Effects of Aging and Individual Differences on Credibility Judgment of Online Health Information

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Abstract

We investigated the effects of aging and individual differences on credibility judgment of online health information. Analysis of credibility judgment ratings revealed that older adults were less influenced by argument strength in content messages and contextual Website features than younger adults. Verbal protocol analysis revealed that older adults tended to accept the facts they read on the Web page instead of further deliberating on their credibility. They also tended to pay less attention to contextual Website features relevant to the credibility of the information. We also found that older adults' lower sensitivity to credibility cues on a Web page could at least be partially explained by their declined cognitive ability and lack of Internet experience. On the other hand, health-related domain knowledge was found to be useful in helping older adults to make better credibility judgments.

Keywords: Web credibility, cognitive aging, Elaboration Likelihood Model

Introduction

Because it is difficult to control the quality of the massive amount of online health information, many argue that credibility judgment should be taken as an indispensable component of online health information consumption, since health advice acquired from unreliable sources can be hazardous, or even life threatening. This issue becomes more prominent as studies have shown that, unlike other routine online activities such as reading news, users often do not have a trusted Web portal in mind when seeking for health related information. Instead, they often rely on search engines to solve their medical problems, and may bypass the main page and encounter information from untrusted sources (Eysenbach, 2007). A better understanding of the factors that influence credibility judgment will greatly enhance the safety and effectiveness of online health information consumption by the public.

Among the increasing number of e-health consumers, older adults constitute a notable group, possibly because of their naturally higher need for health information. Research has shown that, compared to younger adults, older adults tend to exhibit distinctive behavior and performance in terms of searching, evaluating, and comprehending Web information (Chin & Fu, 2010; Hanson, 2009). The age differences, according to these studies, could be attributed to some unique characteristics of older adults, such as declined cognitive ability and inadequate experience with information technology. Despite its importance, there is a general lack of research studying age differences in credibility judgment of online information. To the best of our knowledge, there is still no research aiming at unpacking how age differences, cognitive abilities, Internet experience, and domain knowledge interact to influence credibility judgment of online information. Given that credibility judgment plays a vital role in older adults' successful and safe consumption of online health information, a systematic study on age differences in credibility judgment will critically facilitate older adults to benefit from the massive amount of online health information for better maintenance of their health conditions.

In this study, we were interested in the difference in the credibility judgment of online health information between younger and older adults, as well as the underlying factors of such differences. To this end, we collected the credibility rating and verbal protocols as younger and older adults evaluated the credibility of health information on different Websites. We analyzed the potential differences between the two groups in terms of their credibility judgment, and the strategies they used. We also studied the extent to which these differences could be explained by age-related individual differences such as their cognitive ability, Internet experience, and health related domain knowledge.

Related Work

Many research studies on Web credibility have assumed some forms of the dual processing model of persuasive communications (e.g., Metzger, 2007) such as the Elaboration Likelihood Model (ELM, Petty & Cacioppo, 1986). When applying the ELM to Web credibility, individual's attitude formation could be explained as they encounter two distinctive types of cues: (1) *content cues* are associated with the content/argument of Web information, which requires systematic, deliberative processing, and (2) *contextual cues* may be associated with the surface features of the Websites (e.g., interface design, information source, etc), which can be processed in a heuristic way by relying on practical rules or experience (Petty & Cacioppo, 1986). How cues from these two sources interact and impact users' credibility judgment is an interesting question since users may often receive cues that contradict each other. For example, one study showed that credibility features of healthcare Website have only small correlation with the accuracy of information it provided (Heinke et al., 2002), which implies that apparently credible Website may not necessarily provide reliable health information.

Since the processing of content cues tends to be more cognitively demanding, studies have found that users tended to process them by heuristic processing (Hilligoss & Rieh, 2008;.Sillence et al., 2007). However, there existed mixed results regarding the effects of specific contextual cues on users' credibility assessment. While most studies showed that notably better design appearances contributed

to higher perceived credibility (Alsudani & Casey, 2009), users were often found to disregard certain Website features such as third party endorsement, author information, advertisement, etc, when making credibility judgment (Hong, 2006), even though these features were considered indicators of credibility in reflective situations such as surveys (Fogg, 2001). These results implied that the application of dual processing model to Internet may be a complicated issue.

The primary focus of our study was to explore age differences in credibility judgment of online health information. Several lines of research provided robust evidence for age related declines in central cue (content) processing (Peters et al., 2007), which suggested that older adults tend to process less information and demonstrate worse judgments and decisions than younger adults. However, other age-related factors, such as better experience and knowledge, may be able to narrow the gap by compensating for the age-related declines (Peters et al., 2007). It is possible that, for example, better health knowledge may compensate for the general lack of Internet experiences of older adults in their credibility judgments. A systematic study on the intricate relations among cognitive ability, Internet experience, and health related domain knowledge will shed light on how they interact to influence credibility judgment.

METHOD

Participants

16 older adults (aged between 62 and 80, Mean=69.38, SD=5.81; 62.5% were female) and 16 younger adults (aged between 19 and 26, Mean=21.56, SD=2.10, 50% were female) participated in our study. All participants were recruited from the Urbana-Champaign area in the US. There was no significant difference in the education level and self-reported experience in seeking health related information on Internet between two age groups.

Experimental Design and Materials

We employed a 2×2×2 mixed factor design to study older and younger adults' credibility judgment of online health information. There were two within subject variables: content cue strength and contextual cue strength, and one between subject variable: age. All participants performed eight credibility judgment tasks, with each task composed of four Web pages that corresponded to the four possible combinations of strong/weak contextual and content cues.

Content Cue Manipulation

For content cue manipulation, we adopted the empirical method to verify the argument strength of the contents shown on the Web pages (Petty & Cacioppo, 1986). First, we selected materials from a popular healthcare Website (www.revolutionhealth.com). It has articles of alternative medicine for different diseases, with ratings provided by users and professionals. Based on the ratings we selected articles with "strong" and "weak" content cues. We further

modified their use of evidence, argument rigor, information quality and bias, which have been identified to be information credibility indicators (Fogg, 2003; Hamilton, 1998; Rieh, 2007). The medicine names were modified such that they could not be recognized. To further verify our manipulation, we asked a group of 7 pilot participants naïve to the experiment to rate the credibility by reading the article. We filtered out articles that had the lowest consistencies among the pilot participants and ended up with 8 sets of documents.

Contextual Cue Manipulation

For contextual cue manipulation, we focused on design look and source features. Fogg et al. showed that design look, including layout, typography, images, etc, tended to have the largest impact on web credibility evaluation (Fogg, 2001). Source features are Website features that indicate the source authority, including references, author information, third-party endorsements, site ownership, commercial features, etc (Hong, 2006). We selected web page templates from highly recognized and professionally designed healthcare Websites based on their public reputation, Website traffic, and endorsement by Health on the Net Network (HON). We adopted the design and source features of these Web pages to represent "strong" contextual cues, and deliberately removed some of these features (3-5 changes per page) to create Web pages that had "weak" contextual cues.

Measures of cognitive ability, Internet experience and domain knowledge

For cognitive abilities, we focused on fluid mental abilities (working memory and processing speed), which are found to be most vulnerable to effects of aging. Previous studies also identified these abilities to be some of the major causes for older adults' disadvantages in processing content cues (Peters et al., 2007). Working memory was measured by the Letter Number Sequencing Task, while processing speed was measured by the Pattern and Letter Comparison Task (Salthouse, 1991; Chin & Fu, 2010). These tasks have been frequently used in previous studies to measure individual differences in these cognitive abilities in the area of cognitive aging.

Research on age differences in online behavior often found that older adults tended to have less experience with the Internet. It was suggested that Web use experience could affect individual's credibility evaluation with Web information. To measure Internet experience, we randomly selected 12 questions from the Knowledge-related Internet Information Seeking Semi-structured Interview (KRIISS) (Sharit et al., 2008). The interview asks questions regarding how the Internet works, how to use Web browser tools and how to perform information search task.

According to the theory of ELM, domain knowledge could facilitate individual's deliberative processing of content. Also previous studies have shown that topical knowledge influence users' perceived credibility of Web information (Ferebee, 2008). In our study, task-related domain knowledge was measured by a fluency task, in

which participants were asked to generate as many relevant keywords as possible for each of the eight diseases we used in experiment. The average number of keywords for each disease, as an indication of their retrieval of related concepts from memory (Griffiths et al., 2007), was used as an index of individual's task related domain knowledge.

Task and Stimuli

Before the experiment, all participants were given the set of standardized pretests to measure their cognitive ability, Internet experience, and health related domain knowledge. Participants then read the instruction of the task, which asked them to imagine that they were asked to help a friend to evaluate some alternative medicines randomly collected from the Internet. The concern for potentially ineffective or fake medicine was mentioned to implicitly induce their motivation for judging the credibility of each page. Participants were then presented with the task interface, which presented the 4 web pages under each of the 8 diseases on a regular Web browser. Participants could then click one of the disease names and browse any of the four web pages, each of which described an alternative medicine. Participants could then click on the "Rate" button on the interface and submit their ratings of the medicine based on scale from 1(not recommend) to 7 (highly recommend). Concurrent verbal protocols were collected by asking participants to "think aloud" during two of the eight tasks. All the protocols were recorded as digital files by the computer and later transcribed and analyzed.

RESULTS

We divided our analysis into two parts: First, we tested whether there were age differences in the credibility rating given to the medication information, and analyzed the processes by collecting concurrent verbal protocols from participants as they performed the credibility judgment. Second, we explored how individual differences in cognitive ability, Internet experience, and health related domain knowledge interacted with age difference in credibility judgment.

Age Differences in Credibility Judgments

We performed a three-way ANOVA on the credibility ratings, with content cue strength and contextual cue strength as within subject variables, and age as between subject variable. The results showed that the main effects of content cue ($F(1,30)=22.04$, $p <0.01$) and contextual cue ($F(1,30)=41.81$, $p<0.01$) were significant. Also the interaction between content cue and age ($F(1,30)=4.18$, $p=0.05$) , and interaction between contextual cue and age ($F(1,30)=5.60$, $p=0.03$) were significant. Interestingly, the two-way interactions indicated that older adults were less able to differentiate between more credible information from less credible one in terms of message content, as well as contextual Website features, and gave closer credibility ratings between strong and weak content/contextual cues (Figure 1). Then we tested the main effects of content cue and contextual strength in each age group. The results showed that while younger adults could successfully differentiate between strong and weak contextual cues ($F(1,15)=19.10$, $p <0.01$), old adults were less able to do so ($F(1,15)=3.90$, $p =0.07$). It further confirmed that older adults had difficulties in differentiating between strong and weak contextual cues.
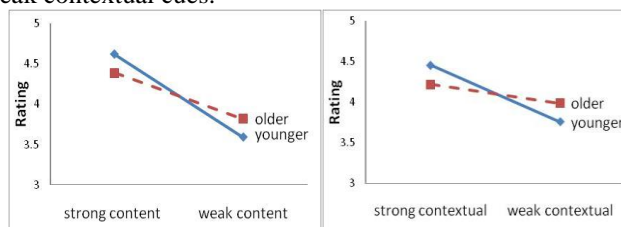

Figure 1. Average credibility ratings given to pages with strong or weak content (contextual) cue

We collected verbal protocols from each participant for two of the eight tasks. We classified the transcribed protocols based on whether they were about the content or

Categories	Subcategories	Criteria	Examples
Content processing: Deliberation	1.1 Checking evidence	Checking studies, data, etc	*"There is high quality scientific evidence"*, *"The research looks only preliminary"*
	1.2 Evaluating information quality	Commenting on the completeness, accuracy, writing tone, or bias of information, etc	*"There is way too much information devoted to healthy lifestyle, not the medicine itself"*,
	1.3 Reasoning	Commenting on logical problems, contradictory facts, unclear explanations, etc; doubting claims, motives, etc;	*" It said few adverse effects in the first part, but listed numerous ones in side effects part"*
	1.4 Relating to personal experience	Talking about personal experience and preference	*"I took similar fiber product before and it helps"* *"I would not recommend OTC products"*
	1.5 Comparson	Comparing with other medicines read	*"It works the same way with last one"*
Content processing: Facts reading	2.1 Introduction (effectiveness)	Reading claims in the introduction part, including treaging efficacy, ease of use, history, background, etc	*"It lowers cholesterol"*, *"It has been used in Asia for 1000 years"*
	2.2 Side effects	Reading claims in the side effects part	*"Side effects included dizziness"*
	2.3 Interactions	Reading claims in the interactions part	*"Caution advised in people who take drugs lowering blood pressure"*
	2.4 Dosage	Reading claims in the dosage part	*"The dosage is 25 mg"*
Contextual cue processing	3.1 Design feeling	Aesthetical quality, layout, color, structure, etc	*"layout is pretty simple, easy to read"*
	3.2 Reference features	Referrence literature, resource links, suggestions for relevant information, etc	*"It lists some decent referecne"*, *"Have links to read abstract of research "*
	3.3 Website source features	Features indicating Website reliability, e.g. sponsor information, contact, endorsement	*"The Website is a non-profit organization"*, *"American Heart Association recommended"*
	3.4 Commertial features	Advertising, promotion, donate button, etc	*"The site is covered by advertisements"*

Table 1. Coding scheme for verbal protocol analysis

contextual cues. For content cue processing, we further differentiated protocols showing that participants were passively reading facts or statements on a page from those showing that they were actively deliberating on information they read (see Table 1). An example of *deliberation* may be "The medicine drops weight too fast, sounds fake", which indicated the participant was making inference based on what they read. In contrast, an example of *facts reading* may be "the medicine can help you lose 15 pounds a week". This differentiation had important practical implications because a higher number of protocol tokens showing that they were passively reading rather than actively deliberating over the information could imply that participants were less sensitive to the information quality or logic of the page content; and if so, they could potentially be misled or misinformed as a result of lack of deliberation.

We then investigated which major categories of the protocols showed significant age difference. First we conducted a two-way ANOVA by using age and type of cues(deliberation, facts reading and contextual cue processing) as independent variables, and the percentage of cue as dependent variable. It showed that the effects of type of cues was significant ($F(1,90)=46.33, p< 0.01$), and the interaction between age and type of cues was significant ($F(2,90)=14.55, p< 0.01$). The results indicated that there was age difference for some type of cues. Hence we conducted post-hoc analysis using three t-tests with Bonferroni correction to compare the results of younger and older adults for each type of cues. As shown in Figure 2, younger adults had higher percentages under the category and contextual cue processing (p=0.016), while older adults had a higher percentage in the category of facts reading(p=0.001). The results suggested that contextual cue processing contributed more to younger adults' final ratings than that of older adults, while older adults' tended to simply rely more on accepting the facts they read to make their final ratings.
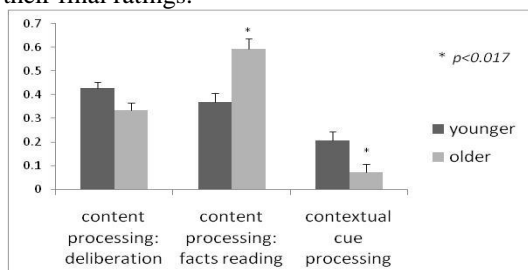

Figure 2. Percentage of cues in each category mentioned by each participant

We were also interested in what cues older and younger adults processed first when they evaluated a new Web page. A two-way ANOVA with type of cues and age as independent variable, and the proportion of the type of cue in the first cue mentioned by each participant was conducted. It showed there was significant effects of type of cue($F(1,90)= 10.52$, p<0.01), and significant interaction between age and type of cues($F(2,90)= 11.99$, p<0.01). The results indicated there was age difference in some type of cues. Then we conducted post-hoc analysis using t-test with

Bonferroni test to compare the results of younger and older adults for each type of cue. As Figure 3 showed, younger adults had a higher tendency to process contextual cues than older adults(p=0.001), while older adults had a higher tendency to read facts of the medicine than younger adults(p=0.010).

Previous studies supporting the stage model of Web credibility assessment indicated that users tended to first engage in preliminary assessment with the site by processing contextual cues before performing a more systematical, in-depth evaluation of the information on that site (Hilligoss & Rieh, 2008;Wathen & Burkell, 2002). However, it is worth noting that our results showed that older adults did not seem to conform adults tended to deviate from "common" behavioral patterns as observed in to this model of credibility assessment. They had a higher tendency to start by reading facts than deliberation (p<0.01) and processing contextual (p<0.01). This trend may imply that older "regular" Internet users (who were likely younger adults in previous studies). Intuitively, this could be explained by the possibility that older adults were less adapted to processing information on Web pages.
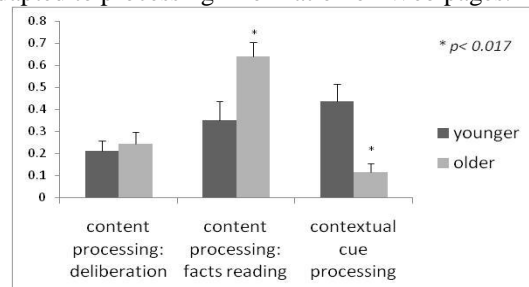

Figure 3. Percentage of first noticed cue from each category for each participant

Effects of Individual Differences

Consistent with previous studies, our pretest showed that older adults in general had lower cognitive ability than younger adults (*p<0.01*). To understand how cognitive ability influenced credibility judgment, we performed median splits in each age group based on the cognitive ability scores and compared how the high and low cognitive ability groups differed in their credibility judgment. Within each of these two groups we performed the same three-way ANOVA. By comparing the results we found that the interaction between content cue and age was only significant among users with low cognitive ability ($F(1,14)=10.92, p<0.01$), but not among users with high cognitive ability ($F(1,14)=0.33, p=0.57$). Figure 4 illustrated the differences: for content cue processing, older adults with high cognitive ability could perform almost as well as younger adults. However, older adults with low cognitive ability were less able to differentiate between credible contents and less credible ones.

Consistent with previous studies, our measure showed that older adults were generally less experienced with Internet than younger adults (*p<0.01*). To study the role of Internet experience in credibility judgment, we performed a
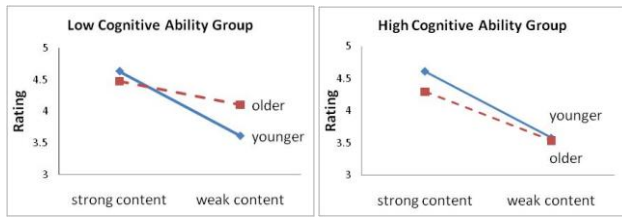
Figure 4. Average credibility rating given to pages with strong or weak content cue by low/high cognitive ability group

median split based on the Internet experience score to generate the high and low Internet experience groups, and performed the same three-way ANOVA in each group. By comparing the results we found that the interaction between contextual cue strength and age was significant in the low Internet experience group ($F(1,14)=5.96, p=0.03$), but not in the high Internet experience group ($F(1,14)=0.50, p=0.49$). It indicated that older adults with more Internet experience could perform just as well as younger adults in contextual cue processing(Figure 5). It suggested that Internet experience was critical for older adults' contextual cue processing when making credibility judgment.
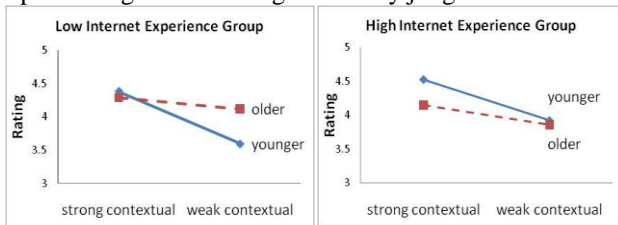

Figure 5. Average credibility rating given to pages with strong or weak contextual cue by low/high Internet experience group

In our study, there was no significant age difference in domain knowledge between the younger and older groups ($p=0.52$). We divided all participants into groups of low and high domain knowledge by performing median split based on the domain knowledge scores. As shown in Figure 6, in the low domain knowledge group, the two-way interaction between content cue and age ($F(1,14)=4.35, p=0.05$), and two-way interaction between contextual cue and age($F(1,14)=6.09, p=0.03$), were still significant. Interestingly, we observed the two-way interaction between age and content cue ($F(1,14)=0.68, p=0.42$) and the two-way interaction between age and contextual cue($F(1,14)=0.50, p=049$) became not significant in the group of high domain knowledge. Three-way ANOVA with domain knowledge (high/low), content cue strength and contextual cue strength performed among older adults showed that there was a marginally significant two-way interaction between domain knowledge and contextual cue ($F(1,14)=4.08, p=0.06$), while no similar interaction was observed among younger adults. The results suggested that higher domain knowledge could compensate for older adults' lower abilities in differentiating between strong and weak content, as well as contextual cues. And older adults who had better health knowledge seemed more likely to perform just as well as younger adults in credibility judgments (Figure 6).
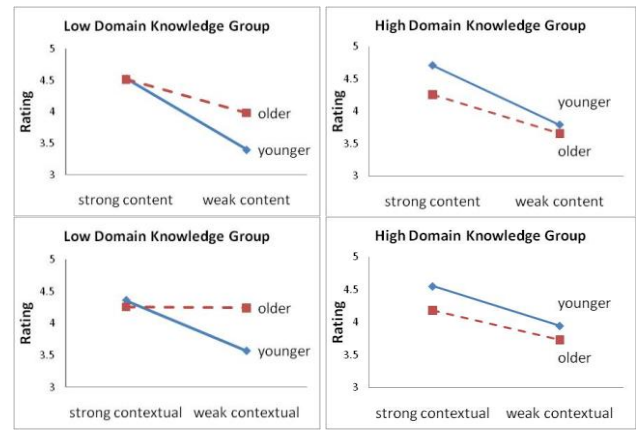

Figure 6. Average credibility rating given to pages with strong or weak contextual/content cue by low/high domain knowledge group

CONCLUSION

To summarize, we found that older adults were in general less able to differentiate between credible content and non-credible one. Also older adults were less sensitive to the contextual Website features that were indicators of information credibility. By performing verbal protocol analysis to study participants' credibility judging process, we found that: 1) For content cue processing, older adults had a higher tendency to passively read facts on the Web page, which implied they may accept what was claimed without further deliberating on its credibility; 2) For contextual cue processing, older adults would less likely pay attention to features or attributes of the Website during credibility judgment. Moreover, while younger adults tended to start with processing contextual cues on the Website, older adults would more likely start by directly reading the text on the Web page. These results seemed to support the notion that older adults' were less adapted to the Web environment than younger adults, and appeared to be browsing Web pages as if they were processing traditional forms of text such as books or newspapers.

To understand how individual differences influenced credibility judgment and contributed to older adults' different performance, we compared results of groups with different levels of cognitive ability, Internet experience, and domain knowledge. We found that: 1) the generally lower cognitive ability largely contributed to older adults' lower ability to differentiate between strong and weak content cues; 2) the generally lower Internet experience of older adults could at least partially explain their lower ability to differentiate between strong and weak contextual cues; and 3) health related domain knowledge could, to some extent, compensate for older adults' lower abilities in making credibility judgments, as those who had better health knowledge could perform as well as younger adults in both content processing and contextual processing.

To the best of our knowledge, this was the first study systematically looking at individual differences and Web credibility judgment. Moreover as a quantitative laboratory study, it provided good supplement for credibility studies

based on dual processing models, considering most previous studies used qualitative evidence or self-reported data. Also, our results have implications for better supporting older adults' consumption of online health information. Specifically, we identified three credibility judgment strategies that were more effective: 1) actively deliberate on the credibility of the message rather than to passively read facts stated on the Web page 2) initiate credibility judging process by examining contextual cues first, as it takes less cognitive effort and could be more easily adopted by older adults, and 3) better training in using Internet as well as general health related knowledge and actively applying them will make the information quality judgment more effective. Future research will focus on how we could provide instructions or training to older adults with these strategies to improve their credibility judgment outcomes.

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