Metacognition and Decision Making:
A Design Evaluation of WebMD's Physician Directory

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Introduction

Metacognition—the knowledge and ability to understand and regulate one's cognitive processes—influences many aspects of human information processing and performance (Flavell, 1979; Brown, 1978; Metcalfe, 1996). This cognitive self-awareness and capacity to monitor and controls one's thoughts and behaviors is particularly important in decision making (Batha & Caroll, 2007).

Decision making is influenced by a variety of factors including the human drive for efficiency, desire to minimize cognitive effort, and sensitivity to emotion (Ashcraft, 1998). While these tendencies often lead to poor and irrational decisions, metacognitive knowledge and strategies can often inhibit their influence on decision making and guide humans towards better, more thoughtful choices (Ariely, 2008; Ewell-Kumar, 1999). To this end, design can foster good decision making by stimulating and supporting metacognition, as well as respectively acknowledging and compensating for common decision making strategies and deficiencies (Diaper & Stanton, 2004).

This paper will examine metacognition and its impact on decision making. Two major classes of decision making models will be reviewed, as well as common heuristics and biases that affect decision making effectiveness. These principles will then be applied to a design analysis of WebMD's Physician Directory, specifically how this database could be improved to better support the process of choosing a physician.

Metacognition

Since the publication of Flavell's seminal 1979 article on the topic, "metacognition" has grown into an umbrella term, which encompasses many related concepts (Veenman, Van Hout-Wolters, Afflerbach, 2006). Early research, however, distinguished between two major facets of metacognition, namely metacognitive knowledge (i.e. knowledge of cognitive processes, both one's own and that of other individuals, such as "I am better at spelling than arithmetic") and metacognitive experiences (i.e. cognitive or affective experiences, such as a feeling of puzzlement) (Flavell, 1979). Metacognitive experiences can impact metacognitive knowledge by supplementing or revising it (Flavell, 1979). Additionally, subsequent research has identified a third major facet of metacognition called metacognitive regulation (Nelson & Narens, 1990). This term encompasses both the monitoring and assessment of one's ongoing progress, as well as the control of cognitive processes (e.g. gauging the usefulness of information on a webpage and deciding to either continue reading or to move to another page) (Dunlosky & Metcalfe, 2009).

Flavell (1979) further divided metacognitive knowledge into three subcategories: person, task, and strategy. Person knowledge refers to one's knowledge of how cognitive abilities vary within and between individuals (Flavell, 1979). Task knowledge relates to the information, demands, and difficulty associated with a task and its likelihood of success (Flavell, 1979). Lastly, strategy knowledge is concerned with the best strategies for achieving one's goals

(Flavell, 1979). Livingston (1997) provides this helpful and illustrative anecdote: "I know that I (*person knowledge*) have difficulty with word problems (*task knowledge*) so I will answer the computational problems first and save the word problems for last (*strategy knowledge*)"(para 12).

Metacognitive knowledge can be accessed consciously (i.e. via a deliberate search of long term memory), as well as automatically and unconsciously (Flavell, 1979). Additionally, it is important to note that metacognitive knowledge is not always correct, which can sometimes lead to problems (e.g. falsely believing one has sufficient knowledge to make an accurate decision about whether your carburetor needs to be replaced) (Dunlosky, Serra, and Baker, 2007).

Clearly, metacognition, in its various forms, can have a powerful impact on human thought and actions. In order to better understand how metacognitive processes can aid humans in making better decisions, it is helpful to examine the decision making process, including common theoretical models and heuristics.

Decision Making

Overview

Decision making is generally defined as a task in which individuals have to choose one of multiple options, based on some degree of available information (Ashcraft, 1998). A hallmark of decision making is that it is conducted in a state of uncertainty, in which the best option is not necessarily clear (Ashcraft, 1998). Wickens (2004) divides decision making into three phases, which often cycle and iterate during the course of a single decision. These phases include (1) cue acquisition and integration (2) hypothesis generation, evaluation, and selection, and (3) plan generation and action choice (Wickens, 2004).

Theoretical Models

In an attempt to better understand and predict human decision making, researchers have proposed a variety of theoretical models. While there is considerable variation amongst these models, the majority can be grouped into two categories: normative and descriptive (Strle, 2012).

Normative models.

Early research into decision making focused on the study of normative, or prescriptive, models that revolved around the concept of utility, or the overall value of a choice (Kurz-Milcke & Gigerenzer, 2007). These models prescribed how humans should act when faced with a decision and generated the "optimal" choice, according to a mathematical or probabilistic model (Yeung & Summerfield, 2012). In addition, they provided a yardstick against which human's deviations from the optimal decision could be judged (Wickens, 2004).

One example of a normative model is multiattribute utility theory (Dyer et al, 1992). The multiattribute utility theory attempted to address the challenge of accurately assessing and comparing multiple options that differed on a variety of dimensions by translating the dimensions of each option into a single assessment of overall value or utility (Dyer et. al, 1992). Despite its elegance, however, it quickly became apparent that humans did not operate in such a rational

manner (Svenson, 1996). As a result, descriptive models were developed in the hopes that they would better predict the human decision making process (Gigerenzer & Gaissmaier, 2011).

Descriptive models.

Unlike normative models, descriptive models assume that humans rely on simpler, less cognitively demanding strategies for decision making (Gigerenzer & Gaissmaier, 2011). One example of an early descriptive model is satisficing (Simon, 1957). Instead of optimizing decisions, Simon (1957) argued that humans generated and evaluated choices only up until they identified a satisfactory option. This concept corresponded with Simon's larger theory of "bounded rationality" which stated that human rationality was restricted by the limited time and information available to a decision maker, as well as their cognitive capacity (Simon, 1957). In accordance with this, Simon was among many researchers to investigate the use of time- and effort-saving mental shortcuts called heuristics (Gigerenzer & Gaissmaier, 2011).

Heuristics and Biases

Heuristics are frequently employed in decision making and strongly influence how humans process and choose from available options (Tversky & Kahneman, 1974). These rules-of-thumb enable humans to make quick and efficient judgments (Tversky & Kahneman, 1974). Since working memory—where decision making takes place—is limited, and humans are innately driven to efficiently process information with minimal time and effort, heuristics are widely used (Miller, 1956; Ashcraft, 1998). However, though effective in certain contexts, heuristics can also lead to biases and, ultimately, poor decisions (Gigerenzer & Todd, 1999; Wickens, 2004).

Though heuristics are pervasive, metacognitive processes can lead to awareness and inhibition of their biasing effects (Jacobs & Klaczynski, 2002; Morsanyi & Handley, 2008). The success and level of this inhibitory effect improves as humans become more cognizant of heuristics and develop and refine their metacognitive skills (Jacobs & Klaczynski, 2002). Additionally, research suggests that reminders, such as an auditory prompt to consider additional options, can help initiate this metacognitive process, leading to more methodical decisions (Klaczynski, 2001).

With that in mind, this paper will turn to an evaluation of the WebMD Physician Directory and how the design could better account for heuristics and biases, as well as harness metacognition.

Use Case: WebMD Physician Directory

Context for Medical Decision Making

While humans are susceptible to poor decision making, they particularly struggle to make rational decisions regarding their health (Donovan & Blake, 1992). This is, in part, due to the heuristics and biases mentioned previously, as well as the stress, anxiety, and even physical

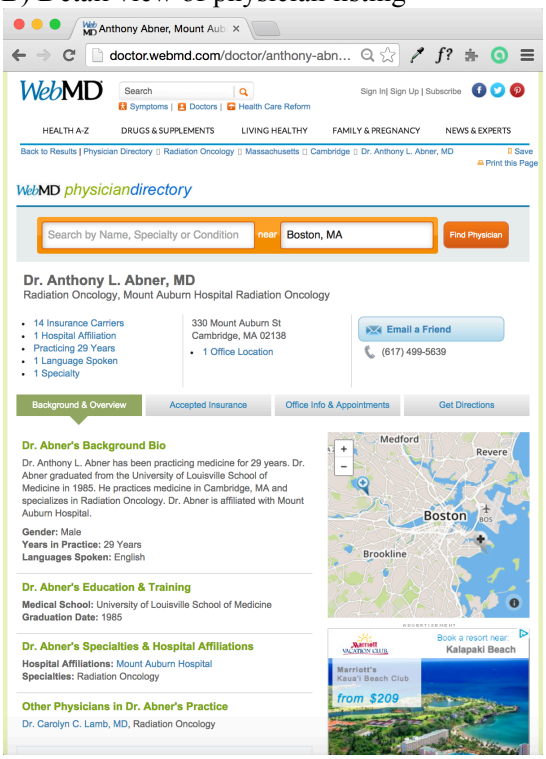
discomfort that can be experienced during the medical decision making process (Donovan & Blake, 1992; Keinan, 1987). Time pressure, such as that felt by a patient diagnosed with an aggressive illness (e.g. cancer), can further predispose an individual to make poor choices about such critical decisions as choosing a physician (Keinan, 1987).

Notably, those who are able to accurately assess their knowledge base, as well as monitor, evaluate, and implement changes to cognitive and metacognitive strategies, are more likely to make effective medical decisions (Higgs & Jones, 2008). For instance, a metacognitively aware patient could assess their knowledge and ability to discern the qualities of a good physician (e.g. years of experience, bedside manner), set a specific goal (e.g. find an oncologist who is both affordable and accessible), devise an appropriate strategy to accomplish this goal (e.g. search for physicians in a 15mi radius of my home, with evening office hours, who accepts my insurance), assess their performance (e.g. Am I finding physicians that meet my criteria?), and, if necessary, modify their strategies (e.g. broaden search by increasing acceptable distance from home).

Figure 1

A) WebMD's Physician Directory Main Page

B) Detail view of physician listing



Product Summary

WebMD is a highly popular medical site that provides users with health-related information, news, and advice. One feature of the site is the Physician Directory (see Figure 1A). This internal database enables users to search for physicians by name, specialty, or condition, as well as geographic location. Individual physician listing pages (see Figure 1B) provide additional information that could prove helpful in selecting a provider, including insurance accepted, hospital affiliation, years of experience, languages spoken, and contact information. Due to the

importance and potentially life-altering ramifications of choosing an appropriate physician, it is essential that the Physician Directory design leverage metacognition, in addition to moderating the influence of common heuristics and biases.

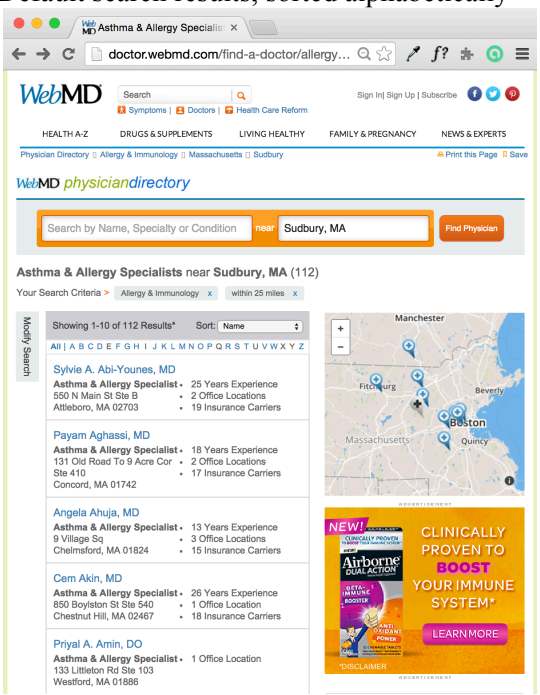
Relevant heuristics and biases.

Cue primacy and anchoring.

Two closely related heuristics at play in the WebMD Physician Directory are cue primacy and anchoring. Cue primacy refers to the human tendency to endow the first cues encountered with above average importance or weight (Adelman et al., 1996). This in turn leads individuals to fixate on these initial cues and use them as an "anchor" against which to compare other cues (Tversky & Kahneman, 1974). For instance, when a user conducts a search for an allergist near Sudbury, MA, the directory lists the search results in alphabetical order, by default (see Figure 2). This would likely lead many users to anchor upon and more heavily weight physicians with "A" names, even though a Dr. Smith might be a better choice for their specific needs and circumstances.

Figure 2

Default search results, sorted alphabetically



Representativeness heuristic.

Another factor that could influence the selection of a physician via the directory is the representativeness heuristic. This refers to the human tendency to judge a situation based on how similar it is to prototypes stored in memory (Tversky & Kahneman, 1974). For instance, if a patient views a provider that shares attributes with a prior physician (e.g. sees a female allergist with the same education and hospital affiliation as his well-liked and competent former allergist), he is more apt to liken the two and ascribe them similar traits, even though the two individuals may, in fact, be very different.

Availability heuristic.

The availability heuristic may also impact the quality of user decisions in this context. This heuristic leads humans to assume that hypotheses that are more easily retrieved from memory, such as those encountered more recently, are more common, important, and good (Tversky & Kahneman, 1974). For instance, if a user recently heard about the success of Beth Israel Hospital oncologists in treating breast cancer, they may make the cognitive leap that competent Beth Israel Hospital oncologists are more common, when that may or may not be the

case. As Wickens (2004) notes, availability in memory is not a solid foundation upon which to base such assumptions.

Familiarity bias.

The familiarity bias refers to the human inclination to favor the familiar over the novel (Ashcraft, 1998). This bias is exacerbated when an individual is experiencing high cognitive load, such as that caused by processing and comparing an overwhelmingly long list of potential physicians (Metcalfe, Schwartz, & Joaquim, 1993). Just as consumers tend to purchase the same brands, a user might seek out a physician associated with a familiar "brand" of hospital (e.g. Newton Wellesley) (Kurz-Milcke & Gigerenzer, 2007). This may or may not be the best criterion upon which to base their decision.

Confirmation bias.

Once humans have generated a working hypothesis, they tend to only seek out information that confirms that hypothesis, while underweighting or ignoring contrary evidence (Cohen, Freeman, & Wolf, 1996). This is known as confirmation bias (Cohen, Freeman, & Wolf, 1996). As with the familiarity bias, its effects are exacerbated under high cognitive load, as well as high stress, both of which are likely to be experienced by someone looking for a physician (Cohen, Freeman, & Wolf, 1996). For example, a user might hone in on a particular physician since he or she is located close to their home, while ignoring later evidence against that choice (e.g. their office has inconvenient hours).

Design Recommendations

While the WebMD Physician Directory offers helpful information to users, much of which is relevant to the process of choosing a physician, its ability to support user decision making could be significantly improved. For instance, the effect of cue primacy and anchoring could be acknowledged by changing the default sorting mechanism from alphabetical order to an arguably more important attribute, such as years of experience. Additionally, the representativeness, availability, and familiarity heuristics could be counteracted by adding a patient and/or peer review system, in which users could compare their heuristically based assumptions about physician competency and personal attributes against actual data. Similarly, confirmation bias could be counteracted by making a physician's strengths and deficiencies more salient. For instance, displaying search results in a chart format that clearly shows whether physicians meet all, some, or none of the user's search criteria would highlight areas where the physician deviates from the ideal match. This type of visual display would further aid the decision making process by reducing the cognitive load on the user, enabling them to directly compare physicians using "knowledge in the world" vs. "knowledge in the head" (Norman, 1988).

Lastly, but perhaps most importantly, the directory could cue metacognitive processes, which are known to improve decision making, through the use of prompts before and after the

initial search query (e.g. visual prompt that asks "Does your doctor need to accept a particular type of insurance?). This could serve the dual purpose of not only reminding users of relevant decision making factors, but also prompting them to consider factors they might not have naturally inferred were important, ultimately leading to the development of better metacognitive knowledge and strategies.

Conclusion

Metacognition clearly plays a powerful role in decision making, impacting how humans understand, monitor, and control their cognitive processes, as well as helping inhibit the often negative influence of heuristics and biases. By acknowledging and compensating for these heuristics and biases, as well as prompting metacognitive awareness, WebMD's Physician Directory could develop into a valuable tool for supporting users in the difficult, but critically important, decision of choosing a health care provider.

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