Should I Open this Email?:
Inbox-Level Cues, Curiosity and Attention to Email

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ABSTRACT

The quantity of email people receive each day can be overwhelming. Previous research suggests that when handling email, individuals prioritize certain messages for attention over others. Since people generally make this decision about which message to read before opening the email, the question largely unanswered in the email literature is: what surface features of an email draw attention to it? In this research, we examined how top-level cues about an email's content influence attention to email. We describe results from a think-aloud study examining people's stated rationale for prioritizing certain emails over others. Based on these results and theory on curiosity, we conducted an experiment examining how message importance, subject line specificity, workload and personal utility influence attention to email. Results suggest that uncertainty about message content at the inbox level increases the likelihood of attention to a message. The influence of uncertainty diminishes, however, in the face of enhanced task and personal utility cues and increased demand, suggesting that curiosity operates in an intrinsic way in the email context. Our results have implications for intelligent email system design, email client interfaces, and reducing email strain.

Author Keywords

Electronic mail, email, prioritization, attention, curiosity, information gap, computer- mediated communication.

ACM Classification Keywords

H5.3. Information interfaces and presentation (e.g., HCI): Group and Organization Interfaces.

INTRODUCTION

Email remains one of the most popular forms of computer-mediated communication, used constantly at work and at home. According to The Radicati Group, about 1.9 billion people around the world used email in 2010 and this number is expected to rise to 2.5 billion by 2014 [23]. Email's low cost and rapid but asynchronous delivery continues to provide benefits over other media [2]. The flexibility for sending files, meeting reminders, and a variety of other types of information, means email is now the vehicle for a large portion of work-related communications.

These benefits come at a cost. Managers in corporate America receive hundreds of emails per day. Newspapers, magazines, and blogs regularly feature articles on handling the constant influx of email (e.g. [29]). Email is a contributor to what organizational scholars call information overload and, more specifically, email overload [7, 27, 30]. Email researchers have gone so far as to label email a "habitat" because employees spend so much time absorbed in it [10].

Given the volume of email exchanged, it is not surprising that people do not always read every message they receive, or read messages in the order they arrive [25, 30]. Research has examined and described the email management process in depth [11]. This previous work on email suggests that individuals prioritize some messages for attention over others when scanning the inbox [2, 25, 30].

A question that remains largely unanswered, however, is *why* people attend to certain messages and not others. It is unclear how individuals weigh the inbox-level information available to prioritize their email [25]. The influences on this decision have implications for how messages are presented to users, for reducing the stress that accompanies receiving large quantities of email, and for improving artificial intelligence systems for sorting email and other asynchronous text-based communication.

In this paper, we consider the influences on email prioritization. We examine when and how inbox-level cues about message content influence attention to email messages. In a controlled experiment we manipulated the

inbox-level features that think-aloud sessions and the information gap theory of curiosity indicated were important. Our results suggest that recipients use inbox-level cues about an email's utility and likely content differentially depending on the demands on their attention and whether utility signals are tied to the direct benefits they receive from a message. Our research deepens the understanding of how people prioritize information, and should inform the design of email clients and email labeling strategies.

RELATED WORK

Prior research demonstrates that people use email in many different ways for a host of purposes [10, 20, 31]. At a basic level, email management involves handling incoming messages. Venolia et al. delineated five stages of 'email workflow' which include *flow, triage, task management, archive, and retrieval* [30]). Email flow, is a term used to describe the process by which people handle incoming email messages as they arrive [25, 29]. The previous work suggests that during 'flow' people preferentially attend to some messages before others, and spend time selecting which message to examine [1, 25, 30]. For example, Bälter found that the majority of participants in their study scanned the inbox an average of 2.3 times before selecting a message to read [2].

Siu, Iverson & Tang [25] extended the work of Venolia et al. [30] by delineating stages within the 'email flow' process. Their results suggested that people interleave flow, triage and task management, and that managing incoming email involves three stages: *glance, scan, and defer* [25]. Individuals *glance* at their inbox periodically to determine whether new messages have arrived. If enough new messages are present or users are expecting a specific message, they will *scan* the headers of the new messages to determine whether something needs to be read, based on inferences about message content. They will subsequently begin acting on messages in the inbox (i.e., begin triage and task management) or *defer* and return to the inbox later. Although Siu et al.'s work describes the general process people use to manage incoming messages as they arrive, it does not describe message selection criteria during the scan stage. Research has not yet identified why people select certain messages for attention over others, or the features people attend to during the message selection process.

At the same time, research on email prioritization, has attempted to facilitate the message selection process by intelligently making certain messages more visually salient as they arrive [8, 16, 21]. This work has, for the most part, made assumptions about which messages require attention, for example using machine learning algorithms to predict the likelihood a message requires a response (e.g. [8]). Results by Dabbish et al. [6] suggest that the need to respond is only one component of perceived message importance, with a large proportion of the variance in perceived message importance not unexplained by it [6].

Other researchers and commercial systems try to support email prioritization by allowing the message sender to define the importance of a message, attaching a visual priority indicator or attaching a currency to some messages and not others [18, 24]. Among the most interesting are systems that allow senders to place an artificial postage or currency on messages. The currency provides an inbox level indicator of how much the sender values the email, and should aid in the decision of whether or not to open an email. The postage also provides direct utility to the recipient, causing them to open messages associated with more postage more quickly [24]. Paying for communication causes senders to ration it [18] and limit it to more serious purposes [15]. However, such systems have seen limited adoption, and experiments investigating the utility of markets and postage for directing email attention have had mixed results [18, 24]. A deeper understanding of the decision to attend to a message may better inform the design of these types of systems.

Our goal in the current research was to address a gap in the previous work and identify why people attend to some emails and not others based on inbox-level cues about message content. We first conducted a think-aloud study to gain insight on how inbox-level cues influenced receivers' motivation to attend to a message. We found that attention was a function of their predictions about the utility of message content and their curiosity about message content. This think-aloud study, along with curiosity theory, informed an experiment examining the relative influence of inbox-level cues on attention to a message. In the next section we describe the think-aloud study and results, and in the following section we describe our laboratory experiment.

THINK-ALOUD STUDY

We used the think-aloud method [12] to explore motivations behind attention to email. While other methods (i.e., logging) can tell us which emails people are opening, the think-aloud method can reveal *why* people are choosing to open one email over another based on inbox-level cues and the inferences they make from these cues.

We conducted one hour think-aloud sessions with five participants, one male and four females (M age = 30.2 years, range = 22 to 55, SD = 14.2) all US citizens who worked full time. Participants included an entertainment intern, health promotions specialist, operations and management performance manager, legal assistant, and lab manager. During the sessions, participants accessed their work email account and were asked to verbalize their thoughts while selecting emails they would like to read immediately. Time permitting, participants also identified emails they could postpone reading and emails they could delete in their inbox.

In total, the five participants selected 24 emails in their respective inboxes as ones they wanted to read immediately

(approximately 5 messages each). In our analysis, we organized the participant responses for each message by similarity in motivation to read. Two themes emerged from this analysis suggesting attention to a message was a function of (1) inferred utility of message content, and (2) curiosity.

Utility

Participants expressed wanting to read emails that directly affected their work. These messages were from senders important to them in their organization, such as a close collaborator or supervisor, and in many cases they associated the messages with very recent ongoing projects. Participants also wanted to read emails that they thought were responses to questions they had asked or requests they had made.

For example, one participant, Anna used the sender and subject line to infer that a message was a response to an email she had sent asking a question. She wanted to read this email to because she expected the response would be useful for her ongoing work. The other participants expressed similar motivations for reading responses to queries.

Curiosity

More surprisingly, participants also wanted to open messages when they had moderate levels of uncertainty about the contents, i.e. they were "curious" what the messages were about. This occurred when they knew who the email was from but were not sure of its content, or when they were sure of the message's topic (because of a detailed subject line), but were unfamiliar with the sender.

For example, one participant wanted to read an email from an unknown sender because the subject line indicated the message was about a future project at another branch of her company. Even though the email had a detailed subject line, the participant could not infer the contents because the participant was only vaguely aware of the project. The participant knew the sender was somebody in her company, but not who the person was or his position. She wanted to read the email to learn more about the sender and the topic, although it was unclear before opening the message whether it would be immediately relevant to her work.

Summary

The primary purpose of the think-aloud study was to gain additional insight into the influence of inbox-level cues on motivations to open certain emails over others. The most surprising finding was that people wanted to open emails when they had moderate uncertainty about message contents. Each participant provided support for the hypothesis that having some idea what an email is about, but not being sure, created a desire to open the email.

It is important to note that our think-aloud study involved reading messages in isolation, away from the fluctuating demands of the workplace. Previous research suggests ongoing work demands should influence attention, motivation, and reading strategies [10, 25]. In particular,

Siu et al.'s results suggest that demand should increase selectivity during email flow. In the next section, we consider expected relationships between utility cues, uncertainty, and demand based on behavioral decision theory on curiosity and research on motivation.

CURIOSITY AND ATTENTION TO EMAIL

The think-aloud sessions suggested that both perceived message utility and curiosity drove attention to email. People used inbox-level cues to form perceptions about message content, consistent with the results of Siu et al. [25]. When there was some uncertainty about the content, i.e. necessary cues were missing or provided insufficient detail, curiosity appeared to drive attention to an email message. Curiosity is a strong desire to know or learn something. It is a driving force in why many people try to obtain more information or realize a goal and an important factor in child development and adult learning [4, 19].

Curiosity has not been examined in the email context. In part, this is because many theories of curiosity view it as a trait that people possess in different strengths [19]. This view is inconsistent, however, with evidence suggesting that curiosity can be generated, and is typically a response to novel cues or stimuli in the environment and thus situational [4, 19].

The "information gap" theory of curiosity posits that desire for new information is generated in response to a difference between what one knows and what one wants to know [19]. When people become aware of a gap in their knowledge, they are driven to fill this gap. As information is gathered, curiosity is most intense when the information gap is moderate, because it makes the missing information all the more valuable and interesting [19]. Our think-aloud results suggested that ambiguous subject lines or unknown senders generated curiosity and a subsequent desire to read messages in the email context. Difficulty predicting exactly what a message would be about motivated participants to close the information gap by reading the email.

The information gap theory of curiosity does not distinguish, however, whether curiosity operates in an extrinsic versus intrinsic way. Intrinsic motivation refers to behavior performed for the inherent enjoyment and satisfaction associated with the activity, while extrinsic motivation refers to behavior performed to achieve some separable goal [8]. Curiosity in the email context may be operating in an intrinsic way, satisfying a natural desire to resolve uncertainty, or in a more utility directed extrinsic way, in that individuals want to read emails with some top-level uncertainty in order to obtain any goal-related information from the message. In our think-aloud study, we were not able to isolate the relative influence of utility versus natural interest.

Related work on email postage in corporations suggests that curiosity may have a direct influence on the likelihood of reading a message beyond personal utility. Participants in a

study by Reeves et al. [24] read messages with higher levels of postage (increasing importance indicators) more quickly. Counter-intuitively, participants also read messages with no postage (i.e. no importance cues) significantly faster than messages with only a small amount of postage. Their result suggests that uncertainty may have a direct effect on attention, but it remains unclear whether that effect is a function of needing the information to achieve task goals (extrinsic view) or a natural desire to satisfy the gap regardless of task or personal value (intrinsic view).

If curiosity operates in an extrinsic way, we would expect that variation in marked message utility (in the form of importance insignias at the inbox-level) would enhance the influence of uncertainty on attention to a message. That is, information gap would have a stronger influence on attention if it was tied to message importance. According to this view, individuals should be more likely to read messages that are marked as important in general, but even more so when there is an information gap. However, if curiosity operates in an intrinsic way, i.e. as a natural desire to satisfy the information gap regardless of value, we would expect uncertainty to have an independent effect from marked importance. Based on the information gap theory of curiosity, we propose the following hypotheses consistent with the intrinsic view:

Hypothesis 1: Messages with greater information gap (less information about the content in the subject line) will induce more curiosity, which, in turn, will increase the likelihood and speed of reading them.

Hypothesis 2: Greater information gap will increase the likelihood and speed of reading a message independent of marked message importance.

Message importance may have a stronger influence on attention when it is aligned directly with the benefits an individual receives from a message. Email postage, as described above, serves to effectively align the benefits an individual receives from reading a message with the sender's information needs. The study by Reeves suggests this should result in more immediate attention to messages with higher pay value [24]. Individuals can assess the utility of a message from top level cues (e.g. importance insignias or priority flags). These cues should have an even stronger influence on attention and extrinsic motivation when they are directly tied with the monetary utility an individual receives from reading a message. Previous work has shown that providing extrinsic motivation for a task typically reduces intrinsic motivation [8]. Thus, if curiosity operates in an intrinsic way, when marked message importance is associated with direct message utility to the individual, information gap should no longer have an influence on attention. However, if curiosity operates in an extrinsic way, we would expect importance-based pay to enhance the influence of information gap on attention to a message. Given these considerations, we present the following hypothesis consistent with the intrinsic view:

Hypothesis 3: The effect of an information gap on attention to a message will decrease when messages vary in their direct utility to the individual.

Finally, we wanted to determine whether curiosity would continue to influence attention to messages under demanding conditions. If curiosity operates in an intrinsic way, under cognitively demanding conditions we should see a decreased influence of information gap on attention to messages [1]. At the same time, higher cognitive demands increase automaticity of cognitive processing, meaning under more cognitively demanding conditions individuals should pay more attention to messages marked as task importance. Thus, we propose the following hypotheses consistent with the intrinsic view of curiosity:

Hypothesis 4: Greater demands on attention will decrease the influence of information gap on likelihood and speed of reading a message.

Hypothesis 5: Greater demands on attention will increase the influence of marked message importance on likelihood and speed of reading a message.

We investigated these hypotheses in a laboratory experiment. In the next section we describe our experiment and results.

EXPERIMENT: ATTENTION TO EMAIL

In order to examine the relationship between inbox-level information gap, task and personal utility cues, and demands on attention, we conducted a controlled experiment.

Task

Participants in the experiment completed a task that involved reading, summarizing, and forwarding simulated emails. Participants were told that the goal of the study was to learn more about how people use email to plan an event. They played the role of a temporary worker substituting for a conference planner, who was out sick. The participants' job was to handle emails the planner received in their absence by briefly summarizing and forwarding them to specific people who could deal with the contents of each message (e.g., requests to change the website were forwarded to the webmaster).

The forwarding task was designed so that the amount of work required to deal with a message would not influence attention to certain messages over others. Participants had an equivalent set of actions to perform with each message, and an equivalent cost per message in terms of processing time. Once participants opened a message, they would read it and type in a one sentence summary of the message contents at the top before forwarding it to the appropriate person. There were no other actions associated with handling a message, and all messages they received needed to be forwarded. Participants were compensated based on how many messages they accurately summarized and successfully forwarded to the correct person.

Subject	From	Date
[No Subject] + + +	jrobertson@ardra.org	9/15/06 10:47
CHANGE-SESSION: Room Configuration ++	dgmurray@ardra.org	9/15/06 10:47
CHANGE-SESSION +	jdrex@ardra.org	9/15/06 10:48

Figure 1. Sample of inbox-level cues in the study

The emails used for this study were modified from the RADAR Wargaming Email Corpus [26]. The corpus contains messages a conference planner might receive when planning a complex conference taking place on a university campus. Over 90% of the content in the email corpus is fabricated. Each email is addressed to the conference planner and has a unique subject line and a sender and a message body between 1-5 sentences long. All of the emails are associated with one of nine categories based on the nature of their content with respect to the conference planning activities (e.g., room change, speaker change, or website change). Participants received emails from this corpus during the study.

All participants were given a message mapping table that listed the person associated with each type of email message, based on the nine original RADAR categories. The recipients' email addresses were pre-entered into the email client's address book, so that the email address of the recipient could be easily selected. All email clients were set at the beginning of each session such that email was ordered by time of arrival. Participants were free to change these settings or reorder the messages in their inbox.

Design
Our experiment used a 3 (information gap) by 3 (marked importance) by 2 (personal utility) by 2 (demand) counterbalanced design. Information gap, importance, and demand were manipulated between messages within subjects while pay rate was manipulated between subjects.

Information gap
In order to induce curiosity, we manipulated information gap within subjects at the message level. We randomly assigned subject lines to messages to vary the amount of information visible at the inbox level about the message's content. Messages either had no subject (large information gap), message category only (e.g. "CHANGE-SESSION" – medium information gap), or message category plus full subject (e.g. "CHANGE-SESSION: Room Configuration" – low information gap). This manipulation was used to vary the participant's certainty about the message content. The message category was printed in the body of all messages so that modifications of the subject line would not affect the ability to complete the message forwarding task.

Importance
We also manipulated the marked utility of a message to the conference planning task at the message level. We randomly assigned a priority indicator to the end of each of the message subject lines (low = "+", medium = "++" and high= "+ + +"). Importance was balanced across message category so that there were an equal number of messages at each importance level in each category. Figure 1 demonstrates how importance and information gap were manipulated in message subject lines.

Personal utility
In order to vary whether the marked importance of the message for the conference aligned with participants' personal utility, we manipulated pay rate as a between-subjects variable. In the fixed pay rate condition, participants were told that they would receive a fixed amount ($0.09) for each correctly forwarded message. Here marked importance was simply a signal of a message's organizational utility. In the variable pay rate condition the participants were told that the pay per message varied based on the message's marked task importance (low importance=$0.08, medium importance=$0.09, and high importance=$0.10). In this variable pay scheme, marked importance became a signal of a message's direct personal utility.

Demand
We manipulated demand within subjects by modifying the message arrival rate in each half of the experimental session. Participants experienced half the session in a condition of high demand with a fast message arrival rate (approximately four messages per minute) and the other half in a condition of low demand with a slower message arrival rate (approximately two messages per minute), with condition order counterbalanced to control for possible fatigue.

In order to have an equivalent set of messages in the high and low demand halves of the session, we created a set of 62 dependent messages that were delivered in every experimental session, half (1-31) in the first part of every session and half (32-62) in the second part. We refer to these as 'target messages'. The target messages were balanced across the first and second half of the session by assigned RADAR category so the messages delivered in each half of the session would be equivalent.

In the high demand condition, participants received a new message every 14.5 seconds on average (range: 10.88-18.3 seconds), in the span of 18 minutes. 31 out of the 76 messages received were target messages and 45 of the messages were filler (although to the participants these messages were indistinguishable). In the low demand condition, participants received a new message every 28 seconds on average (range: 22.5-37.5 seconds), for a total of 42 emails in 18 minutes. In the low demand condition, 31 out of the 42 messages were target messages (80%) and the other 11 were filler.

Dependent measures
The primary outcome variable in this study was whether or not an email was read. We examined the impact of our experimental manipulations on the likelihood of reading the 62 target messages sent to all participants across both

demand conditions.

RESULTS

A total of 38 participants completed the study. Eighteen participants (47%) were male and twenty participants were female. Participants' average age was 25 years (min = 19, max = 53; std. dev. = 8), 25 (66%) were college students, and 30 (80%) reported that English was their first language. On average, participants were compensated $13.00 for completing the study, which took one hour.

Analysis

We were primarily interested in how our manipulations influenced attention to a message. Therefore, our analyses were conducted at the message level. Attention to a message was measured in terms of likelihood of reading a message and the order a message was read relative to when it was sent. We focus here on the likelihood of reading a message. As noted above, each of the 38 participants in the study were sent 31 target messages in each of the two sessions in the study trial, or 62 target messages overall, for a total of 2,356 messages included in the analysis.

Preliminary analyses showed no difference on any outcomes between the medium and low information gap conditions, in which subject lines contained only the message category or the message category plus complete subject line respectively. This was because the message category was the only information needed to accomplish the email forwarding task, rendering the medium and low uncertainty subject lines equivalent in terms of the participant's expectation about message content. As a result, to simplify the analysis, we collapsed medium and low uncertainty conditions to create a 'certain message' condition, which we compared with the high uncertainty condition (no subject line).

We analyzed the message data using a mixed-model logistic regression with participant included as a random effect control for the non-independence of data at the participant level, since participants read and responded to multiple messages per session. Our model included main effects variables for our manipulations of interest (information gap, task importance, personal utility, and demand), and two-way interactions for importance by utility, information gap by utility, information gap by demand, and importance by demand. Results from this analysis were qualitatively consistent with a mixed-model least squares regression, and so we report the results from the latter analysis for ease of interpretation. The overall model was significant ($p<0.0001$; R-squared=0.22).

We first present results on the influence and success of our manipulations of task importance, personal utility, and demand. We then discuss the tests of our hypotheses about curiosity.
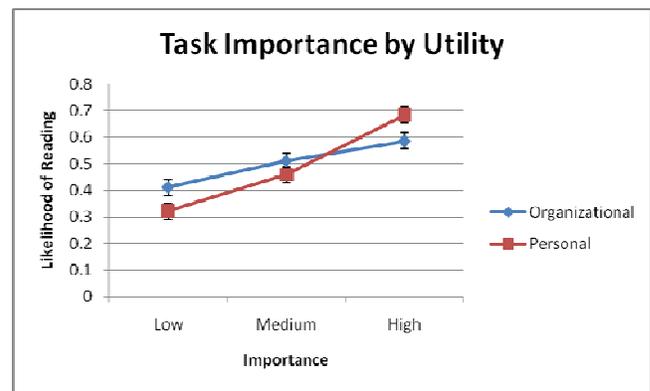

Figure 2. Importance by pay scheme interaction. Importance had stronger influence when aligned with personal utility.

Importance, Utility, and Demand Manipulations

Task Importance

Across all conditions participants were substantially more likely to read a message the more task important it was labeled ($F(2,2319)=56.6$; $p<0.0001$). Participants had a 30.1% (std. dev. = 45.9%) likelihood of reading low importance messages, a 43.9% (std. dev. = 49.7%) likelihood of reading the medium importance messages and a 58.0% (std. dev. = 49.4%) likelihood of reading the high-importance messages.

Personal Utility

Our manipulation of pay scheme allowed us to examine whether aligning personal utility with organizational utility would change attention to a message. There was no significant difference in the likelihood of reading a message in the personal utility condition (45.1%, std. dev. = 49.8%) compared to the organizational utility condition (43.3%, std. dev. = 49.6%) ($F(1, 38)=0.26$; $p=0.61$).

We examined the 2-way interaction between utility and task importance interaction to understand whether aligning personal utility with task importance strengthened the influence of importance on attention to a message. There was a significant interaction as shown in Figure 2 ($F(2,2320)=9.10$; $p<0.001$). The effect of importance on attention was significantly stronger when aligned with personal utility (variable pay). This interaction suggests that importance provided the strongest extrinsic motivation for attention to a message when aligned with personal utility. Thus in the personal utility (or variable pay) condition we expected to see the strongest relationship between information gap, importance and attention if curiosity operates in an extrinsic way and no influence of information gap if curiosity operates in an intrinsic way.

Demand

In order to check whether the manipulation of demand was successful, participants completed the six-item NASA Task Load Index (TLX) questionnaire [14] to measure the workload they experienced in each half of the experiment. Respondents answered questions such as, 'how mentally demanding was the task?', 'how hurried or rushed was the

pace of the task', and, 'how hard did you have to work to accomplish your level of performance?' They also judged the perceived message arrival rate.

Using a paired t-test, we compared within subjects the responses on each of the NASA TLX items and the question about perceived message arrival rate following the high versus low demand condition. Participants reported higher time demand and effort for the high demand compared to the low demand condition (Time demand: $t(37)=2.65$, $p=.04$; Effort: $t(37)=2.58$, $p=.05$). In addition, participants perceived the messages were arriving at a significantly faster rate in the high demand condition ($t(37)=2.33$, $p=.01$).

In the high demand condition, participants were less likely to read any particular message and read fewer messages, overall ($F(1,2312)=158.8$; $p<0.0001$). This difference was expected because participants received 120% more messages in the high demand condition compared to the low demand condition, meaning they had a larger set of messages competing for their attention. Participants read 26.9 messages in the high demand condition (std. dev.=10.7, min=10, max =49) and 20.1 messages in the low demand condition (std. dev.=5.59, min=9, max=31). These differences, along with our manipulation check, indicate that our manipulation of demand increased perceived and experienced demands on attention. In light of these effects of our manipulations, we now examine our central hypotheses about curiosity.

Curiosity Results
We hypothesized that if curiosity operates in an intrinsic way, there would be a main effect of information gap (H1) independent of importance (H2), that when marked message importance was aligned with personal utility it would reduce the influence of information gap versus when it did not have direct utility for the recipient (fixed pay condition) (H3), and that participants would pay less attention to information gap (H4) and more to message importance (H5) when overloaded.

Information Gap
The presence of an information gap strongly increased the likelihood of reading a message, consistent with H1. Participants read 56% of the messages with an information gap, versus 38% of messages with no gap, where the subject lines contained information about content type ($F(1,2315)=87.3$; $p<0.0001$).

Task Importance and Information Gap
In order to test H2, we looked at the interaction between marked message importance and information gap. If curiosity operates in an extrinsic way, marked task importance should enhance the effect of information gap on

attention to a message. However, we found no significant interaction between marked importance of a message and information gap ($F(2,2320)=3.09$; $p=0.10$).

Personal Utility and Information Gap
If curiosity operates in an intrinsic way, aligning marked message importance with personal utility (variable pay condition) should reduce the influence of information gap on attention (H3). If extrinsic, we would expect this alignment to enhance the influence of information gap on attention to a message. We examined this relationship by looking at the interaction between the pay rate condition (fixed versus variable) and information gap.

We found a significant interaction in that information gap significantly increased attention to a message in the fixed pay condition (no personal utility) and no longer influenced attention to a message under the variable pay condition (when personal utility aligned with marked message importance). The presence of an information gap doubled the likelihood of reading a message in the fixed pay condition ($F(1,2316)= 45.4$; $p<0.0001$), but did not change the relationship in the variable pay condition. This interaction suggests that curiosity may be operating in an intrinsic way, having the strongest influence on behavior when the task payoff does not vary (fixed pay condition).

Demand, Importance and Information Gap
Finally, we examined the influence of demand on curiosity. If curiosity is operating in an intrinsic way, we would expect increased attentional demand to lower the influence of curiosity (H4) consistent with previous work demonstrating the influence of demand on intrinsic motivation [1]. If however, curiosity is operating in an extrinsic way, increased demand should increase the influence of an information gap on attention. This should be evidenced by a similar increase in the influence of marked message importance on attention (H5).
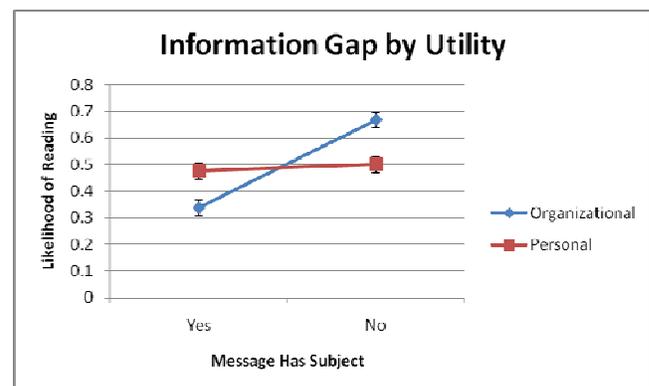

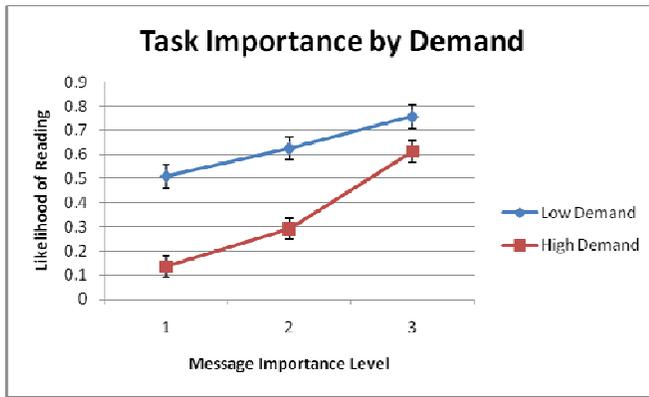**Figure 3. Information gap by utility interaction on attention to a message.**

Figure 4a. Task importance by demand interaction on attention to a message.

Figure 4b. Information gap by demand interaction on attention to a message.

Our analysis revealed significant interactions between demand and information gap ($F(1, 2324)=15.3$; $p<0.0001$) and demand and importance ($F(2, 2320)=12.4$; $p<0.0001$), both consistent with the intrinsic view of curiosity. Demand increased the influence of importance on attention (Figure 4a) but decreased the influence of information gap on attention (Figure 4b). In the low demand condition, information gap significantly increased the likelihood of reading a message, while information gap had much a much smaller effect in the high demand condition.

Summary

The goal of our laboratory experiment was to examine the influence of the factors identified in our think-aloud sessions on attention to email messages. We wanted to determine exactly how inbox-level cues about message utility and certainty about message content interact to influence attention to a message. A controlled laboratory task allowed us to manipulate certainty about a message's contents independently of the message's marked importance, personal utility, and attentional demand.

Our results suggest that curiosity drives attention in the email context, and operates in an intrinsic way. We found that information gap had an influence on attention (H1), independent of message importance (H2). When personal utility was aligned with importance, creating extrinsic motivation for attention to important messages, information gap no longer influenced attention (H3). When participants were overloaded and had more messages to choose from, information gap had much less of an effect on attention (H4), while task importance had an even stronger effect (H5). These results are consistent with other work showing that intrinsic motivations diminish in the face of extrinsic motivation for a task and cognitive demand.

DISCUSSION

Our results shed light on why people choose to attend to some email messages in their inbox and not others, and on the motivational mechanism of curiosity. Our results suggest that one of the reasons people may attend to an email is because they are curious about the content. By
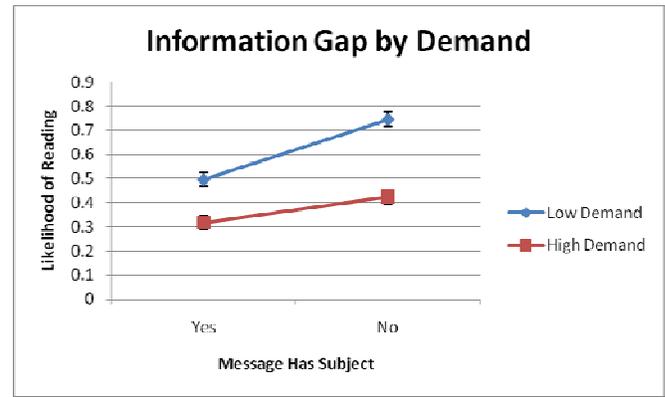
experimentally and randomly varying the amount of information people received in an email's subject line, we produced a gap in how much one knows about the content of a message based only on the inbox-level information available when scanning the inbox. Consistent with our hypotheses, people attended to messages that had the largest information gap in terms of the least amount of information about the content in the subject line, regardless of marked task importance. This is particularly interesting because common intuition is to make the subject line detailed so that people know at a glance what a message is about and then will read it.

People seemed to attend to messages with the largest information gap for intrinsic rather than extrinsic reasons. Curiosity no longer drove attention in the face of extrinsic rewards (when they were paid more to attend to certain messages) or increased demand (when people were overloaded).

Our results also suggest that surface-level signals of utility may be useful for directing attention to benefit both high volume email users and senders who need an email read immediately. Attaching a utility signal to a message, such as postage or currency, may intensify the effect of signals of organizational or task importance. The results of the current laboratory study support the findings of the Reeves study because participants in our study, when compensated by importance level, were more likely to read important emails and chose to read more important emails before less important emails.

We expected increased demand to reduce the influence of information gap if uncertainty operates in an intrinsic way. We found that demand enhanced the effect of importance signals but reduced the effect of uncertainty on attention. The fact that uncertainty no longer drove attention when demands were high suggests that curiosity may be a more deliberative motivation requiring cognitive or perceptual resources, diminished when an individual feels stressed or time pressured. This suggests that for overloaded recipients, crafting subject lines that imply organizationally important

content, will cause people to open the message sooner than varying the amount of detail at the inbox-level.

People are naturally curious, but the mechanism of curiosity remains unclear. In our study, participants wanted to read messages with no subject, perhaps because they wanted to figure out what the message was about. But the reduced effect of information gap in the face of varying personal utility and increased demand sheds some light on the mechanism behind curiosity. We see that in the email context, curiosity operates in an intrinsic way, diminished by variation in extrinsic rewards and increased cognitive demand. This may be the case in other dynamic information contexts as well, such as internet based information feeds like RSS or lightweight communications such as twitter. Future work should consider the application and extension of these results to contexts where attention to incoming information or communication is critical for effective task performance.

Implications for HCI

Our results may have implications for email client design. Prioritization systems could integrate our results into when and how they flag and reorder messages for attention, incorporating some of the curiosity inducing factors we found, e.g. job-relevance and sender familiarity. Email clients could dynamically adjust presentation based on moment by moment inferred user demand.

Our results may also have more general implications for the design of interfaces presenting multiple pieces of information simultaneously (e.g. search interfaces, Twitter, RSS feeds, etc.). Future work should examine whether these results extend beyond email.

Limitations

Our experiment had many of the limitations typically associated with laboratory research. First, realism was traded for experimental control. In our experiment we used a realistic management simulation with an organizational back story to engage participants in the task. The participants were assigned a role as a secretary in a hypothetical organization and the emails were related to their assigned task. However, the participants did not know the individuals they were receiving messages from, and the organizational context was hypothetical. The messages were not personally meaningful to participants beyond the constraints of the task assigned by the experimenter. Because we wanted to reduce variability we simply assigned an importance indicator to each message and randomly varied the message sender. Normally, people do not receive emails with importance so obviously labeled and subject lines that categorize message contents. Message importance in a corporate environment, may be strongly correlated with who sends the message. Future work should examine how the type of sender and the relationship with that sender interacts with the variables we have considered.

At the same time, the effects observed in our study provide evidence of face validity of the experimental simulation.

Participants valued important messages even though the task was simulated. In addition, we were able to engender curiosity about message contents, even though participants were reading and forwarding emails completely disconnected from their own work and social life.

Because we used a repeated-measures design, we were able to collect a sizeable set of observations on attention to messages with a relatively low number of participants. In addition, individual differences accounted only for a moderate portion of the variance we observed in our model (5 out of 22%). However, testing the mechanisms we discovered using a between subjects design or simply including more participants would increase our validity.

Despite these limitations, our results significantly advance the understanding of why people attend to some emails and not others, showing the differential effects of inbox-level cues about message context as work demands vary.

Conclusion

Managing email is a task that millions of people complete on a regular basis. A basic stage in email management is going through the inbox and choosing which messages to read. Although previous work has identified that people scan through these emails and choose which emails to attend to, we understand less about why some messages receive attention and not others.

In this research, we developed and then experimentally tested hypotheses about why people attend to some messages and not others. Our think-aloud study suggested that individuals make inferences about message content based on top-level cues and that inferred utility as well as curiosity seem to drive attention to a message. We applied the information gap theory of curiosity, which suggests that curiosity can be induced by a gap between what someone knows and what someone wants to know [19]. In a controlled laboratory experiment, we investigated the relationship between information gap, utility and demand. We discovered that curiosity drives attention to email under conditions of low demand, and independent of the marked importance of a message. Future research should explore the best ways to leverage the influence of curiosity to improve information management effectiveness.

On a daily basis, both at home and at work, people are bombarded with email messages. Our results suggest that curiosity has an influence on attention in the email context. Our work provides hope for overloaded individuals, suggesting that visual indicators of task and personal utility could help them select appropriate messages to read. By applying these results, perhaps reading email will become less of a burden.

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