The effect of information access effort and metacognition on doctors’ information access behaviors and performances during pre-handover

Qualitative observations of healthcare practitioners’ activities during pre-handover phase suggest that they collect a variety of information retrieval strategies when collecting handover information. Some of them collect patient information from various written documents whereas others follow a rather memory intensive strategy, resonating the dichotomy of “Knowledge in the World” versus “Knowledge in the Head”. This paper examines the effect of information access effort and metacognition on doctors’ information retrieval behaviors and performances during pre-handover phase. An experiment simulating real handover preparation scenarios is being undertaken, with junior physicians as participants.

INTRODUCTION

The handover of information in health care is conceptualized as a three-phase process, consisting of a pre-handover phase, a handover communication phase, and a post-handover phase (Kerr, 2002; Raduma-Tomás, Flin, Yule, & Close, 2011). The main objective of the pre-handover phase is to ensure that an outgoing staff is ready to give handover to an incoming staff. It involves activities such as updating the patient list, collecting handover information, and preparing handover sheets. Ideally, pre-handover should be a structured process. In a chaotic environment such as the hospital, however, a structured pre-handover could easily be lost or truncated, resulting in compromised or lost information (Lawrence, Tomolo, Garlisi, & Aron, 2008). For example, doctors may lose track of time and suddenly realize they have to hand over cases very rapidly and deliver whatever information available at hand.

Qualitative observations of healthcare practitioners’ activities during the pre-handover phase suggest that they follow a variety of strategies when retrieving handover information. Some of them adopt a fairly structured process by collecting patient information from various written documents and cross examining the information accuracy and adequacy with their colleagues. Others follow a rather ad-hoc practice by handing over patients “wherever and whenever” without proper preparation. Under such circumstances, healthcare practitioners are more likely to depend on information in their heads. It is well known, however, that human memory is vulnerable to errors (Wickens, Hollands, Parasuraman, & Banbury, 2013). Therefore, such a strategy may impose potential threats to patient safety.

The two types of strategies resonate with the dichotomy that Norman has described as relying upon “knowledge in the world (KIW)” versus “knowledge in the head (KIH)”. Studies in Human Computer Interaction (HCI) have shown that the information access effort (IAE) either from the world or from the head affects the information retrieval strategies. As IAE in the world increases, people adopt a more memory dependent strategy (Ballard, Hayhoe, & Pelz, 1995; Gray & Fu, 2004).

However, none of the studies have taken into consideration the factor of ‘expected gain’, as suggested in the effort-performance space (Wickens, et al., 2013) and the contingency decision model (Payne, Bettman, & Johnson, 1988). According to them, one maximizes the utility of a choice by balancing the expected gain and the cost of effort. When retrieving knowledge from either the world or the head, people balance the expected gain of retrieving a desired memory item from the world or the head against the cost of information access in the world or the cost of memory search in the head. On this basis, the study of information retrieving behaviors would not be complete without the consideration of the ‘expected gain’ in utility of KIW versus KIH.

This study, therefore, aims to investigate the effect of IAE and the confidence judgment of information accuracy on doctors’ information retrieval strategies and performances.

TRADEOFF BETWEEN EFFORT AND ACCURACY

We argue in this paper, that doctors’ decision on whether to retrieve information from written documents or their heads, is based, at least in part, on the balance between two forces, as shown in table 1.

<table>
<thead>
<tr>
<th>Influence</th>
<th>Lookup (KIW)</th>
<th>Recall (KIH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anticipated accuracy</td>
<td>“100%”</td>
<td>Variable</td>
</tr>
<tr>
<td>Information Access Effort (IAE)</td>
<td>Variable</td>
<td>“0”</td>
</tr>
</tbody>
</table>

One influence on the choice between lookup and recall is the anticipated accuracy of the two strategies. If a piece of information is safety critical, such as whether a patient is deathly allergic to a frequently administered drug, it is essential that the information is retrieved with high accuracy. We might assume for simplicity that information retrieved from the world is essentially 100% accurate. Information retrieved from the head may also be extremely high, for example, the physician just read the chart, and remembers this allergy vividly. In this case, the reason why the physician may not always rely on the near perfect lookup is because of the possible effort, if the knowledge in the world is not immediately available, for example, the chart has been relocated in a different room, or the information needs to be retrieved through a difficult computer interface. This effort to retrieve KIW may be variable. On the other hand, we assume that the effort of recall is much less than that of lookup.
Thus, within the table, we see that the two courses of action can be represented by some certain outcomes (100% accuracy for lookup, 0 cost for recall), as well as some variable ones (AA for recall, and IAE for lookup). The influence of these two variables is complicated by two additional considerations. First, there is a growing body of knowledge that people are overconfident in the accuracy of their memory (Koehler, Brenner, & Griffin, 2002). Hence AA may be overestimated, biasing the decision toward a KIH strategy more than it should. Second, the actual IAE may be influenced by multiple factors, and the nature of such an IAE function in influencing actual decision choice is unclear. For example, it may have discontinuities such that IAE from my desk is much less than IAE if I need to get up and walk to another room.

In the following, we review three classes of literature bearing on this decision between KIH (recall) and KIW (lookup). First, we review the limited amount of research on how healthcare practitioners collect patient information for handover. Second, we consider the role of effort in information retrieval, even as it does not specifically describe the tradeoff with AA. Third, we review studies that have examined AA, particularly as manifest in overconfidence, documenting the circumstances when people anticipate that their accuracy is higher than it actually is, and what drives this overconfidence upwards.

**LITERATURE REVIEW**

**Information retrieval strategies in hospitals**

The majority of studies on medical handover have focused on the inter-handover phase whereas research on pre-handover phase was scarce with few exceptions.

In a qualitative study, Vidyarthi, Arora, Schnipper, Wall, and Wachter (2006) surveyed residents at three hospitals and reported no uniformity in how they handled their cross-covering doctors. Many residents handed over verbally “wherever and whenever” they could find the cross-covering doctor without proper preparation of handover notes. Due to the lack of preparation, it is highly likely that the residents depend on their own memory when transferring patient information.

In another study, Alem, Joseph, Kethers, Steele, & Wilkinson (2008) studied the information tools used by the outgoing doctors during handovers in a general medical ward and an Emergency Department (Lundeberg, Fox, Brown, & Elbendeur) (Lundeberg, et al.). They found that in both the general medical ward and the ED handovers, very few information tools were used. Outgoing doctors mainly used handwritten notes, either on patient lists or on blank sheets of paper. The information documented was often used as a “memory trigger” and much additional information, related to the trigger, would then be presented during the handover. Moreover, medical records were not used during handovers in either ED or the general medical ward. Doctors claimed that they often remembered patients who had been under their care before, and this information was used in handover. However, as the authors stated, there was no guarantee that a doctor would remember, or would even have been on the ward during a patient’s previous admission.

Similarly, Yang et al. (2011) interviewed residents on their handover practices from a three-phase prospective in a Singapore public hospital. The results showed that there is no structured protocol implemented for the pre-handover phase. Outgoing doctors tended to depend on a memory intensive strategy by retrieving patient information from their memory instead of referring to various kinds of written documents.

Apart from the studies focusing on doctors’ handovers, Kerr (2002) conducted a qualitative study of shift handover practices among different wards in a hospital and documented a variety of strategies that nurses adopted in the pre-handover phase. Nurses of the Oncology/Hematology wards were concerned with up-dating the official documents, such as care plans and the ward diary. The one or two nurses who were preparing to hand over at the handover meeting gathered information from team colleagues, official documents and their personal notes. On the ENT/Plastic/Dental ward, more off-going nurses were involved in pre-handover activities. Each nurse went off the ward with the official communication book and their own notes, in order to record information about the patients they had been caring for. The official documentation was passed round the off-going staff until a full report has been recorded.

Although limited, the above mentioned studies suggest that there is a variety of strategies that healthcare practitioners follow in the pre-handover phase to retrieve patient information. The nurses are more inclined to a KIW strategy and doctors are more inclined to a KIH strategy.

**Information access effort**

Effort has been the focus of numerous studies in psychology (Newell, 1990) and decision theory (Kahneman, 2011; Kahneman, Slovic, & Tversky, 1982). A consistent finding in these studies is that humans have limited physical and mental resources and thus are ‘inherently effort conserving’ when performing a task (Wickens & Macarley, 2007). Examples of effort conservation include the ‘edge effect’ in visual search where participants reduce visual scanning on peripheral areas of a screen due to increasing effort to do so (Parasuraman, 1986; Stelter & Wickens, 2006), and the ‘cost of compliance’ in unsafe behaviors where participants are less inclined to wear safety harness if the effort of obtaining or wearing it is high (Wickens, Lee, Liu, & Becker, 2004; Wogalter & Laughery, 2006).

A specific area of research in HCI is concerned with information retrieval effort. Ballard et al. (1995) developed the Blocks World Task (BWT) paradigm to investigate the relationship between information retrieval effort and people’s interactive strategies. They analyzed the strategies subjects used when performing the task and found that at the beginning of the task, a memoryless strategy was used most frequently. As the task proceeded, however, a memory intensive strategy was used increasingly and outweighed the memoryless strategies at the end of the task. The changes in strategy adoption can be explained as follows: at the beginning of the task, memorizing a block was difficult and thus subjects...
adopted the memoryless strategy. As the subjects proceeded with the task, they became more familiar with the block and hence the effort of retrieving the information of that block from memory decreased gradually. Therefore, the subject adopted the memory intensive strategy.

Gray and Fu (2001) proposed soft constraint theory to investigate the retrieval behaviors between information in the world and information in the head. They stated that there are two kinds of memories: internal memory and external memory, and effort is needed to retrieve information from the two kinds of memories. Internal effort refers to the effort used in encoding, storing and retrieval of an item from memory (i.e., KIH). External effort refers the effort spent searching the environment and the effort of retrieve an item at a known location (i.e., KIW). The soft constraint hypothesis claimed that the selection of an interactive behavior depends on the cost-benefit tradeoffs between the effectiveness and efficiency.

Despite the proposition of the two concepts - effectiveness and efficiency, in the hypothesis, the authors conducted a series of follow-up experiments solely focusing on testing the effect of IAE on the selection of interactive behaviors (Gray & Fu, 2001, 2004; Gray, Sims, Fu, & Schoelles, 2006). Despite of the different manipulating methods in these experiments, including eye movement versus mouse movement, varying levels of Fit’s index and varying levels of lookout time, the results have revealed a consistent finding that IAE is an important factor in determining information access behaviors - an increasing IAE encourages a more memory intensive strategy.

Utilizing the soft constraint hypothesis, Morgan, Patrick and their colleagues (2009; 2007) conducted a series of experiments on the effect of IAE on the encoding and retention of visually presented information and the results revealed a consistent shift from memoryless strategy to memory intensive strategy when IAE increased.

In summary, the effect of IAE is well documented in HCI literatures - an increasing IAE leads to less access to KIW.

**Metacognition and overconfidence**

Metacognition means the knowledge of one’s knowledge or beliefs (Koriat, 2007). Studies on metacognition have found that when making decisions, the confidence judgment of accuracy, rather than the actual accuracy determines the strategy selection (Chu & Spires, 2003; Fennema & Kleinmuntz, 1995; Payne, Bettman, & Johansson, 1993).

Under perfect calibration, metacognition reflects the exact level of one’s mental state. However, over 40 years of empirical research suggests that people are subject to systemic biases and usually overconfident about their knowledge or beliefs. Under the umbrella of metacognition, there is an increasing body of research on the confidence judgment of KIH, which is referred to as metamemory (Nelson & Narens, 1990). Two major domains in metamemory research are eyewitness memory (EM) and general knowledge (GK).

Bornstein & Zickafoose (1999) studied the relationship between confidence and accuracy in EM through two experiments imitating situations commonly found in criminal cases. Participants were exposed to two confederates for a controlled duration and one week later presented with a set of questions concerning the characteristics of the two confederates such as the color of their clothes. The results revealed a strong overconfidence bias that participants were on average 19% overconfident. Similar results were reported in the majority of research on EM in criminal settings (Allwood, Granhag, & Johansson, 2003; Granhag, Stromwall, & Allwood, 2000; Olsson, 2000).

Besides the studies in criminal EM, Krug & Weaver (2005) studied the reliability of EM in civil cases. An experimental paradigm was proposed where participants were asked to follow recipes for a dish and later were given surprise memory tests on the specific brands of products used in the recipes. In addition, they were asked to report their subjective confidence for each response. The results showed that metamemory accuracy was poor after even a brief delay, subjects’ being overconfident in their responses. Furthermore, the overconfidence bias was exacerbated by longer delay.

Another domain where retrospective memory has been investigated is memory for general knowledge, where participants are presented with general knowledge questions and asked to assess the probability that the chosen answer is correct. An overconfidence bias is typically observed, with mean probability judgments exceeding the proportion of correct answers (Lichtenstein & Fischhoff, 1982).

Lichtenstein and Fischhoff (1977, Experiment 3) studied confidence judgments on GK where participants responded to 75 questions with highly varied topics using a 4AFC (4 alternative forced choice) format and indicated their confidence to each answer. The results showed that on average, participants were correct in 63.8% of the answers, but assigning a mean probability of 0.724. Along the same line, Bornstein & Zickafoose (1999) studied the relationship between confidence and accuracy in GK. The results showed that participants were on average 16% overconfident in GK.

Overconfidence was also reported in research in classroom settings (Lundeberg, et al., 2000; Lundeberg, Fox, & Punciochar, 1994). Students were assessed on their learning results through course exams and asked to indicate their confidence on the correctness of their answers. An overconfidence bias has been observed across countries.

Since metacognitive judgments determine strategy selection, it is expected that the confidence judgment of accuracy for KIH will affect the information retrieval behaviors. It is further complicated by the prevalence of OC bias.

**RESEARCH MODEL AND HYPOTHESES**

None of the studies on information retrieval behaviors has considered the factor of ‘expected gain’ - confidence judgment of information accuracy. This paper, therefore, examines the effects of both IAE and confidence judgment in the research model, as shown in Figure 1.
The first independent variable is IAE from the world, which in the present study is manipulated by varying the physical distance to get handover information. The second independent variable is confidence of accuracy for KIH. The two dependent variables, information access attempt (IAA) measures the number of times that KIW is accessed, and performance measures the recall task performances (recall test 2 in the present study, refer to experimental procedure below for more details).

As IAE or confidence increases, people adopt a more memory-intensive strategy and make fewer IAAs to KIW.

H1a: As IAE increases, the number of IAAs will decrease.
H1b: As confidence judgment increases, the number of IAAs will decrease.

IAA and actual KIH accuracy together determine the performance. If the number of IAAs is less than it should have to be, resulting from OC or high IAE, performance will be impaired.

H2a: OC impairs performance (recall test 2)
H2b: High IAE impairs performance (recall test 2)

METHOD

Experimental material

To stimulate real patient cases that residents encounter in their daily work, a group of subject Matter Experts (SMEs) consisting of one consult, one registrar and one resident developed a pool of patient cases as experimental materials. Each patient case included patient admission information, hospitalization courses, handover instructions from consultant, and necessary investigation results.

Experimental design

The experimental design was a two by two within-subject design. IAE was manipulated by varying the physical distance of accessing KIW (in recall test 2). In the low condition, the original case notes (KIW) were stored at the same workstation as the recall tests. In the high condition, the case notes were stored at a computer 5 meters away from the workstation. Confidence judgment is manipulated by whether or not inserting a statement that emphasizes the accountability when answering questions in the recall tests. Accountability was defined as the “social pressure to justify one’s views to others” (Tetlock & Kim, 1987). Studies have shown that as accountability increases, accuracy increases, confidence decrease, and OC decreases (Sniezek, Paese, & Switzer III, 1990).

Participants and experimental procedure

Twenty junior residents consisting of house officers and medical officers from a public hospital of Singapore participated in the experiment.

Each subject participated in studying 4 patient cases randomly selected from the patient case pool. Subjects were then given two recall tests and each recall test consisted of 10 questions. In test 1, subjects had to depend on their memory entirely and provide confidence estimates, whereas in test 2 they were allowed to access information in the world, and no confidence assessments were made.

RESULTS AND DISCUSSION

To validate the research model, a pilot experiment with 36 university students as subjects has been conducted. In the experiment, each participant viewed 120 pictures and later on recognized them from some distractors. IAE was manipulated by varying the delay time when accessing KIW and confidence judgment was manipulated by utilizing the accuracy-confidence inversion pattern reported in Tulving (1981). The results revealed significant effects of IAE (p=.013) and confidence judgment (p=.032) on IAAs. As IAE increased from 1s to 2s or confidence judgment increased from 0.75 to 0.79, the number of IAAs decreased significantly.

The experiment with junior residents is being undertaken and expected to be completed in May 2013. The results will be written up for the proceedings paper, if it is accepted, and hence presented in the HFES conference.

REFERENCES


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