abilities which are expected to manifest the most during the input and output stages of RA use, as this is where most of the interaction with the user takes place.

IS studies (e.g., Venkatesh et al. 2003; Venkatesh et al. 2012) have mainly explored the moderating effects of age on the interactions between different variables such as behavioral intention and its antecedents. In these studies, age has mainly been measured as the number of years from birth (i.e. chronological age) without much attention to individual self-perceptions about their age (Hong et al. 2013). According to Schiffman and Sherman (1991, p. 188), "[A]ge is revealing itself to be more a state of mind than a physical state." Studies show that it is the self-perception of individuals' own age (i.e. cognitive age) rather than mere chronological age that influences their behaviors towards technology (Hong et al. 2013).

Previous studies have investigated the effects of RAs on consumer experiences in online shopping environments. For example, Komiak and Benbasat (2006) explored the effects of perceived personalization and familiarity on the intention to adopt an RA. Swaminathan (2003) studied the impact of RAs on consumer decision making while considering the moderating roles of category risk, product complexity, and consumer knowledge. However, no studies have examined the role of consumer cognitive age as well as the impact of the complexity of RAs on an individual's online shopping experience. Thus, there is a need for additional research in this area, especially in terms of customizing these agents for specific e-commerce consumer segments such as older adults. Therefore, the key objective of this study is to understand the impact of cognitive age and RA complexity on consumers' intention to use RAs in their online shopping decision making. Hence, the main research questions for this study are **RQ1**: How does cognitive age impact the antecedents of user intentions to use RAs?; **RQ2**: How does RA complexity impact the antecedents of user intentions to use RAs?; and **RQ3**: How do the perceptions of users of RAs of different complexity vary between younger and older adults?

Literature Review and Theoretical Development

Aging

There are three popular 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,

¹ The United Nations report that whereas 5.2% of the population was over 65 in the year 1950, this percentage is projected to rise to 15.9% by 2050, to 27.5% by 2150, and to 32.3% by 2300 (Baecker et al. 2012).

refers to the limited amount of cognitive resources available for allocation for a given cognitive task (Kahneman 1973). Studies show that reduced attentional resources decrease older adults' ability to engage in more complex and cognitive demanding tasks (Salthouse 1982). Second, aging is associated with a decline in the speed with which processing can be executed, and this decrease in speed leads to impairments in cognitive functioning (Balota et al. 2000). Third, age related deficits in cognitive performance may also arise from a reduced efficiency in the ability to inhibit irrelevant information to the current task demands (Balota et al. 2000).

Chronological age which refers to the number of years a person has lived is a useful age measure (Visvabharathy 1982), however, it is no longer considered a good predictor of factors such as mental outlook and cognitive ability (Barak and Gould 1985). Thus, despite the great popularity of chronological age, its use is problematic for researchers interested in age-related research that evaluates the behavioral patterns of individuals (Hong et al. 2013). As discussed by Hong et al (2013), the use of chronological age limits our understanding of the role of individuals' age in technology acceptance and use, as there may be an increasingly wide range of variation in the perception of age amongst individuals with the same chronological age (Salkowitz 2008). Lindberg et al. (2006) suggest that as computer performance among individuals has been shown to vary widely, predictions regarding user performance should not be based only on chronological age. As such, some research attention has focused on the subjective perception of how old one feels (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. Three main concepts of self-perceived age could be identified from the literature on aging: i) cognitive age, which refers to how old individuals are based on their self perceptions regarding their looks, feels, acts, and interests (Barak and Gould 1985); ii) comparative or relative age, which refers to whether individuals feel the same, older, or younger than most other people with the same chronological age; and iii) ideal age, which refers to "an individual's ideal age-role self-concept: the age he/she considers to be a person's ideal age, expressed in years" (Barak and Gould 1985, p. 53). These alternative measurements of age enable a better understanding of the individuals' attitudes and behaviors. Among these self-perceived age concepts, cognitive age has been the most commonly used in consumer research and it has been found to impact consumers' behaviors (Barak and Gould 1985). To measure an individual's cognitive age, Barak and Schiffman (1981) asked subjects to indicate which age decade (e.g., 20s, 30s, 40s, 50s, 60s, 70s, 80s, or 90s) best described their perceptions of themselves in terms of do-age (how involved a person is in doing "things" that are favored by members of a certain age group), feel-age (how old a person feels), interest-age (how similar an individual's interests are to members of a certain age group), and look-age (how old a person looks). Schwall et al. (2012) suggest that there are three subcategories of individual aging: biological (i.e., individual's physiological capabilities which captures senescing, the aging of the body), social (i.e., social roles and habits), and psychological (i.e., individual's ability to adapt behavior to the demands of the environment (e.g., expectation to retire)). They noted that cognitive age is a type of subjective age which considers all these subcategories in computing individual age.

Cognitive age has been used and validated in consumer research (e.g., Underhill and Cadwell 1984; Wilkes 1992; Hong et al. 2013) as well as in aging research (e.g., Neugarten and Hagestad 1976; Baum and Boxley 1983). Aging research suggests that most adults tend to feel younger than their chronological age and such tendencies become more pronounced as individuals get older (Kastenbaum et al. 1972), which is supported by many studies (e.g., Barak and Gould 1985; Clark et al. 1999). In addition, consumer research has shown that cognitive age influences individuals purchasing behaviors (Sherman et al. 2001; Hong et al. 2013). For example, Yoon et al. (2005) found that compared to chronological age, cognitive age can provide a better insight into consumer behaviors, as it can affect decision processes more than chronological age. Moreover, Iyer et al. (2008) found that older consumers whose cognitive age is significantly lower than their chronological age are an attractive segment to purchase online products.

Cognitive age can help to understand variances in IT-related phenomena that remain unexplained when relying merely on chronological age measures (Hong et al. 2013). Much evidence exists from psychology and consumer behavior regarding the problems of assuming the same attitudes and characteristics of individuals with the same chronological age (Barak and Schiffman 1981; Neugarten and Hagestad 1976; Sherman et al. 2001). Therefore, IS research should also take into account individuals' cognitive ages to gain deeper understandings regarding individual behaviours with IT beyond what was explained by chronological age. Hong and Tam (2006) suggest that using cognitive age as a basis for customer personalization and segmentation can help practitioners to better understand what consumers really

need. Moreover, Hong et al. (2013) suggest that designers can also gain further insights into individual needs through the concept of cognitive age.

As online RAs increasingly becoming available to consumers to facilitate their online shopping decision making (Leavitt, 2006; Xiao and Benbasat, 2007; Wang and Benbasat, 2009), it is important to understand the influence of individual self-perceptions with regard to aging on the use of RAs. Thus, in this study, the impact of self-perceived age on users' behavioral intentions to use RAs to support their decision making in online shopping tasks is considered. As cognitive age provides better insights into consumer behaviors, it is utilized as an effective measure of self-perceived age.

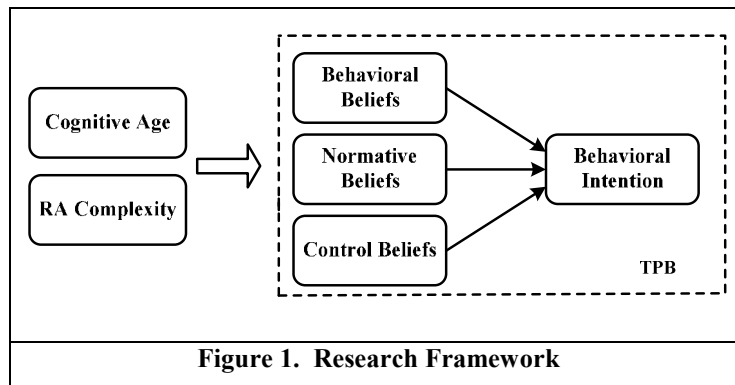
Complexity

Complexity is defined as “the degree to which an innovation is perceived as relatively difficult to understand and use” (Rogers 1995, p. 242). Kieras and Polson (1985) proposed a Cognitive Complexity Theory, which considers the cognitive complexity of the interaction between the device and user. Dean (2008) suggests that Cognitive Complexity Theory helps explain user difficulty in accepting and using new technology. One important issue throughout the discussion of human-centered design principles is a focus on reducing perceived complexity and the extraneous cognitive load that users experience with a new technology. 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). Thus, if the amount of information processing exceeds an individual's cognitive capacity, his/her attention to the task may get diluted (Kahneman 1973). Further, Cognitive Load Theory (WM Van Gerven 2000) which is mainly concerned with the limitations of human working-memory capacity suggests optimizing “schema acquisition by stimulating an efficient use of working memory” (p. 16).

Research Framework and Research Model

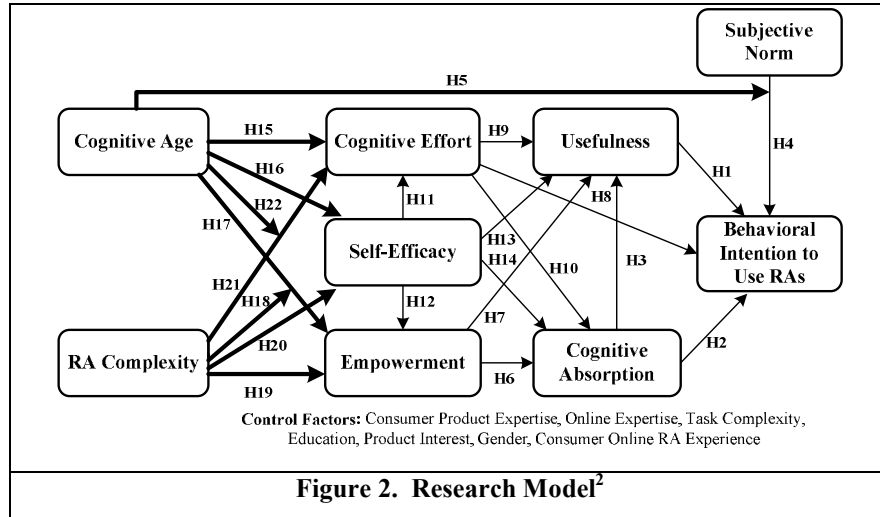
The Theory of Planned Behavior (TPB) (Ajzen 1991) has been widely used to understand user intentions to use information technologies (IT) (e.g., TAM). Several studies (e.g., Morris and Venkatesh 2000; Morris et al. 2005) have used TPB as their base framework to evaluate individual behavioral intention. For example, Morris and Venkatesh (2000) used TPB to understand the impact of age in an organizational setting. Accordingly, as shown in Figure 1, this theory is utilized as the main research framework for the theoretical development of a model to understand the influence of cognitive age and RA complexity on consumer intentions to use RAs (an information technology).

TPB suggests that salient beliefs about an individual's attitude toward a specific behavior be considered as relevant to the particular behavior. Davis (1989) proposed two constructs in the Technology Acceptance Model (TAM) as salient beliefs: perceived usefulness (PU) and perceived ease of use (PEOU). According to TPB, a variety of other salient beliefs can be applicable depending on the specific context of IT use (Benbasat and Barki 2007). Accordingly, perceived cognitive absorption (Agarwal and Karahanna 2000) is included as another salient belief in the research model (Figure 2) to cover the hedonic motivational aspect of online shopping (Childers et al. 2002) while being supported by an RA.



Further, according to Cognitive Complexity (Kieras and Polson 1985) and Cognitive Load (WM Van Gerven 2000) Theories, it is argued that to use RAs, users need to expend cognitive effort which would be

increased when using complex RAs compared to simple ones. Thus, perceived cognitive effort is included in the research model of Figure 2 instead of PEOU in TAM as it is a more appropriate construct for the context of this study since it captures elements that go beyond the initial phase of learning how to use an RA. Prior research has shown that perceived behavioral control has two distinct dimensions: empowerment, a similar concept to controllability (external control factor), and self-efficacy (internal control factor) (Tang et al. 2010). Thus, the impact of these two dimensions on consumer intention to use RAs is also considered.



Hypotheses Development

Behavioral Intention: Based on Fishbein and Ajzen’s (1975) definition, behavioral intention (BI) in this paper is a measure of the strength of a user’s willingness to use RAs while shopping online. BI to use a particular system is deemed critical in the acceptance and use of new technology (Venkatesh et al. 2003), and hence, this construct is selected as the endogenous variable for this study.

Usefulness: Perceived usefulness (PU) is defined as the “degree to which a person believes that using a particular system would enhance his job performance” (Davis 1989, p. 320). In the context of this study, PU refers to the degree to which a user believes an RA to be useful for her/his shopping task. Many studies have found a positive relationship between PU and BI (e.g., Mathieson 1991; Adams et al. 1992; Agarwal and Karahanna 2000). Thus, we hypothesize that **H1:** *Higher perceived usefulness of an RA positively influences intentions to use the RA.*

Cognitive Absorption: Cognitive absorption refers to the “state of deep involvement with software” (Agarwal and Karahanna 2000, p. 665) which derives its theoretical bases from work in individual psychology, particularly, research related to a personality trait dimension called absorption (Tellegen 1982), the notion of cognitive engagement (Webster and Ho 1997), and the state of flow (Csikszentmihalyi et al. 2004). In a state of cognitive absorption, a person derives pleasure and enjoyment from his/her interactions with the system. Through this enjoyment dimension, cognitive absorption has been found to positively affect PU and BI (Agarwal and Karahanna 2000). Thus, we hypothesize that **H2:** *Higher perceived cognitive absorption while using an RA positively influences intentions to use the RA;* and **H3:** *Higher perceived cognitive absorption while using an RA positively influences perceived usefulness of the RA.*

Subjective Norm: Subjective norm is defined as “the perceived social pressure to perform or not to perform the behavior” (Ajzen 1991, p. 188), which is a critical factor in predicting an individual’s intention to use a system (Venkatesh and Bala 2008; Tan et al. 2012). Older adults have a considerably lower need for autonomy than younger adults (Feingold 1993). Thus, normative influences are more important in

² The bold arrows in Figure 2 indicate the main focus of this study.

understanding the behavior of older adults (Morris et al. 2005). Thus, we hypothesize that **H4**: *Higher perceived subjective norm in using RAs positively influences intentions to use the RA*; and **H5**: *Cognitive age moderates the effect of subjective norm on intention to use an RA, such that the effect is stronger for older adults*.

Empowerment: Empowered individuals are expected to feel a sense of control in accomplishing their tasks (Pires et al. 2006). Studies show that empowerment enhances individuals' engagement in their tasks (Roth 1994) which is expected to enhance their cognitive absorption. Sandhu and Corbitt (2003) suggest that perceiving a sense of control (i.e. perceived empowerment) in accomplishing online tasks positively affects consumers PU of a website. Thus, we hypothesize that **H6**: *Higher perceived empowerment while using an RA positively influences users' perceived cognitive absorption*; and **H7**: *Higher perceived empowerment while using an RA positively influences users' perceived usefulness of the RA*.

Cognitive Effort: Cognitive effort is defined as "the amount of available attentional capacity allocated to a specific process at a given instant" (Tyler et al. 1979, p. 607). Studies have found that effort is an important factor influencing users' intentions to use decision aids (Wang and Benbasat 2009). Furthermore, Davis (1989) identified the amount of effort required in using a system as a negative predictor for PU. Studies show that increasing cognitive effort in accomplishing a task results in disrupting positive mood by generating negative affect in individuals (Garbarino and Edell 1997). Thus, RAs that require a high level of cognitive effort may decrease an individual's cognitive absorption, as they result in negative effect. Thus, we hypothesize that **H8**: *Higher perceived cognitive effort while using an RA negatively influences intentions to use the RA*; **H9**: *Higher perceived cognitive effort while using an RA negatively influences users' perceived usefulness of the RA*; and **H10**: *Higher perceived cognitive effort while using an RA negatively influences users' perceived cognitive absorption*.

Self-Efficacy: Self-efficacy refers to the "belief in one's capabilities to organize and execute the courses of action required to produce given attainments" (Bandura 1997, p. 3). Prior studies have found that a strong sense of self-efficacy results in individuals perceiving themselves to have exerted less cognitive effort than those with a lower sense of self-efficacy (Agarwal et al. 2000; Venkatesh and Bala 2008). On the other hand, diminished self-efficacy has been shown to decrease personal empowerment (Kleim et al. 2008). Based on Bandura's (1977) Social Cognitive Theory, Compeau and Higgins (1995) suggested self-efficacy to positively influence individuals' PU (Venkatesh 1999). Moreover, studies show that increased self-efficacy leads to higher perceived enjoyment and engagement towards using a technology (Yang 2012) (i.e. perceived higher cognitive absorption). Thus, we hypothesize that **H11**: *Higher perceived self-efficacy in using RAs leads to lower perceptions of cognitive effort*; **H12**: *Higher perceived self-efficacy in using RAs leads to higher perceptions of empowerment*; **H13**: *Higher perceived self-efficacy in using RAs positively influences users' perceived usefulness of the RA*; and **H14**: *Higher perceived self-efficacy in using RAs positively influences perceived cognitive absorption*.

Cognitive Age: As discussed above, cognitive age is defined as individuals' age perceptions regarding their looks, feelings, acts, and interests (Barak and Gould 1985). Montepare and Lachman (1989) suggest that most adults perceive themselves as being younger (i.e., having lower cognitive age compared to their actual chronological age). Studies also show that as individuals get older complex RAs provide consumers with more complete information than them (i.e. having lower cognitive age compared to their chronological age) become more obvious (Peters 1971). However, the cognitive age of an older person is still generally higher than that of chronologically younger individuals (Wei 2005). Thus, as there is a correlation between chronological age and cognitive age (Hong et al. 2013), it is argued that the aging theories (i.e., Resources, Speed, and Inhibition) discussed above are also applicable to cognitive aging. Hence, adults with higher cognitive age have less attentional capacity, lower speed with which processing can be executed, and less efficiency in the ability to inhibit irrelevant information.

Welford (1980) found deficits in working memory to be more pronounced in older adults when the information presented is complex, or in an unfamiliar cognitive domain. Researchers have suggested that technologies would be beneficial for older adults when they reduce requirements to maintain information in working memory (Morris and Venkatesh 2000). Based on the above, and the Resources, Speed, and Inhibition Theories of aging, it is argued that older adults with higher cognitive age will perceive higher levels of cognitive effort while using RAs compared to younger adults. Moreover, beliefs that people may become slower and forgetful with age have been supported in the literature (Heckhausen et al. 1989; McCloskey and Leppel 2010; Boi et al. 2014). To the extent that older adults believe that these

characteristics decline with age, these beliefs may contribute to judgments that they are not capable of improving and learning (i.e. lower perceptions of self-efficacy) (Warr and Pennington 1993). Further, RAs that involve users more fully in the input and output stages of the RA operation (e.g., asking users to input a higher number of product attributes in the input stage) are thought to result in higher perceptions of user empowerment. However, this may not be the case for older adults, since aging is associated with declines in physical and cognitive functioning. These changes develop feelings of cognitive disability among elders, which increase their feelings of powerlessness (Shapira et al. 2007). Hardy et al. (1999) found that older adults may perceive a sense of powerlessness in what to them is a complex system. Thus, if the RA expands choices for older adults, they may not perceive to be empowered as younger adults would. Thus we hypothesize that **H15: Higher cognitive age leads to higher perceptions of cognitive effort while using an RA; H16: Higher cognitive age leads to lower perceptions of self-efficacy in using an RA; H17: Higher cognitive age leads to lower perceptions of empowerment while using an RA; and H18: RA complexity moderates the effect of cognitive age on perceived empowerment while using an RA, such that the effect is stronger for higher complexity RAs.**

RA Complexity: As explained above, complexity is defined as “the degree to which an innovation is perceived as being relatively difficult to understand and use” (Rogers 1995, p. 242). RAs may exhibit various degrees of complexity for users, especially in the input and output stages of their operation. Users can perceive high or low complexity in the input stage based on the amount of information RAs gather about their product attribute preferences. Similarly, in the output stage of the RA operation, users may perceive high or low complexity based on the number of recommendations produced by the RA as well as the level of detail associated with these recommendations. Providing too many product recommendations may induce users to compare a larger number of alternatives which may increase their perception of cognitive effort. As such, although, in a sorted recommendation list, the most promising options are at the top of the list, simultaneously considering a large number of options in the recommendation list increases RA complexity by diverting a user’s attention from the better options to the less preferred ones (Xiao and Benbasat 2007). Similarly, providing too many details on recommended product attributes would also increase the complexity of RA outputs, while simple descriptions would reduce its complexity.

When more complex RAs provide consumers with more complete information and expand consumers’ choices regarding their preferred product attributes, and provide them with more recommendations with sufficient details, consumers may perceive a higher sense of control (i.e. empowerment which refers to an external control factor) compared to their experience when using simpler RAs. On the other hand, consumers may perceive lower self-efficacy when confronted with difficult tasks (e.g., using a complex RA) compared to when they are confronted with simple tasks (e.g., using a simple RA) (Hu et al. 2007). In other words, as self-efficacy (an internal control factor) refers to judgments people make regarding their ability to successfully perform their online tasks (Yi and Gong 2008), individuals may perceive less self-efficacy in using complex RA as they may perceived it to be difficult to use.

According to Cognitive Complexity and Cognitive Load Theories, it is logical to expect that consumers will experience higher cognitive effort in using more complex RAs. This effect would be even more pronounced for older adults due to the cognitive limitations associated with aging discussed above (McCloskey and Leppel, 2010). Thus, we hypothesize that **H19: Higher levels of RA complexity leads to higher levels of perceived empowerment while using an RA; H20: Higher levels of RA complexity leads to lower levels of perceived self-efficacy in using an RA; H21: Higher levels of RA complexity leads to higher levels of perceived cognitive effort while using an RA; and H22: Cognitive Age moderates the effect of RA complexity on perceived cognitive effort, such that the effect is stronger for older adults.**

Methodology

Experimental Design

In the experimental design, participants with a wide range of cognitive ages will be asked to buy a car online while being supported with RAs of different complexity. A car is selected as the product for this study because it has many product attributes, it requires strong consumer involvement in the purchasing process, and it is a product of interest for both young and old adults (Lambert-Pandraud et al. 2005).

In this study, two attribute-based RAs will be used that vary in terms of the complexity of their input and output stages (i.e. simple RA and complex RA). Attribute-based agents obtain inputs regarding

preferences for each product attribute and produce recommendations based on these preferences (Ansari et al. 2000). As shown in Table 1, the simple and complex RAs will differ in the number of solicited attributes in the input stage and the number of displayed attributes and associated details in the output stage of the RA operation.

Alvarez and Cavanagh (2004) suggest that a human’s short term memory has a limited capacity. Their results show that memory capacity limits exist in terms of both the number of objects and the information details for each object (they found that when little or no information is provided for each object, only four or five objects can fit in storage in individuals’ memory). In another study, Miller (1956) found that people can concurrently hold 7 ± 2 chunks of information in their working memory. Thus, the complex RA in this study represents a condition with a clearly high level of RA complexity, while the simple RA represents a condition with a clearly low level of RA complexity. It should be noted that the attribute numbers shown in Table 1 are a starting point based on guidance from the above research and may be updated after the pilot study.

Table 1. RA Design		
	Simple RA	Complex RA
RA Input		
• Number of attributes	• 8 attributes	• 26 attributes
RA Output		
• Recommendations’ detail	• Low (8 attributes & associated details)	• High (26 attributes & associated details)

A pilot study involving 40 participants will be conducted to test the experimental procedures and survey instrument. To ensure that the selected RAs are significantly different in terms of their complexity, pilot study participants will rate RAs as being high or low in terms of input, output and overall complexity. In this study, the experimental tasks will be designed in such a way to minimize any confounding effects due to brand or design elements. This study will involve a cross-sectional survey of online shoppers who will be recruited through a market research firm. After signing an initial consent form, and responding to the cognitive age questions, participants will be randomly assigned to one of the two experimental treatments (i.e. simple or complex RAs) and online survey tool will be used to link subjects to their assigned RA to complete the car shopping task. They will then be directed to complete the survey instrument. Open ended questions will be used to gather details about participants’ experiences in using their assigned RA. Participants will also be asked to respond to open-ended questions assessing whether the RA complexity was mostly perceived because of the number of the product attributes in the input stage, and/or the number of attributes and associated recommendation details in the output stage. A manipulation check for perceived RA complexity will be conducted using a 4-item scale adopted from Thompson et al. (1991). Participants’ demographic information including chronological age will also be collected to explore which type of age measurement (i.e. chronological age or cognitive age) is a better predictor of the antecedents of individuals’ intention to use online RAs. Moreover, participants’ product expertise, online experience, education, product interest, and their online RA experience as well as perceived task complexity and gender will be controlled for in the model. Participation will be voluntary, and each participant will be given monetary compensation for his/her participation. To motivate participants to view the experiment as a serious task, they will be informed that 25% of them will get an additional award from \$10 to \$50 based on their performance where they will be asked to provide justifications for their shopping choices. Ethics approval for pilot and main study will be secured prior to any data collection.

Measurement Instrument, and Instrument Validation

To ensure content validity, measurement scales for constructs in our research model will be selected from the extant literature. BI to use RAs and perceived cognitive effort will be measured using 3-item scales adapted from Wang and Benbasat (2009). PU will be measured using a 4-item scale from Hassanein and Head (2007). Perceived cognitive absorption will be measured using a 5-item scale from Burton-Jones and Straub (2006). Perceived self-Efficacy will be measured using a 5-item scale adapted from Tan and Teo (2000). Perceived empowerment will be measured using an 8-item scale adapted from Vatanasombut et al. (2008). Subjective norm will be measured using a 3-item scale from Venkatesh et al. (2012). Scales will be slightly adapted to reflect the context of this study. RA complexity will be coded as a dummy variable (i.e. 0 for simple RA and 1 for complex RA). Cognitive age will be measured using a 4-item scale

from Barak and Schiffman (1981) where participants specify which age group (twenties, thirties, forties, fifties, sixties, seventies, eighties or nineties) they perceive they belong to in terms of how they feel, look, act, and their interests. Cognitive age will then computed as the numerical average of the decade midpoints of these four components with higher numbers indicating a higher cognitive age (Wilkes 1992). All the constructs in the model are reflective constructs, thus construct validity (i.e. convergent and discriminant validity) and construct reliability will be examined (Au et al. 2008).

Data Analysis, Post Hoc Analysis and Sample Size

The first two research questions (RQ1, and RQ2) will be answered through validating the model of Figure 2 through structural equation modeling techniques, specifically Partial Least Squares (PLS) as it is more suited for exploratory research (as the proposed study) (Gefen et al. 2000) and it gives optimum prediction accuracy (Fornell and Cha 1994). The goodness of model fit will also be examined (Vinzi et al. 2010). To answer the third research question (RQ3), an ANOVA analysis will be conducted to compare the perceptions of adults of younger and older cognitive age while using simple or complex RAs. As shown in Table 2, four groups will be created following a 2X2 factorial design (Box et al. 1978). The two ranges of cognitive age were chosen as according to Tucker-Drob and Salthouse’s (2008) results, the cognitive ability 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.

Table 2. Experimental Treatments		
Cognitive Age	RA Complexity	
	<ul style="list-style-type: none"> • Simple RA • Low Cognitive Age (between 20-30) 	<ul style="list-style-type: none"> • Complex RA • Low Cognitive Age (between 20-30)
	<ul style="list-style-type: none"> • Simple RA • High Cognitive Age (above 60) 	<ul style="list-style-type: none"> • Complex RA • High Cognitive Age (above 60)

A post-hoc analysis will be also conducted to examine other possible significant relationships which are not hypothesized in the research model through a saturated model analysis (Chin et al. 2003). In addition, any possible interaction effects between variables not hypothesized in the model will be evaluated using PLS as suggested by Gefen et al. (2000). ANOVA tests will be used to find if there are significant differences between the perceptions of subjects whose cognitive age falls between 30 and 60 and those of subjects belonging to the other two age groups (i.e. young and old).

According to power analysis for mixed design, 45 subjects for each of the 4 between-subject factor groups will assure a sufficient statistical power of 0.8 for medium effect size (f = .25) (Cohen 1988). Thus, 90 adult subjects whose cognitive age is below 30 and 90 subjects whose cognitive age is above 60 will be needed. Since a PLS analysis will be also conducted to answer the first two main research questions and in order to have a consistent number of subjects across all age groups, 90 subjects whose cognitive age is between 30 and 60 will also be recruited. Thus, a total of 270 subjects will be needed for this study. To account for possible spoiled surveys, a total of 300 participants will be recruited. This sample size also satisfies the PLS analysis requirements (Chin 1998).

Potential Contributions and Limitations

From a theoretical perspective this will be the first study to develop and validate a comprehensive model for the impacts of cognitive age and RA complexity on consumers’ intention to use RAs for online shopping. As opposed to most IS studies involving understanding the role of age in technology adoption, in this study, individuals’ cognitive age will be used rather than simply using their chronological age to understand their intentions to use RAs. The results of this study will also help practitioners understand if the complexity of online RAs influences online consumers experiences based on their cognitive age. Accordingly, they can offer RAs of different complexity levels to suit the cognitive abilities of different customer segments.

Notwithstanding the contributions of this study, it has a number of limitations. The study will be conducted among North American online shoppers. Furthermore, only attribute-based RAs are considered in this study, which limits the generalizability of the results to other types of RAs such as need-based agents (Ansari et al. 2000). Thus, further research is required to determine the extent to which the findings of this study can be extended to other geographic regions as well as other types of RAs.

References

- Adams, D. A., Nelson, R. R., & Todd, P. A. 1992. "Perceived usefulness, ease of use, and usage of information technology: a replication," *MIS Quarterly* (16:2), pp. 227-247.
- Agarwal, R., Sambamurthy, V., & Stair, R. M. 2000. "The evolving relationship between general and specific computer self-efficacy – An empirical assessment," *Information Systems Research* (11:4), p. 418-430.
- Agarwal, R., & Karahanna, E. 2000. "Time flies when you're having fun: Cognitive absorption and beliefs about information technology usage," *MIS Quarterly* (24:4), pp. 665-694.
- Ajzen, I. 1991. "The theory of planned behavior," *Organizational Behavior and Human Decision Processes* (50:2), pp. 179-211.
- Alvarez, G. A. & Cavanagh, P. 2004. "The capacity of visual short-term memory is set both by visual information load and by number of objects," *Psychological Science* (15:3), pp. 106-111.
- Ansari, A., Essegaier, S., & Kohli, R. 2000. "Internet recommendation systems," *Journal of Marketing Research* (37:3), pp. 363-375.
- Au, N., Ngai, E.W.T., & Cheng, T.C.E. 2008. "Extending the Understanding of End User Information Systems Satisfaction Formation: An Equitable Needs Fulfillment Model Approach," *MIS Quarterly* (32:1), pp. 43-66.
- Baecker, R. M., Moffatt, K., & Massimi, M. 2012. "Technologies for aging gracefully," *Interactions* (19:3), pp. 32-36.
- Balota, D. A., Dolan, P. O., & Duchek, J. M. 2000. "Memory changes in healthy young and older adults," *The Oxford Handbook of Memory*, pp. 395-410.
- Bandura, A. 1977. "Self-Efficacy: Toward a Unifying Theory of Behavioral Change," *Psychological Review* (84:2), pp. 191-215.
- Bandura, A. 1997. *Self-efficacy: The exercise of control*. New York: Freeman.
- Barak, B., & Gould, S. 1985. "Alternative age measures: a research agenda," *Advances in Consumer Research* (12:1), pp. 53-58.
- Barak, B., & Schiffman, L. G. 1981. "Cognitive age: a nonchronological age variable," *Advances in Consumer Research* (8:1), pp. 602-606.
- Barak, B. 2009. "Age identity: A cross-cultural global approach," *International Journal of Behavioral Development* (33:1), pp. 2-11.
- Baum, S. K., & Boxley, R. L. 1983. "Age identification in the elderly," *The Gerontologist* (23:5), pp. 532-537.
- Becker, S. A. 2004. "A study of web usability for older adults seeking online health resources," *ACM Transactions on Computer-Human Interaction (TOCHI)* (11:4), pp. 387-406.
- Benbasat, I., & Barki, H. 2007. "Quo vadis, TAM?" *Journal of the Association for Information Systems* (8:4), pp. 211-218.
- Boi, N., Weert, J.C.M., Haes, H., Loos, E.F., Heer, S.D., Sikkels, D., and Smets, E.M. 2014. "Using Cognitive and Affective Illustrations to Enhance Older Adults' Website Satisfaction and Recall of Online Cancer-Related Information," *Health communication* (29:7), pp. 678-688.
- Box, G. E. P., Hunter, W. G., and Hunter, J. S. 1978. *Statistics for Experimenters: An Introduction to Design, Data Analysis, and Model Building*. John Wiley and Sons. New York.
- Braun M.T. 2013. "Obstacles to social networking website use among older adults," *Computer in Human Behavior* (29:3), 673-680.
- Burton-Jones, A., & Straub Jr, D. W. 2006. "Reconceptualizing system usage: An approach and empirical test," *Information Systems Research* (17:3), pp. 228-246.
- Cabeza, R. 2002. "Hemispheric asymmetry reduction in older adults: the HAROLD model," *Psychology and Aging* (17:1), 85-100.
- Chattaraman, V., Kwon, W.-S., Gilbert, J.E. and Shim, S.I. 2011. "Virtual agents in e-commerce: representational characteristics for seniors," *Journal of Research in Interactive Marketing* (5:4), pp. 276-297.
- Childers, T.L., Carr, C.L., Peck, J., and Carson, S. 2002. "Hedonic and utilitarian motivations for online retail shopping behavior," *Journal of Retailing* (77:4), pp. 511-535.
- Chin, W. W. 1998. "The partial least squares approach to structural equation modeling," *Modern Methods for Business Research* (295:2), pp. 295-336.

- Chin, W.W., Marcolin, B., L., Newsted, P. 2003. "A Partial Least Squares Latent Variable Modeling Approach for Measuring Interaction Effects: Results from a Monte Carlo Simulation Study and an Electronic-Mail Emotion/Adoption Study," *IS Research* (14:2), pp. 189-229.
- Clark, S. D., Long, M. M., & Schiffman, L. G. 1999. "The mind-body connection: the relationship among physical activity level, life satisfaction, and cognitive age among mature females," *Journal of Social Behavior and Personality* (14:2), pp. 221-240.
- Cohen, J. 1988. *Statistical power analysis for the behavioral sciences*. Routledge. Retrieved from http://books.google.ca/books?hl=en&lr=&id=TloN2lRAO9oC&oi=fnd&pg=PR11&dq=Statistical+Power+Analysis+for+the+Behavioral+Sciences&ots=dp5IRdklYw&sig=IBu3fD5-2Mdj2_9uMpJFjesBgYc
- Compeau, D. R., and Higgins, C. A. 1995. "Computer Self-Efficacy; Development of a Measure and Initial Test," *MIS Quarterly* (19:2), pp. 189-211.
- Csikszentmihalyi, M., Kolo, C., & Baur, T. 2004. "Flow: The psychology of optimal experience," *Australian Occupational Therapy Journal* (51:1), pp. 3-12.
- Davis, F. D. 1989. "Perceived usefulness, perceived ease of use, and user acceptance of information technology," *MIS Quarterly* (13:3), pp. 319-340.
- Dean, D. H. 2008. "Shopper age and the use of self-service technologies," *Managing Service Quality* (18:3), pp. 225-238.
- Feingold, A. 1993. "Cognitive gender differences: A developmental perspective," *Sex Roles* (29:1-2), pp. 91-112.
- Fishbein, M., & Ajzen, I. 1975. *Belief, attitude, intention and behavior: An introduction to theory and research*, Retrieved from <http://trid.trb.org/view.aspx?id=1150648>
- Fornell, C., Cha, J., 1994. *Partial least squares, in Advanced Methods of Marketing Research*. Bagozzi, R.P. (Ed.), Basil Blackwell, Cambridge, MA, pp. 52-78.
- Garbarino, E & Edell, J. 1997. "Cognitive effort, affect and choice," *Consumer Research*, pp.147-158.
- Gefen, D., Straub, D., Boudreau, M., 2000. "Structural Equation Modeling Techniques and Regression: Guidelines for Research Practice," *Communications of the Association for Information Systems* (4), pp. 1-78.
- Guido, G., Amatulli, C., & Peluso, A. M. 2014. "Context Effects on Older Consumers' Cognitive Age: The Role of Hedonic versus Utilitarian Goals," *Psychology & Marketing* (31:2), pp. 103-114.
- Hardy, B., Young, R., & Wistow, G. 1999. "Dimensions of choice in the assessment and care management process: the views of older people, carers and care managers," *Health & Social Care in the Community* (7:6), pp. 483-491.
- Hassanein, K., & Head, M. 2007. "Manipulating perceived social presence through the web interface and its impact on attitude towards online shopping," *International Journal of Human-Computer Studies* (65:8), pp. 689-708.
- Heckhausen, J., Dixon, R. A., & Baltes, P. B. 1989. "Gains and losses in development throughout adulthood as perceived by different adult age groups," *Developmental Psychology* (25:1), pp. 109-121.
- Hong, S.J. Tam, K.Y. 2006. "Understanding the adoption of multipurpose information appliances: the case of mobile data services," *Information Systems Research* (17:2), pp. 162-179.
- Hong, S.-J., Lui, C. S. M., Hahn, J., Moon, J. Y., & Kim, T. G. 2013. "How old are you really? Cognitive age in technology acceptance," *Decision Support Systems* (56:12), pp. 122-130.
- Hu, J., Huhmann, B. A., & Hyman, M. R. 2007. "The Relationship between task complexity and information search: The role of self-efficacy," *Psychology & Marketing* (24:3), pp. 253-270.
- Iyer, R., Reisenwitz, T. H., & Eastman, J. K. 2008. "The Impact of Cognitive Age on Seniors' Lifestyles," *Marketing Management Journal* (18:2), pp. 106-118.
- Kahneman, D. 1973. *Attention and effort*. Retrieved from <http://www.citeulike.org/group/7631/article/4299238>
- Kastenbaum, R., Derbin, V., Sabatini, P., & Artt, S. 1972. "The ages of me": Toward personal and interpersonal definitions of functional aging," *The International Journal of Aging and Human Development* (3:2), pp. 197-211.
- Kieras, D., & Polson, P. G. 1985. "An approach to the formal analysis of user complexity," *International Journal of Man-Machine Studies* (22:4), pp. 365-394.
- Kleim, B., Vauth, R., Adam, G., Stieglitz, R.-D., Hayward, P., & Corrigan, P. 2008. "Perceived stigma predicts low self-efficacy and poor coping in schizophrenia," *Journal of Mental Health* (17:5), pp. 482-491.

- Komiak, S., and Benbasat, I. 2006. "The Effects of Personalization and Familiarity on Trust and Adoption of Recommendation Agents," *MIS Quarterly* (30:4), pp. 941-960.
- Lambert-Pandraud, R., Laurent, G., & Lapersonne, E. 2005. "Repeat purchasing of new automobiles by older consumers: empirical evidence and interpretations," *Journal of Marketing* (69:2), pp. 97-113.
- Leavitt, N. 2006. "Recommendation technology: Will it boost e-commerce?," *Computer* (39:5), pp. 13-16.
- Lindberg, T., Näsänen, R., & Müller, K. 2006. "How age affects the speed of perception of computer icons," *Displays* (27:4), pp. 170-177.
- Mathieson, K. 1991. "Predicting user intentions: comparing the technology acceptance model with the theory of planned behavior," *Information Systems Research* (2:3), pp. 173-191.
- McCloskey, D.W. and Leppel, K. 2010. "The impact of age on electronic commerce participation: an exploratory model," *Journal of Electronic Commerce in Organizations* (8 :1), pp. 41-60.
- Miller, G. A. 1956. "The Magical Number Seven, Plus or Minus Two: Some Limits on Our Capacity for Processing Information," *Psychological Review* (63:2), pp. 81-97.
- Morris, M. G., & Venkatesh, V. 2000. "Age differences in technology adoption decisions: Implications for a changing work force," *Personnel Psychology* (53:2), pp. 375-403.
- Morris, M. G., Venkatesh, V., & Ackerman, P. L. 2005. "Gender and Age Differences in Employee Decisions About New Technology: An Extension to the Theory of Planned Behavior," *IEEE Transactions on Engineering Management* (52:1), pp. 69-84.
- Montepare, J. M., & Lachman, M. E. 1989. "'You're only as old as you feel': self-perceptions of age, fears of aging, and life satisfaction from adolescence to old age," *Psychology and Aging* (4:1), pp. 73-78.
- Nam, J., Hamlin, R., Gam, H. J., Kang, J. H., Kim, J., Kumphai, P., ... Richards, L. 2007. "The fashion-conscious behaviours of mature female consumers," *International Journal of Consumer Studies* (31:1), pp. 102-108.
- Neugarten, B. L., & Hagestad, G. O. 1976. *Age and the life course*. Handbook of Aging and the Social Sciences, 1, 35.
- Oviatt, S. (2006). Human-centered design meets cognitive load theory: designing interfaces that help people think. *Proceedings of the 14th annual ACM international conference on Multimedia*, pp. 871-880.
- Peters, George R. 1971. "Self-Conceptions of the Aged, Age Identification and Aging," *The Gerontologist* (11), pp. 69-73.
- Pires, G. D., Stanton, J., & Rita, P. 2006. "The internet, consumer empowerment and marketing strategies," *European Journal of Marketing* (40:9/10), pp. 936-949.
- Rogers, E. M. 1995. *Diffusion of Innovations*, Free Press, New York.
- Roth, M. S. 1994. "Enhancing consumer involvement in health care: the dynamics of control, empowerment, and trust," *Journal of Public Policy & Marketing* (13:1), pp. 115-132.
- Salkowitz, R. 2008. *Generation Blend: Managing Across the Technology Age Gap*, John Wiley & Sons, Inc., Hoboken, NJ.
- Salthouse, T. A. 1982. *Adult cognition: An experimental psychology of human aging*. Springer-Verlag New York.
- Sandhu, K., & Corbitt, B. J. 2003. "Assessing web-based electronic services adoption model (E-SAM)," *In Proc of the 11th European Conference on Information Systems*, Naples, Italy, 1683-1696.
- Schiffman, L. G., & Sherman, E. 1991. "Value orientations of new-age elderly: the coming of an ageless market," *Journal of Business Research* (22:2), pp. 187-194.
- Schwall, A. R., Hedge, J. W., & Borman, W. C. 2012. *Defining age and using age-relevant constructs*, The Oxford Handbook of Work and Aging, pp. 169-186.
- Shapira, N., Barak, A., & Gal, I. 2007. "Promoting older adults' well-being through Internet training and use," *Aging and mental health* (11:5), pp. 477-484.
- Sherman, E., Schiffman, L. G., & Mathur, A. 2001. "The influence of gender on the new-age elderly's consumption orientation," *Psychology & Marketing* (18:10), pp. 1073-1089.
- Swaminathan, V. 2003. "The impact of recommendation agents on consumer evaluation and choice: the moderating role of category risk, product complexity, and consumer knowledge," *Journal of Consumer Psychology* (13:1), pp. 93-101.
- Tan, M., & Teo, T. S. 2000. "Factors influencing the adoption of Internet banking," *Journal of the AIS* (1:1), 5-25.

- Tan, G.W.H., Sim, J.J., Ooi, K.B., & Phusavat, K. 2012. "Determinants of Mobile Learning Adoption: An Empirical Analysis," *The Journal of computer information systems* (52:3), pp. 82-91.
- Tang, Z., Chen, X., & Wu, Z. 2010. "Using behavior theory to investigate individual-level determinants of employee involvement in TQM," *Total Quality Management* (21:12), pp. 1231-1260.
- Tellegen, A. 1982. "Brief manual for the multidimensional personality questionnaire," *Unpublished Manuscript, University of Minnesota, Minneapolis*, pp. 1031-1010.
- Thompson, R. L., Higgins, C. A., & Howell, J. M. 1991. "Personal computing: toward a conceptual model of utilization," *MIS Quarterly* (15:1), pp. 125-143.
- Tucker-Drob, E.M., & Salthouse, T.A. 2008. "Adult age trends in the relations among cognitive abilities," *Psychology and aging* (23:2), pp. 453-460.
- Tyler, S. W., Hertel, P. T., McCallum, M. C., & Ellis, H. C. 1979. "Cognitive effort and memory," *Journal of Experimental Psychology: Human Learning and Memory* (5:6), pp. 607-617.
- Uechi, N. 2010. "An instructional video module on spreadsheets accommodating the needs of senior citizens," Retrieved from <http://scholarspace.manoa.hawaii.edu/handle/10125/15365>
- Underhill, L., & Cadwell, F. 1984. "“What age do you feel” Age perception study," *Journal of Consumer Marketing* (1:1), pp. 18-27.
- Vatanasombut, B., Igbaria, M., Stylianou, A. C., & Rodgers, W. 2008. "Information systems continuance intention of web-based applications customers: The case of online banking," *Information & Management* (45:7), pp. 419-428.
- Venkatesh, V., Morris, M. G. 2000. "Why don't men ever stop to ask for directions? Gender, social influence, and their role in technology acceptance and usage behavior," *MIS Quarterly* (24:1), pp. 115-139.
- Venkatesh, V., Morris, M. Davis, G.B., & Davis, F.D. 2003. "User acceptance of information technology: Toward a unified view," *MIS Quarterly* (27:3), pp. 425-478.
- Venkatesh, V., & Bala, H. 2008. "Technology acceptance model 3 and a research agenda on interventions," *Decision sciences* (39:2), pp. 273-315.
- Venkatesh, V., Thong, J., & Xu, X. 2012. "Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology," *MIS quarterly* (36:1), pp. 157-178.
- Vinzi, V. E., Trinchera, L., and Amato, S. (2010). *PLS Path Modeling: From Foundations to Recent Developments and Open Issues for Model Assessment and Improvement*, Springer Berlin Heidelberg: Berlin, Heidelberg, pp. 47-82.
- Visvabharathy, G. 1982. "Product Specificity in Public Toward the Elderly," *Advances in Consumer Research* (9:1), pp. 23-26.
- Wang, W., & Benbasat, I. 2009. "Interactive decision aids for consumer decision making in e-commerce: The influence of perceived strategy restrictiveness," *MIS Quarterly* (33:2), 293-320.
- Warr, P., & Pennington, J. 1993. "Views about age discrimination and older workers," *Age and Employment: Policies, Attitudes and Practices*, pp. 75-106.
- Webster, J., & Ho, H. 1997. "Audience engagement in multimedia presentations," *ACM SIGMIS Database* (28:2), pp. 63-77.
- Wei, S.-C. 2005. "Consumers' Demographic Characteristics, Cognitive Ages, and Innovativeness," *Advances in Consumer Research* (32:1), pp. 633-640.
- Welford, A. T. 1980. "Sensory, perceptual, and motor processes in older adults," *Handbook of Mental Health and Aging*, pp. 192-213.
- Wilkes, R. E. 1992. "A structural modeling approach to the measurement and meaning of cognitive age," *Journal of Consumer Research* (19:2), pp. 292-301.
- WM Van Gerven, F. G. P. 2000. "Cognitive load theory and the acquisition of complex cognitive skills in the elderly: Towards an integrative framework," *Educational Gerontology* (26:6), pp. 503-521.
- Xiao, B., & Benbasat, I. 2007. "E-commerce product recommendation agents: use, characteristics, and impact," *Mis Quarterly* (31:1), pp. 137-209.
- Yang, K. 2012. "Consumer technology traits in determining mobile shopping adoption: an application of the extended theory of planned behavior," *Journal of Retailing and Consumer Services* (19: 5), pp. 484-491.
- Yi, Y., & Gong, T. 2008. "The electronic service quality model: The moderating effect of customer self-efficacy," *Psychology & Marketing* (25:7), pp. 587-601.
- Yoon, C., Laurent, G., Fung, H. H., Gonzalez, R., Gutchess, A. H., Hedden, T., Peters, E. 2005. "Cognition, persuasion and decision making in older consumers," *Marketing Letters* (16:3-4), pp. 429-441.