Getting Lost in Email: How and Why Users Spend More Time in Email than Intended.

Benjamin V. Hanrahan

Dissertation submitted to the Faculty of the
Virginia Polytechnic Institute and State University
in partial fulfillment of the requirements for the degree of

Doctor of Philosophy
in
Computer Science and Applications

Manuel A. Pérez-Quiñones, Chair
Gregorio Convertino
Andrea L. Kavanaugh
Carlos Evia Puerto
Deborah G. Tatar

December 4, 2014
Blacksburg, Virginia

Keywords: Personal Information Management, Email, Task Management, Meta-Contextual

Getting Lost in Email: How and Why Users Spend More Time in Email than Intended.

Benjamin V. Hanrahan

Email has become deeply embedded in many users' daily lives. To investigate how email features in users lives, particularly how users attend to email and get lost within it, I ran five studies that probed how users determined relevancy of messages, logged interactions with email, gathered diary entries related to individual sessions, and investigated the gratifications sought from email use. For the first study, I performed an exploratory experiment in the laboratory to determine how participants assessed the importance of individual emails (N=10). The next investigation I undertook involved three different studies, which I detail individually: a survey on email usage (N=54); a two-week study of email usage (N=20); and finally, the application of Attentional Network Test (N=9). My final study was to validate my findings around the reasons for attending to email, this was done through deploying a survey that followed the Uses and Gratification Theory tradition (N=52)

In my studies I found that the majority of attentional effort is around reading email and participating in conversations, as opposed to email management. I also found that participants attended to email primarily based on notifications, instead of the number of unread messages in their inbox. I present my results through answering several research questions, and leverage Conversation Analysis (CA), particularly conversation openings, to explicate several problematic aspects around email use. My findings point to inefficiencies in email as a communication medium, mainly, around how summons are (or are not) issued. This results in an increased burden on email users to maintain engagement and determine (or construct) the appropriate moment for interruption.

My findings have several implications: email triage does not seem to be problematic for the participants in my studies, somewhat in contrast to previous research; much of the problem around email, particularly *getting lost in email* is in managing the tension between promptly responding to messages while limiting engagement with email; due to the social nature of the problems with email, modifications to the email client are limited in their potential effectiveness to prevent getting lost and reduce email related anxiety.

Contents

List of Figures

List of Tables

Chapter 1

Introduction

Email has become deeply embedded in many people's daily lives. Since its inception, email has become an evermore ubiquitous and central tool, playing a part in many work and personal activities. Email is used to communicate with friends, family, and co-workers; interact with automated systems; and to facilitate organization, coordination, and collaboration. It is a core application in many of our most familiar personal computing devices. As a result of all of these factors, email has become a staple for computer users and has received a great deal of attention from both research and industry.

Much of this research and development has focused on the problems centered around email overload [Whittaker and Sidner, 1996; McMurtry, 2014; Reinke and Chamorro-Premuzic, 2014; Sumeckia et al., 2011; Grevet et al., 2014], namely around the triaging and management of messages [Whittaker et al., 2006]. Hence, the problem of the sheer amount of emails people can receive is well known, it can take a large amount of time to simply manage the volume. However, an interesting related question is about the *draw* and disruption email can have during our daily lives. There has been comparatively less research around how email features in users' daily lives, particularly how email attracts attention, how users attend to email [Whittaker et al., 2006], engage in sessions, and employ strategies to manage their email interaction. While researchers are addressing this gap, there are still calls for qualitative studies around the 'lived experiences' of email [McMurtry, 2014].

Industry publications have noted the common problems with email such as those noted above[1, 2]. They also propose several strategies in dealing with them, or even calls to action about collectively reducing email use[3, 4, 5]. In many senses we are all very engaged with

[1] http://www.businessknowhow.com/manage/email-overload.htm

[2] http://www.motherjones.com/media/2014/05/smartphone-addiction-statistics-work-charts

[3] http://blogs.hbr.org/2012/02/stop-email-overload-1/

[4] http://www.businessweek.com/articles/2013-12-19/asanas-justin-rosenstein-on-e-mail-overload

[5] http://www.forbes.com/sites/drewhansen/2012/12/15/stop-the-madness-a-call-to-reduce-email-overload/

the problem of email and the effect that it can have on our daily lives. The concerns voiced in the media have been echoed in research communities. Whether it is the breaking down of boundaries associated with email use [Cecchinato et al., 2014], or the amount of time it typically takes to re-engage with the interrupted task (24 minutes) [Hemp, 2009], or the effect on our productivity and well being [Chase and Clegg, 2011], or simply its propensity to increase burn-out [Reinke and Chamorro-Premuzic, 2014].

To investigate the draw of email, I explore several themes. These themes relate to how email features in users' daily lives, particularly how email attracts attention and how users decide to attend to email. To investigate the disruption of email, I explore what happens after users decide to attend to email and to what degree they are aware of and manage their engagement to minimize negative effects. I further isolate a particular aspect of the disruption that email can have on its users through investigating a phenomenon that I call *getting lost in email*. *Getting lost in email* is the process of becoming further distracted from the original intent of an email session. This phenomenon at its most basic is the loss of agency over one's attention during an email session, and is similar to the distraction chains identified by Iqbal and Horvitz [2007].

In this dissertation I report this investigation and my findings into how email features in users' daily lives. Through this investigation I gain insight into how users are managing their email and how it manages them (i.e. the way its design, functioning, and status within activities and relationships influence user behavior). I seek to give a greater depth of understanding to several aspects of how users attend to email and what they do once they are there, through exploring several questions as the framework for this investigation.

What aspects of email grab user attention and draw them in? What level of engagement with email do users maintain while not specifically using the email application? Furthermore, once users enter into email, what activities do they do and what keeps them in email for longer sessions? What are the consequences and perception of engagement with email? Finally, are users of email developing strategies to manage any of these factors (indicating their awareness of them)? These questions are not straightforward to answer comprehensively but through studying users we can begin to unlock them.

1.1 Motivation

As both the amount of information users encounter and the number of tools they use increase, guarding one's attention during computer use has become increasingly important. This need is particularly stark when coupled by the penchant for tools to compete for user attention through numerous notifications that compel their use. This is in contrast to the initial visions of Bush [1945], in which computers were meant to *support* work and *aid* in directing one's attention to the correct place, and not for applications to compete for user attention. Clearly, researchers must come to a better understanding of how to support the direction of

users' attention and avoid compounding this problem.

In order to be able to support the direction of attention across the entire tool set, we must first understand how individual tools capture and divert our attention in both constructive and destructive ways. I argue that *Personal Information Management* (PIM) tasks, particularly email management, provide an especially rich area for studying how attention is directed. First, PIM tasks are often attention intensive activities that are rarely the primary task that a user is engaged with. Knowledge workers don't use computers just for the sake of emailing documents or bookmarking web pages; instead these are sub-tasks in accomplishing larger goals (e.g. writing a proposal, preparing a presentation, researching a topic on the web, or programming an application). This means that PIM activities are situations where there is increased pressure on attention. Email provides a salient example of such a PIM task due to its ubiquity and centrality to work.

In 2011 and 2012 I conducted a series of studies which highlighted our lack of understanding of why users feel overloaded by email and how they decide to attend to email. The first study investigated the saliency of different cues within the inbox [Hanrahan, 2011] and the findings were somewhat unexpected (this study is presented and the analysis expanded in Chapter 5). My initial hypothesis was that social proximity, the relationship between the receiver and sender, had a strong effect on how long would it take to triage the message and determine its level of importance. This assumption was based around a more established common ground between the two parties. Instead, my findings indicate the decision was based primarily on the topic of the email, not the sender, where a sender that occupied multiple facets in one's life seemed to be make the decision increasingly difficult.

My next investigation was through the building of Procrastinate [Hanrahan and Pérez-Quinones, 2012], which was a tool that aimed to remove visual anchors to prospective memory from the inbox. This was accomplished by purging already triaged messages from the inbox and returning them to the inbox at a future date. While some of our initial set of pilot users within our lab found this useful, others simply did not. Functionality very similar to our concept has since found its way into applications such as MailPilot and Mailbox.

During this time I was also making heavy use of project management applications, many of which are designed around philosophies similar to the *Getting Things Done* (GTD) methodology by David Allen [Allen, 2001]. In GTD users are encouraged to use different contexts and projects to group their work by, with the specific intent to enable practitioners to focus on their current task. However, these tools require a high degree of initial investment and maintenance to become valuable. Perhaps, a similarly large investment of time in optimizing information practices is simply required to alleviate feelings of overload and this is why users, designers, and researchers of email have had difficulty in making improvements. I claim that a better understanding of attending to email and *getting lost in email* will provide valuable insight into this difficult problem and suggest methods for how to resolve it.

1.2 Domains Involved in Attending to Email

The question of how users engage and get lost in email intersects several domains of research. This dissertation focuses on three primary domains, complemented by one common perspective covered in the related work. The domain that crosscuts and defines much of the existing research in email is PIM. Within PIM, researchers have expended a considerable amount of effort investigating how users make use of email, particularly focusing on the triage of email. This domain serves as a backdrop for my research.

The first way that I look at email in this dissertation is as a destructive distraction or interruption. This analysis focuses on how users' cognitive resources are impacted by interruptions and to what degree these concepts help to explain attending to and getting lost in email. Within this research I measure users' attentional resources by leveraging work done in psychology.

The second way that I examine email is to frame the phenomena around email through conversation analysis (CA). I focus on how emails function similarly, or in contrast to, summons over other conversational mediums in getting attention.

The final manner that I use to examine email is as a media of consumption. This perspective is analyzed through the uses and gratifications approach, which was originally developed to analyze reasons for media consumption.

Below I scope each of these perspectives in more detail.

1.2.1 Personal Information Management

PIM researchers have investigated several topics over the course of its existence, however, a large portion of the work has concerned itself with methods to support knowledge workers in their information tasks [Bush, 1945; Lansdale, 1988; Jones, 2007]. Particularly, PIM researchers have investigated how knowledge workers have managed communications, which has become increasingly important as computers have gained in both power and acceptance. With this greater power and acceptance new problems have emerged, such as information overload [Schick et al., 1990; Whittaker and Sidner, 1996].

Within the study of personal communications, email has been chief among the investigative efforts, as the majority of tasks performed by today's knowledge workers occur in email [Ducheneaut and Bellotti, 2001; Whittaker et al., 2006, 2007]. As part of this study researchers have sought to understand what actions users perform during email use [Dabbish et al., 2005; Tyler and Tang, 2003; Wainer et al., 2011]. Researchers have also constructed tools to assist in email management [Cselle et al., 2007; Fisher et al., 2006b; Nardi et al., 2002]. Throughout these investigations, researchers have successfully studied Personal Information Management through the examination of usage logs [Fisher and Dourish, 2004;

Muller et al., 2010; Whittaker et al., 2011]. These same researchers have called for more studies that examine Personal Information Management with more than just a snapshot of data [Whittaker et al., 2011].

However, there has been a lack of understanding of how users engage with email and what happens to a user once they engage with the email tool that leads them to feel overloaded. Why are users compelled to engage with email?

1.2.2 Attention and Interruptions

The study of interruptions and distraction in *Human Computer Interaction* (HCI) is a well established area of inquiry [Roda, 2011], particularly the effect of interruptions on primary tasks [Mcfarlane, 1998; McFarlane and Latorella, 2002]. Within this domain researchers have sought to understand the impact of the length of the *distraction chain* resulting from the interruption on primary task resumption [Iqbal and Horvitz, 2007; Czerwinski et al., 2004], this work serves as an inspiration for *getting lost in email*. As the understanding of the interruption process has increased researchers have proposed conceptual frameworks to assist is designing more usable notification systems, such as the IRC (interruption, reaction, and comprehension) framework done by Chewar et al. [2004]. Notifications and distractions have a clear connection with email use, therefore, these frameworks are relevant to this research.

The study of attention is closely related to investigations within HCI on interruptions and their effect on the cognitive resources of the user. A widely accepted method for measuring attention is the Attentional Network Test (ANT) [Fan et al., 2002].

Within this dissertation I examine two activities in regard to attention and interruption, email notifications and the focusing of attention within the inbox. The primary reasons to look at email as a distraction is to see whether there is some connection between personal traits, for example as measured by ANT, and email use.

1.2.3 Conversation Analysis

As email is a medium where conversations can and do happen, I analyze the process of attending to email through the use of conversation analysis (CA) [Sacks et al., 1992; Schegloff, 2004, 1968]. CA is the analysis of social interactions through their structure and content. I contrast aspects of email communication (i.e. how email grabs attention and how email use plays out as sequences of interactions) with conversations from other media and outline why certain similarities and differences contribute to and explain particular phenomena and difficulties I observed. The contrast between mediums lends insight into how the use of features of email have mixed consequences, or are simply unhelpful, for its users, and I discuss how they might be changed.

I explain decisions to attend to email through the discussion of email messages and their presentation to users as both summonses and requests [Sacks et al., 1992; Schegloff, 1968]. I highlight decisions and strategies to attend to email to show that the nature of thought that goes into email work appears variable, and outline how emails sometimes have features of a summons to conversations or a request for attention.

1.2.4 Uses and Gratifications

Uses and Gratifications Theory (UGT) has been developed to explain various types of media consumption. The roots of the theory can be tracked back to the work of Herzog [1944], where she analyzed why housewives listened to radio soap operas. UGT has since been used to analyze many types of media including, television, telephone, and print communication. More recently it has been applied to Twitter [Chen, 2011], internet usage [Papacharissi and Rubin, 2000], and social networking sites like Facebook [Park et al., 2009].

Relating this research to email, I apply this method to determine what the anticipated gratifications of my participants are. Are they simply wanting to use email for functional business purposes or are there other reasons? I answer questions as to whether or not users project their professionalism. As well as, whether or not email use is only done to serve a purpose or if it is also used in response to boredom or passing time.

1.3 Research Questions and Approach

In this dissertation I investigate two aspects of email use.

1. The decision to attend to email.
2. The activities performed while engaged with email.

Within the topic of *deciding to attend to email*, I investigate specific reasons for attending to email within individual sessions, which gratifications are expected as a result of general email use, and how features of email play in the decision to attend to email. In regard to *activities undertaken*, I investigate what activities or attributes correlate with both session length and the frequency of getting lost in email and why my participants were susceptible to becoming lost.

This section outlines the general approach I used for this investigation, the research questions I investigated, and my initial hypotheses around each research question.

1.3.1 General Approach

Investigating email usage is problematic and investigating a specific phenomenon such as attending to email or *getting lost* is even more so. Kelly and Teevan [2007] acknowledge these common problems to PIM research when they outline the difficulties in the uniqueness of both personal information and practices, as well as the amount of change in these collections from minute to minute. For this reason, I made use of a mixed method approach, with which I was able to isolate the decision to attend to email, what activities occurred in email, when participants became lost, and gain insight into why users make use of email. First, I surveyed the participants about their email usage, perception, and demographic information. Within this survey I recruited participants into the main part of the investigation, a two-week study of their email usage. This study of email usage logged changes to the email corpus every three minutes to determine which email actions, if any, the participant has performed. When certain conditions had been met, a diary entry was dispatched via SMS. This diary entry asked the participant why they initiated the session, whether or not they had gotten lost, and what they did during the session. Lastly, I deployed an additional survey that determined the gratifications expected to be gained from email use.

Generally, in my analysis I look at several sets of features and how they impact a specific research question. These roughly group into three sets of features:

- **predispositions**, which includes aspects measured by the Attentional Networks tests (Alerting, Orienting, and Executive Control), as well as, situational aspects (how many projects the participant is involved in, upcoming deadlines, etc.);
- **preconditions**, including aspects such as number of unread messages, number of messages replied to, diversity of senders, reasons for initiating the session, or if this was an interruption.
- **mitigating behaviors**, including reading habits, filing habits, or strategies.

1.3.2 RQ 1: When and how are users deciding to attend to email; specifically, is it the result of user predisposition, preconditions of email, mitigating behaviors, or social obligations?

There is high level of noise in the email channel and many emails are simply not important. Are users having trouble distinguishing the noise in the email channel from the important emails within the channel? Is there a measurable impact of user predisposition or preconditions of email on the frequency of attending to email? Previous research established that users of email are conscious of others' projected response rhythms [Tyler and Tang, 2003], this implies an amount of social obligation in email use. Are users attending to email because the feel an obligation to respond to emails? Is the frequency of email use more a function of

the user, the email load, or strategies that they employ to help manage email? Surely the frequency with which users check email is a function of personal characteristics and the level of email load.

The investigation of this research question gives insight into how haphazard or premeditated the decision to attend to email is and how difficult this process is.

Hypothesis

Users engage with email for several reasons, such as receiving a notification, having a high unread count, or engaging in routine sessions.

I hypothesize that there is a complex mixture between situations where users make deliberate, premeditated decisions to engage with email and other situations, where they have been pulled into the application in a less deliberate, more situational manner. I further hypothesize that the activities of these different types of sessions are noticeably different in discernible ways. I believe the situation around email is complex and nuanced, relating not only to several features of the email content (and to an extent the technology itself), but also shaped by a wider context of on-going relationships and activities.

Users are being distracted by spurious email notifications.

Even though I believe attending to email is a complex decision, notifications about even unimportant emails develop an urge to check the email. Activity like this causes more engagement with email that the user would prefer and brings them into email more, as engagement with email begets further engagement.

Users have trouble filtering through messages to find the ones that must be read or replied to.

I hypothesize that as users have more unread emails in their inbox it becomes harder for them to locate the important emails and the sessions become longer as a result.

Attentional network scores have a measurable impact on how often users check email and become lost.

I hypothesize that we will see an effect from the different attentional network scores, particularly around the direction and mediation of attention in regard to getting lost.

1.3.3 RQ 2: What is the level of engagement that users are maintaining with email when not actively using email and how does this feature in their decision to attend to email?

How much are users of email thinking about email when they are not using email? How does this feature in their decision to attend to email? Previous studies have shown that

individuals that check email more often suffer less anxiety about email [Dabbish and Kraut, 2006], what about email use is causing this anxiety?

Hypothesis

Users of email maintain a background engagement with email throughout the day.

Due to the importance of email to our work, I hypothesize that users are required to have a background awareness of email throughout their day. This background awareness is mostly concerned with obligations to others, particularly superiors and important emails about upcoming deadlines.

Users are aware of the time since they last checked email, and longer periods of inactivity cause anxiety.

The unknown is what causes this anxiety, and the anxiety will be greater if there is some amount of expectation.

1.3.4 RQ 3: Once users have decided to attend to email, what are the activities, predispositions, or preconditions that correlate with longer sessions and how do these relate to getting lost?

Once a user initiates an email session are there a particular set of activities that are more likely to result in longer sessions or getting lost in email? Are different users more predisposed (as measured by the ANT or the gratifications that they expect) to getting lost? To what extent does the initial state of the email client impact session length and getting lost in email, is it simply a matter of the number of unread messages? Are there any behaviors that can be identified that relate to a propensity to getting lost or longer sessions.

Hypothesis

The email state will have the most effect on both the frequency and duration of use.

I hypothesize that the strongest signals will come from the features of the email state. Simply because if there is less incoming email there is less reason to interact with email.

Users with more responsibilities will check email more often.

Even though the email state should be where the strongest signals originate from, users with increased numbers of projects and responsibilities should spend more time checking and interacting with email.

Number of important unread messages trumps sheer number of unread messages on session length and getting lost.

I hypothesize that the sheer number of unread messages will be a surprisingly poor signal for the duration of an email session. Primarily because the amount of time that is required to delete ten obviously unimportant emails, is presumably much smaller than the time required to read one important email. I hypothesize that some activities, reading important mail, are more conducive to getting lost than deleting spam.

User traits have an impact on whether or not users will get lost in any given email session.

Once users begin an email session, which earlier I hypothesized would be more influenced by the email state, the likelihood that they will get lost will be mostly due to their individual traits. How many projects that they are involved in, whether or not they have pending deadlines, and their attentional characteristics.

Within these user traits I specifically hypothesize that the alerting network will be an important signal. This is because the alerting network is associated with continuous performance and vigilance tasks, as such, the interaction between the alerting network and the frequency of getting lost will be due to both the number of times that they check email and their propensity to notice more emails once in the email program.

Furthermore I hypothesize the orienting network will not have a significant effect, primarily because of the similarity of the stimuli, in that emails are located in the same area of the interface and are mostly similar in appearance.

A higher value for the executive control network will experience getting lost in email more frequently. Primarily because these users will find it easier to switch rule sets for which emails are important during triage. This easier context switching will reduce the inertial effect of context switching Wickens and Hollands [1999a] and makes the handling of conflictive evidence easier [Fan et al., 2002], which enables participants to consider more emails important thus increasing the likelihood of getting lost. Participants that have more trouble switching contexts and rule sets will be more likely to stay within the current context of their work, reducing the likelihood of getting lost.

1.3.5 RQ 4: Are the gratifications that users expect out of their email use related to personal or professional reasons and how do these help to predict email use?

What are the reasons that users are making use of email? Is it only for professional use? What gratifications are they expecting to receive from email and how do these expectations correlate with email use?

Hypothesis

Email use is driven by the need to communicate about work tasks.

I hypothesize that people are not using email as a primary method to keep in touch with relatives and friends, that coordination has migrated to a different medium. However, collaborating and communicating about work is still handled primarily through email and this will be a main driver. Furthermore, this will be evidenced through the reported gratifications and their power in explaining email use.

Email use is driven by the desire to project a professional appearance.

As email is a medium of communication and I hypothesize that it is used primarily for professional purposes, face-work and the projection of responsiveness will be important and powerful in explaining email use. We know that users are aware of others' level of responsiveness [Tyler and Tang, 2003], it logically follows that they are mindful about their projection of responsiveness as well.

1.4 Goals and Key Contributions

This work is meant to shed light on how users engage with email and explore the consequences of that engagement.

1.4.1 Contributions to Research

This study utilized a novel method for studying email and capturing difficult phenomena. The study of PIM is difficult for several reasons [Kelly and Teevan, 2007], in that it is heavily situated in one's personal information and practices. Any attempt at studying a phenomena must take this in to account. In my work I was able to pinpoint several interesting moments during the use of email with minimal impact to my participants. This method of investigating email, discussed in Section 3, can be used to identify additional phenomena in the future.

In my work I also take (or refresh) the perspective of email as a conversational medium. Based on my research, conversations, and both participating in them and identifying them, are clearly the activity that takes the most time and causes the most anxiety. Framing email in this way also gives more insight into how email features in the lives of its users.

An additional contribution of my work is in extending the phenomena of distraction chains [Iqbal and Horvitz, 2007] and identifying the phenomena of *getting lost in email*. Aside from identifying this phenomena I have substantiated that it exists and occurs rather frequently. As well as, identifying several causes for becoming lost in email.

1.4.2 Contributions to Practice

The contribution of this work to practitioners is primarily in terms of insight into the design of email, and secondarily in the design of conversational mediums.

In terms of the design of email, I have identified in what ways features of email are problematic to its users and suggested features that may help to alleviate this. One of these features has a direct line drawn from our initial paper to a developed product.

In terms of designing new conversational mediums, great care will need to be taken that it satisfies the different needs of conversations established here. The easy identification of and participation in a conversation, is clearly needed.

1.5 A Guide to this Dissertation

My findings around these questions are that there is a complex mixture between situations where users make deliberate, premeditated decisions to engage with email and other situations, where they have been pulled into the application in a less deliberate, more situational manner. In Chapter 4, I discuss my analysis of the reasons to check email as reported by my participants; these primarily include receiving a notification, expecting a communication, or engaging in routine sessions. In my analysis of these reasons, Section 4.8, I outline how the potential for distraction in email communication has similarities and stark differences from other communication channels (e.g. over the phone), and how the design of email either mitigates or contributes to these differences.

I further discuss in what ways email lends itself to *getting lost* and spend more time in email than initially intended in Chapter 6. In Chapter 7, I theorize that email has this potential because it is fundamentally different from more primary, focused interfaces like document based applications (Word, Excel, etc.), in that email is relevant to all of the user's current contexts. This means that email is a *meta-contextual* tool, in that all of a user's contexts are interleaved throughout the interface, in contrast to a tool like Word which typically involves working on a document that belongs to a single context.

These various results evidence that the situation around email is complex and nuanced, relating not only to several features of the email content (and to an extent the technology itself), but also shaped by a wider context of on-going relationships and activities.

As the phenomenon of email use is complex and involves several different interesting moments, I utilize several perspectives to investigate particular moments in the process. I discuss each of them individually before addressing them in their entirety to construct a more complete picture of how users engage with email than previously understood. First, in Chapter 4, I report the analysis of my primary study as to why users are choosing to engage with email and the distraction or interruption and draw it can have. In Chapter 5,

I report the results of a pilot study designed to determine how users determine an email is *important*. In Chapter 6, I analyze the same study through investigating the activities that participants engage in during an email session, with a focus on how participants become lost in email during certain sessions. In Section 4.7, I look at email as a media from the uses and gratification perspective and explore for what reasons users are using email. Finally, in Chapter 7, I tie these studies together to construct a coherent view of the process of engaging with email and becoming lost.

This dissertation is organized as follows:

- This chapter frames the problem that I am investigating, presents the domains involved in the investigations, outlines the research questions, hypothesis, and contributions of this dissertation.
- Chapter 2 outlines the previous research in the respective domains that are involved in this investigation.
- Chapter 3 explains the methods that I conducted throughout my research.
- Chapter 5 takes a qualitative perspective around how users attend to email, mainly through the use of concepts from conversation analysis.
- Chapter 4 takes a quantitative perspective in an examination of email use and relationships.
- Chapter 6 examines session length and the phenomenon of getting lost.
- Chapter 7 outlines how these investigations unify to answer the research questions.

Chapter 2

Literature Review

2.1 Personal Information Management

In the mid twentieth century, even as computing technology was in its infancy, researchers were investigating how these new devices could assist users in organizing the information they encountered throughout the day. In 'As We May Think' Bush [1945] introduced the *Memex*, which was an exploration of how a personal computer could capture the trails of information that knowledge workers left as they performed their research and work. Englebart [1962] furthered the development of this concept when he postulated that the upcoming technologies would enable further augmentations to our intellect. His vision of assisting workers in dealing with the various bits of information that we both encounter and use to interact with others, led to developing some of the first personal computers.

As technology pushed forward, researchers recognized the need for further, more focused investigations into how knowledge workers organized their information. One of the first of these investigations was done by Malone [1983], when he studied how knowledge workers organized their desks. The findings in this research lead to the first usage of the phrase *Personal Information Management* in 1988, when Lansdale [1988] coined the term.

Since its inception, the *Personal Information Management* field of research has investigated several topics ranging from music organization to note taking. Within these investigations, *Personal Information Management* researchers have been particularly concerned with methods to support knowledge workers in their information tasks [Bush, 1945; Lansdale, 1988; Jones, 2007]. One particular area in this body of research explores how knowledge workers manage their communications, an increasingly important problem as computers have gained in both power and acceptance. Coupled with this increase in power and acceptance users have experienced a drastic increase in the number of communications that they receive each day, causing new problems to emerge, e.g. information overload [Schick et al., 1990; Whittaker and Sidner, 1996].

Within the study of personal communications, email has been chief among the investigative efforts, as the majority of tasks performed by today's knowledge workers either occur on or pass through email [Ducheneaut and Bellotti, 2001; Whittaker et al., 2006, 2007]. As part of this study researchers have sought to understand what actions users perform during email use [Dabbish et al., 2005; Tyler and Tang, 2003; Wainer et al., 2011]. Researchers have also constructed various tools to assist in email management [Cselle et al., 2007; Fisher et al., 2006b; Nardi et al., 2002]. Throughout these investigations, an increasingly popular approach for researchers studying *Personal Information Management*, particularly in studying email, is the examination of usage logs [Fisher and Dourish, 2004; Muller et al., 2010; Whittaker et al., 2011]. Some researchers have even called for even more studies to utilize more than just a snapshot of data [Whittaker et al., 2011].

However, even though there has been a large amount of research into communication through email, there is still a marked lack of understanding in the process of attending to email: why do users choose to check email; what happens to a user once they engage with email; and do these factors contribute to them feeling overloaded? As these questions are investigated and unpacked we should be able to answer many similar questions. For example, do different users feel more overloaded by similar amounts of email and what factors of the incoming email impact the feeling of overload?

2.1.1 Definition of Personal Information Management

The term *Personal Information Management* has been defined and used in various ways, spurring some debate as to what exactly constitutes *Personal Information Management* research. This ambiguity is due in part to the relatively wide swath that the field cuts across various research topics in Human-Computer Interaction and beyond. The phrase '*Personal Information Management*' first appeared when Lansdale [1988] defined it in a very general sense:

> [...] personal information not necessarily in the sense that it is private, but that we have it for our own use. We own it, and would feel deprived if it were taken away.

In the introduction from the book '*Personal Information Management*' Jones and Teevan provide the following definition:

> Personal information management or *Personal Information Management* is both the practice and study of the activities people perform to acquire, organize, maintain, retrieve, use, and control the distribution of information items such as documents (paper-based and digital), Web pages, and email messages for everyday use to complete tasks (work-related and not) and to fulfill a person's

> various roles (as parent, employee, friend, member of community, etc.). [Jones and Teevan, 2007]

Bellotti et al. [2002] provided another narrower definition of *Personal Information Management* in the context of refinding things:

> [T]he ordering of information through categorization, placement, or embellishment in a manner that makes it easier to retrieve when it is needed.

Jones et al. [2008] also developed a broad categorization of information to be considered *Personal Information Management*, including, information controlled by, about, directed toward, sent by, experienced by, and relevant to the user. The debate about what is PIM and what is not PIM is ongoing and not likely to be resolved. However, as far as this dissertation is concerned, there is a clear consensus that email is certainly PIM, and is central to understanding PIM.

2.1.2 Importance of Studying Personal Information Management

As a field of inquiry, *Personal Information Management* is becoming increasingly important as we encounter more information. As time has progressed computers have gained a level of ubiquitous acceptance that has contributed to an exponential growth in the amount of information generated by users. However, as Levy [2005] noted our attentional resources have remained essentially stagnant.

This increase of information coupled with a stagnation of both attentional and other resources (e.g. time) has resulted in users experiencing information overload [Schick et al., 1990]. Information overload has particularly manifested itself in email, established by Whittaker and Sidner [1996]. As time progressed the ubiquity and centrality of email to the work of knowledge workers increased, resulting in an increase in the number of emails encountered on a daily basis. This increase in emails and experience of information overload established by Whittaker, was again replicated by Fisher et al. [2006a], where he found that the number of emails that workers receive had increased over the last decade. Interpolating the data provided by these two studies and extending the trend into another decade, one would expect that information overload has only increased and its effects worsened. Especially when coupled with the large number of new sources of information that have been introduced and adopted since 2006. Interestingly, in the midst of this increase the design of email has remained virtually unchanged over the decades.

2.1.3 Study of Email

Email is an important tool worthy of study and has been called one of the most successful computer applications [Whittaker and Sidner, 1996; Dabbish and Kraut, 2006; Whittaker et al., 2007]. It is considered to be a common, if not critical, part of everyday life for many, especially at work [Whittaker et al., 2011; Wainer et al., 2011; Mackay, 1988; Fisher et al., 2006a; Ducheneaut and Watts, 2005; Dabbish et al., 2005]. As such it has a long history of research in its forty years of existence and there have been many tools proposed to help users once they are in the inbox [Freed et al., 2008; Whittaker et al., 2004; Venolia and Neustaedter, 2003; Nardi et al., 2002; Cselle et al., 2007; Faulring et al., 2010]. While many of these tools have centered around email triage, Vacek [2014] has recently reiterated the call for better email triaging tools. However, Kokkalis et al. [2013] (in creating EmailValet, where task detection was done by the crowd) questioned the utility of the better detection, hypothesizing that it may be causing extra, unnecessary work. A slightly different tool, MinEMail [Rector and Hailpern, 2014], layered an additional level of notification for more important senders. Singh et al. [2013], posits that the problems around email are caused by its inability to scale to the volume of emails we receive, as it was designed to mimic paper-based workflows.

Email is also a place to do work. Researchers have both studied and proposed several re-imaginings of the inbox in terms of the tasks that are contained within it. Gwizdka [2000, 2002] called for more explicit support for tasks within the email client, citing the propensity of its users to use it in a variety of ways and in a variety of temporal aspects. Bellotti et al. [2003] created a system that brought task management very prominently to the inbox.

Even though email is a place of work, increased engagement with email increases feelings of overload [Sumeckia et al., 2011]. Other studies have also identified that email volume contributes to email stress, as well as worrying about email [Jerejian et al., 2013]. Along these lines I seek to understand what the source of worry within email is and what are the causes for increased use.

Researchers have also proposed changes to the practices rather than tools. Chase and Clegg [2011] proposed that users better manage sender expectations. Others have called for organizational training courses [McMurtry, 2014], or to put limits on email as a company or an individual [Hemp, 2009]. Bradley et al. [2013] found evidence for the efficacy of these types of approaches in reducing email stress, when they found that infrequent checking is better than frequent checking for email related stress. Although, this is somewhat in contrast to the findings of Dabbish and Kraut [2006], where it was found that frequently checking email reduced email related stress.

There are mixed signals emerging from the research into email use. As such, with this study I endeavor to bring understanding to a key point of email use, how users decide to attend to email. I link qualitative insights about the reasons participants engaged with email with quantitative insights into what types of actions cause lengthier sessions. While

I acknowledge that not all of these sessions are necessarily destructive, I cite the literature above to substantiate my general use of increased email usage as a concern.

Researchers in the area have also proposed multiple frameworks to assist in understanding the topography of research activities. Ducheneaut and Watts [2005] proposed several metaphors for email, a file cabinet, production line, or communication genre. Whittaker et al. [2007] divide email into activities of allocating attention, deciding actions, managing tasks, and organizing messages into folders. I find Whittaker et al. [2007] to be particularly useful in highlighting the lack of knowledge in how users decide when and why to attend to email. In fact, when Whittaker et al. proposed this framework they highlighted that there has been "relatively little systematic study of what causes people to attend to their email" [Whittaker et al., 2007, p. 172]. This was further echoed by McMurtry [2014], who called for more qualitative studies around the 'lived experience' of email. Rennecker and Derks [2013] also call for more multi-dimensional investigations of email overload that look at more than just email length or the number of emails.

Whittaker et al. [2007] further divide the allocation of attention into (1) the decision of *when and why* to attend to email and (2) deciding *which* messages to attend to once the user has entered into the email client.

When and Why Users Attend to Email

One of the more informative pieces on how users decide to attend to email was done by Mackay [1988], where she performed extensive interviews of office workers in order to gain a richer understanding of their email habits. Among Mackay's findings were the strategies that the different participants used in attending to email. A few of the users she interviewed strictly managed their engagement with email, citing that they read it only two times a day allowing "mail to accumulate and read it only when convenient" [Mackay, 1988, p. 388]. However, the majority of her users reported that they read mail as soon as it arrived and were constantly engaged with it.

Another relevant study was conducted by Czerwinski et al. [2004], where they conducted a diary study focused around task switching and interruptions. They found that 23% of tasks reported by their participants were email tasks. I draw inspiration from this study in my work, but instead aim my diary studies directly at email and link the diaries to specific usage sessions. This helps to minimize the amount of work needed by participants, in this way I try to avoid the so-called "Heisenberg-style" challenge mentioned by Czerwinski et al. [2004], where heavily measuring a phenomenon can change it. I also differentiate from this study in that I prompt for diary entries as opposed to depending on participants to choose which sessions they complete a diary entry for.

The *effects* of constantly attending to email have been explored by several researchers. For example, Ducheneaut and Bellotti [2001] portray email as a habitat, which is indicative of

the amount of attention that is allocated by users. As part of their work, they highlighted the network effect that results when a group of workers attend to email. As more workers attend and use email, the need arises for the same group to attend to email in increasing amounts. That is, email use feeds itself. Whittaker and Sidner [1996] also touch on the topic in that they recognize users must spend a large amount of time in email due to the sheer quantity of email they deal with. Further support for concern over users' allocation of attention comes from Dabbish et al. [2005] who found that university members check their email an average of 19 times a day. Later, Dabbish and Kraut [2006] found this behavior of frequent email checking to reduce email-related stress, somewhat in contrast to the findings of Bradley et al. [2013]. Venolia et al. [2001] found that more than half of their participants keep their mail client visible at least two-thirds of their work time.

A related area of research is the study of the negative effects of interruptions to work. This research has focused on areas such as interruptions from email, instant messaging applications, general notifications, and how users recover from interruptions [Mcfarlane, 1997a; Czerwinski et al., 2000a; Cutrell et al., 2001a; Franke et al., 2002a; Adamczyk and Bailey, 2004; Mark et al., 2008; Hemp, 2009]. This research helps motivate the need for studying why users of email choose to attend to email, even at the detriment to their productivity and work. In addition, the various, sometimes contradicting findings of email research, points to the diversity and variety in these phenomena.

An additional relevant area of research is the research around notifications. Work has been done to determine how notifications should attune to the attention of the user [McCrickard et al., 2003a], how users recover from notifications [Iqbal and Horvitz, 2007], as well as how notifications affect users [Cutrell et al., 2001a]. This area of research is helpful to my research both from a methodological standpoint and in terms of insight from a more general viewpoint.

How Users Decide Which Messages to Attend to

The next division of attention allocation that Whittaker et al. [2007] propose is deciding *which* messages to attend to. This work is relevant to this dissertation as it gives additional insight into how users decide which emails are important and gives some insight into the reasons users have for using email.

The number of incoming email messages that users receive on a daily basis has been established as a problem by the *Personal Information Management* community over the last 15 years. Whittaker and Sidner [1996] first established this problem of email overload in 1996. A decade later, Fisher et al. [2006a] found incoming mail messages had nearly doubled from a mean of 49 daily incoming messages to a mean of 87 amongst knowledge workers. Additionally, Fisher found that email archives had grown ten fold in the same time frame, from a mean of 2,482 total messages to a mean of 28,660 total messages per user. There have been several efforts to help alleviate the pain of email management by the *Personal*

Information Management and Computer Supported Cognitive Work community, however, users of email have seen little to no improvement [Ducheneaut and Watts, 2005].

These studies point to a problem in email management. One process of concern is email triage, the process by which users survey and assess emails and determine any action required. Much of the research done to combat this area has focused either on social relationships with the sender, ContactMap [Nardi et al., 2002] and SNARF [Neustaedter et al., 2005], or has instead focused on the topic or subject of the email, BuzzTrack [Cselle et al., 2007]. Examining the process of email triage armed with the models and frameworks provided by situated cognition, signal detection theory, and decision making can help us to understand what pieces of information the recipients of an email use to make decisions about relevance.

Email triage has been recognized as a difficulty to users for over a decade [Whittaker and Sidner, 1996], and there have been several attempts to alleviate this problem. There are patterns that have been identified, such as the desire to maintain an image of responsiveness [Tyler and Tang, 2003] that may effect these decisions as well. Particularly of interest are the efforts to make users more aware of their social structures and topics that they are interested in during email use.

One study, performed by Fisher and Dourish [2004], involved presenting social structures constructed by information dissemination to participants. These social structures were the representation of how a document was disseminated through an organization. One example is the onion structure, where the document's distribution was represented as concentric circles around a central source. Upon reviewing these social structures participants were able to recall richer information about the events and provide insight into the structure. Another project focused on leveraging social information for email triage was SNARF (the Social Network and Relationship Finder) [Neustaedter et al., 2005]. SNARF extended Fisher's work utilizing the deducted strength of relationships and performing a social sort. This situated the message within the social order for the recipient. Later work utilizing SNARF found that the social sorting functionality did little to decrease participant's feelings of overload [Fisher et al., 2006b].

A project focused on better situating the individual messages a participant has received within conversations that they are involved in, focused primarily on the sequencing of the messages [Venolia and Neustaedter, 2003]. The authors concluded that their design was not suited for most conversations and was unable to alleviate many of the problems experienced by users and suggested more work needs to be done.

Another path that some researchers have taken is to provide better information about the topics, as done by Cselle et al. [2007] in their work with BuzzTrack. BuzzTrack is an email plugin that groups messages not by subject, but by a topic that the system had determined. Users were then given control on merging or renaming the suggested topics. However, to this author's knowledge no user studies have been performed as of yet using this system.

Wainer et al. [2011] found that inbox-level cues such as importance indicators as well as

curiosity had an effect on users' decision to attend to messages. In the "Bifrost" tool by Bälter and Sidner [2002], emails were categorized based on factors like the number of recipients, user-defined importance of sender, and direct vs. cc messages in order to facilitate attending to different messages. Nardi et al. [2002] developed ContactMap to provide some support for allocating attention between messages by displaying whether the user had new mail from a contact on their contact card. Bellotti et al. [2005] also touched on allocating users' attention between emails, but they focused more on helping users find incomplete tasks in their inbox. Venolia et al. [2001] developed a user interface that indicated which messages in a complex thread were either read or unread, which also helped users to decide which messages to attend to. Gwizdka [2000, 2002] found that users attend to messages in different temporal manners, sometimes prospective, retrospective or ephemerally.

The divergent paths of research on email triage and management are an indication that this process is not completely understood. One of the contributions of this dissertation is to elucidate the information that recipients of email use to situate the information into their daily lives. Specifically, I present a study that explores the role of social context in situating an individual email message, as well as, investigating specific reasons for attending to email as a whole.

2.2 Attention and Distraction

The relevant literature on human attention explores how humans allocate attentional resources to perform tasks or events [Cutrell et al., 2000]. C.D. Wickens' classic book on *Engineering Psychology* [Wickens and Hollands, 1999b] devotes a full chapter to human attention. The topic continues to be relevant in today's digital environment, as evidenced by a recent collection of readings on the topic [Roda, 2011].

In this section I first give an overview of some important concepts that are used in attentional models. Next I go over research studying interruptions and distractions in the computer environment. Following this I review mechanisms that are relevant to my research: prospective memory, vigilance tasks, and dual tasks.

For the purposes of this research, I am taking the perspective of attention taken by the Attentional Network Test (ANT) developed by Posner's group [Fan et al., 2002]. In this model attention is divided into three different attentional networks: alerting, orienting, and executive control. The authors define alerting as "achieving and maintaining an alert state;" orienting as "the selection of information from sensory input;" and executive control as "resolving conflict among responses." This model is well substantiated as Posner's group has developed the Attentional Network Test to separately identify the traits of each participants individual network.

An additionally relevant development is CopyCat which was developed by Hofstadter [1995]. CopyCat models attention in terms of *codelets*, meaning different items request attention

based on how much it activates long term conceptual memory. 'Unhappy' objects are objects that make few connections to long term conceptual memory and request more attention for sensemaking. This could help to explain some of the findings by Wainer et al. [2011], where they found curiosity to be a primary driver for selecting individual messages to read.

2.2.1 Working Memory

The concept of working memory is used in many attentional models, as one of its primary features is that it is susceptible to degradation from interruptions.

Working memory is comprised of three components according to Baddeley's model [Wickens and Hollands, 1999c; Baddeley, 1995]. The three components are: the phonological store, which holds auditory information; the spacial store, which holds visual and spatial information; and the central executive, which controls activity and provides attention.

The phonological and spacial stores work cooperatively together, however, interference does occur within the individual codes. That is, completing two tasks, one that is spatial in nature and one that is auditory in nature results in minimal interference between the tasks. However, if completing two auditory tasks simultaneously there is a degradation in performance that can be attributed to the interference within the phonological store of working memory [Wickens and Hollands, 1999c].

Similar to the two stores in working memory, the central executive can also experience interference. However, this interference is a bit different in its nature. While the central executive is distributing working memory and attentional resources, it will be interfered with if the task that it is delegating for execution is not automatic. Interference occurs if the task requires more resources than required by a task that has been rehearsed to automaticity [Wickens and Hollands, 1999c].

There are several relatively well established limitations of working memory both in duration and capacity. The duration of working memory storage, without rehearsal, is around 20 seconds and the capacity is limited to 7 ± 2 chunks [Wickens and Hollands, 1999c].

2.2.2 Resource Theory

The resource metaphor for attention and memory was introduced by Norman and Bobrow [1975] and is explained in detail by Wickens and Hollands [1999b]. This metaphor is one of the more complete ways to conceptualize how human attention works and many theories build on top of the resource metaphor in some way.

Basically, this theory posits that while performing a task, we must devote a portion of our limited attentional resources to the task. When performing multiple tasks, resources are distributed unevenly among tasks (more difficult tasks requiring more resources), which

helps to explain the degradation in performance when multitasking. Additionally, attentional resources are also required to switch between tasks, so more frequent task switching requires more resources. The attention required for multitasking varies based on how similar or dissimilar the tasks are, similarity between tasks can increase confusion and the resources being used.

In general, an increase in the amount of required resources leads to a decrease in performance and/or an increase in effort. This relationship can be described as either a trade-off between effort and performance or task load and errors. That is, depending on the complexity of the tasks the increased load on attentional resources may manifest itself in several ways. For simple tasks, an increase in effort is required to maintain acceptable performance across the tasks. For complex tasks, an increase in the number of errors or time required to complete the task will be the result of spreading attentional resources across tasks. To quote C.D. Wickens:

> The act of time-sharing itself pulls resources away from tasks above and beyond the resources that each task demands by itself. Thus, time-sharing, even with no resources allocated to the other task, produces worse performance than the single-task condition [Wickens and Hollands, 1999b, page 370].

An aspect of resource theory that is somewhat contentious, is the competing theories of attentional resources being comprised of either a single-resource or multiple-resources [Wickens and Hollands, 1999b]. Where single-resource theory refers to all of the attentional resources being of the same type, thus capacity or available resources come from the same pool and multiple resource theory being comprised of the three aforementioned types of resources that provide the ability for some types of multitasking to be easier than others.

For the purposes of the research presented in this dissertation, it is not important to which one of these two theories the reader subscribes to. This is primarily because the types of tasks I am exploring are similar in structure and content, thus there is a large amount of competition for resources and confusion between tasks regardless of whether the user has one or several pools of resources. Both the primary and the secondary tasks, are done on the computer, using the same type of perceptual sensor (reading the screen) and using the same type of response (typing on the keyboard or moving the mouse). In summary, the tasks that I will be studying are so similar, that I expect much conflict between them in either the single or multiple-resource contexts.

2.2.3 Visual Attention

Attention, especially in the context of a computer, is often guided by visual attention [Wickens and Hollands, 1999d]. In regards to email, there is often a visual indicator that seeks to capture the attention of its users. These notifications take advantage of the manner in

which visual attention is directed. Specifically, visual attention enters a search mode when the eyes seek out a target. There are two methods of visually acquiring the target: pursuit, during which the eye follows a moving target; and saccadic where the target is somewhat fixed and the eye jumps to acquire it. Clearly, email notifications appeal to the later of the two.

Human factors engineers have developed various methods for grabbing attention using visual cues [Wickens and Hollands, 1999d]. One example, is to divide the display space into different channels to grab attention for different purposes. This is a reason why email notifications appear in a consistent place around the screen.

However, visual attention does not always correlate with where the eye is focused, humans are able to shift the focus of their attention on something in the periphery of their vision. The attentional spotlight metaphor developed by Posner [1980], states that attention can be shifted around the visual field in the manner of a spotlight without moving the eye.

There has been additional work that focuses on how humans process information both serially and in parallel as we scan information [Wolfe, 1994]. This is relevant in the case of email triage in that, according to this work, we are able to process the different cues, e.g. colors and text, in parallel, not just serially reading each message.

2.2.4 Interruptions and Distractions

Mcfarlane [1997b] studied interruptions and the manner in which they increased the cost in user performance in interactive systems [Mcfarlane, 1998; Franke et al., 2002b; McFarlane and Latorella, 2002]. He found, in general, that interruptions demand the knowledge worker make a context switch, as they shift their attention from one task to another. This context switch increases the cognitive load of dealing with the work at the moment, which causes the overall workload to increase. This increase in workload is associated with a higher probability of errors [Franke et al., 2002b].

The research that I am reporting is similarly investigating the impact of the context switch and the resulting increase of cognitive workload. However, and different from the work done by McFarlane, my research is explicitly investigating *internal interruptions*, that is, interruptions that initiate within the knowledge worker. I argue that this is a typical scenario for *Personal Information Management* tasks, and leads to many expensive external interruptions due to the different *Personal Information Management* related tools (i.e. email giving indicators of unread emails). Thus, in addition to "managing [external] interruptions" [Mcfarlane, 1998; Franke et al., 2002b; McFarlane and Latorella, 2002] I need to understand how *internal* interruptions lead to *external* interruptions in *Personal Information Management* tools.

Mary Czerwinski, Ed Cutrell and Eric Horvitz at Microsoft have done extensive studies of the impact of interruptions in HCI environments [Cutrell et al., 2000; Czerwinski et al., 2000b;

Cutrell et al., 2001b; Czerwinski and Horvitz, 2002; Czerwinski et al., 2004, 2006; Cutrell et al., 2000]. In one such study [Cutrell et al., 2000], they found that being interrupted by an instant message while doing a web search task could have different effects depending on where in the search task the interruption took place, and depending on the similarity of the interruption to the task at hand. In their work, as in other interruption literature, the similarity of the interruption to the task at hand has a direct impact on the cost of the interruption. They report that if the interruption is relevant to the task at hand, the effect is less disruptive than if the interruption is irrelevant. The types of interruptions they used in this study are all external interruptions.

Czerwinski et al. [2000b], similarly reported that interruptions have different impacts on the task at hand depending on the task phases that are interrupted. Their work confirms previous findings reported in the literature and provides support for systems that might provide automated assistance based on rules about when to report an interruption. Czerwinski et al. [2004] further studied task switching for information workers, acknowledging that some interruptions observed were self-guided (internal), but their study only focused on external interruptions.

A considerable amount of work has been done in the area of interruptions and distractions in the form of notifications. McCrickard's group at Virginia Tech has contributed several advancements to this area in the form of attenuated systems [McCrickard et al., 2003a; McCrickard and Chewar, 2003], investigating multitasking goals [McCrickard et al., 2003b], and the IRC (interruption, reaction, and comprehension) framework [Chewar et al., 2004].

2.2.5 Prospective Memory

Another aspect of memory that is relevant to my research is *prospective memory*, which is where humans hold events to be remembered in the future. More specifically, it is "remembering to remember" [Roda, 2011]. I hypothesize that this memory is a primary source of *internal interruptions* for knowledge workers.

There has been a relatively large amount of research in studying the mechanics of prospective memory. The four phases of the prospective memory mechanism [Roda, 2011], as related to personal information management tasks with which I am concerned are:

- *Intention formation* - this is the point of realization that the user is going to have to handle some event at a later time;
- *Intention retention* - this is the period between planning to handle the do the task and actually doing the task;
- *Intention initiation* - when the user actually starts the task; and
- *Intention execution* - actually doing the task.

2.2.6 Vigilance

Vigilance tasks are relevant to email, as keeping situational awareness of one's inbox can be thought of as a vigilance task. Vigilance tasks are described by Wickens and Hollands [1999e] as requiring the user to keep watch of one or more stimuli. This relates to keeping track of incoming mail for users of email to maintain situational awareness.

There are several different types of vigilance, free response, inspection, successive, simultaneous, sensory, and cognitive. In this work I am most interested in the free-response vigilance task, when events can happen at any time. I am also interested in cognitive vigilance tasks, for example reading an email or determining whether or not to read an email.

2.2.7 Primary and Secondary Tasks

Primary and secondary tasks are a special, limited case of multitasking. In this research I am concerned with the primary and secondary task in that the primary task is interrupted and the secondary task displaces the primary task. Wickens describes the situation, "When the primary task is emphasized in a dual-task situation, the concurrent task is called a *secondary task*." [Wickens and Hollands, 1999a, page 443].

The costs of switching between the primary and secondary have been shown to be relatively costly, especially in more stressful conditions [Wickens and Hollands, 1999a, page 445]. Due to this cost there is an *inertia effect*, where users avoid the cost of switching by continuing a lower-priority task than is optimal.

2.3 Conversation Analysis

Research in the area of conversation analysis is relevant to my research as a primary use of email is as a communication medium [Whittaker and Sidner, 1996; Ducheneaut and Watts, 2005]. That is, email is often used to have a conversation of sorts, similar to a conversation on the phone where conversation analysis techniques have been applied [Schegloff, 1968]. Conversations through email exhibit several of the *non-basic* settings outlined by [Clark, 1996, p. 11], e.g. they lack copresence, visibility, audibility, instantaneity, evanescence, and recordlessness. Of course, while it is true in a basic fashion that email can be quite conversation-like, proceeding mail-to-mail in a chatty, rapid fashion, it is important to note that not all email interactions or messages have this type of form. There are a number of ways in which email, or particular emails, differ quite markedly from conversations (e.g. text can be formal and formally arranged, exchange of messages does not occur, turns are positioned far apart temporally), or conversation turns (e.g. some emails are more like letters, broadcast messages, adverts or information briefings). This said, emails often form into sequences of interaction, and these sequences of interaction are opened up, organized and closed in a

way that it is relevant and useful to look at how findings from studies of conversation may be applied to email in order to gain analytic traction on what is going on and why. This dissertation uses conversation analysis [Sacks et al., 1992] for this purpose and, therefore attempts to show its usefulness for this purpose rather in the way that a similar approach of successfully applying CA was taken to text-chat [O'Neill and Martin, 2003].

Differences withstanding, there are a number of purposes that conversations on email serve, which are common to conversations independent of the medium or setting (e.g. face-to-face, telephone, or text-chat). One example is Goffman [1967], and his definition of the job of 'face-work' (i.e. the work to present oneself in a particular manner), which is currently being done over email as well. The idea of 'face-work' is important in conversation analysis, and my work, as this is an activity that drives many aspects around conversation, as it is a primary method that individuals use to construct their presentation to others.

Another concept that is used to uncover special events and breakdowns within conversations is that of the 'perceived normal' developed by Garfinkel [1963]. That is, one can assume that an event in everyday life is exceptional or normal through the treatment of said event by the participants and their opinions about what is expected.

CA was developed primarily by Sacks et al. [1992] along with several colleagues in the 60's and 70's, however this work was not published until 1992. Sacks worked primarily from detailed transcriptions of phone calls, and his investigations initially centered around the conversations that occurred on a mental health hotline. During his analysis of phone calls he developed a method for analyzing conversations. Simply put, his method was to uncover and delineate the ways in which the participants in a conversation could be shown to organise their conversations. For example, how did they manage turns of talk? And, how were questions, demands, inquiries, orders and so forth produced, recognized, and oriented to by the collocutors? Sacks was interested in the participants' practices, methods and understandings exhibited in unfolding sequences of talk and its local management, rather than in using externally generated theory as a means of categorising and explaining talk. In this way he hoped to get up-close to the real phenomenon.

Sacks' method, CA, was a close relative of ethnomethodology (EM) [Garfinkel, 1967] essentially applying the EM analytic orientation (to uncover the methods, practices and reasoning of those being studied, through using naturalistic methods of study) to the specialised domain of conversation, presented in transcript form. Through his studies and analysis he showed how units of conversation were defined and recognised by the participants [Sacks et al., 1992, p. 4]. He showed that units of conversation occurred in pairs and that the utterance of the first unit provides a slot for the next unit to take place, but does not guarantee it. More specifically, the completion of the pair requires the perception and acknowledgment of the first unit through the 'correct,' prefigured response of the interlocutor, e.g. for a question to gain the status of 'question' it needs to be recognized and oriented to as such. Sacks showed that these units make up the various sequences that provide the architecture for conversations. These different sequences serve various purposes in a conversation, the

particular sequence that I am most interested in for this research are the exchanges that makeup conversational openings, i.e. how the start of conversations are negotiated and set up.

While I realize and acknowledge that there are other frameworks that can be used to analyze conversations [Clark, 1996; Levinson, 1983; Shiffrin, 1987; Winograd, 1983], I focus primarily on conversational openings as I feel this is the most applicable and explanatory for the phenomenon that I investigated. In essence, the activities around email notifications and attending to email, where there is a shift from 'doing' something else to 'doing' email, whether this is a reflex reaction or a conscious decision.

2.3.1 Opening Sequences

Conversational openings were described in part by [Sacks et al., 1992, p. 72] in his description of accountable actions (the grounds for why we are talking, why someone was called, and why it is appropriate), which are used by a summoner to explain how they came to make the call or why they initiated the conversation. Schegloff [1968, 1979, 2004], carried on the investigation of conversational openings throughout his career, of particular note is the paper 'Sequencing in Conversational Openings' [Schegloff, 1968]. Much like Sacks, in his investigations Schegloff focused primarily on transcriptions of conversations over the phone.

Several key ideas came out of Schegloff's investigation around the particularities involved in answering the phone. He developed the distribution rule to explain how turns in a conversation function between the two parties on the phone. This rule was used to explain why the answerer speaks first [Schegloff, 1968, p. 1076], even though the answerer does not know who the caller is.

Another important contribution of Schegloff's work is the *summons-answer* sequence. Schegloff described a *summons* as an 'attention getting device' [Schegloff, 1968, p. 1080]. For example, in phone conversations the ringing of the telephone is the summons to the conversation, whereas, in face-to-face conversations there is a larger amount of variation (e.g. "Hey, John" or whistling to get someone's attention) [Schegloff, 2004]. An important aspect of a summons, particularly a ringing phone, is how we are beckoned to answer it as it has a compelling nature.

The *summons-answer* sequence when treated together has a more complex relationship with the conversation and is accompanied by several obligations both within the exchange and upon its successful completion. While simply initiating a summons does not necessarily obligate the potential answerer to answer the summons (at which point the potential conversation would not occur), if they do answer the summons it becomes a non-terminal sequence after which the summoner is obligated to speak. The summoner can choose one of several follow-ups at this point, such as an accountable action (e.g. why I got your attention) or the work of identifying parties. In this way summons-answer sequences are non-terminal,

while a summons can be merely an 'attention getting mechanism' [Schegloff, 1968, p. 1080], a summons-answer sequence is 'specifically preliminary to something that follows' [Schegloff, 1968, p. 1080].

I want to make a clear distinction between an aspect of a *summons* versus a *summons-answer* sequence, in that a summons is not necessarily non-terminal. More specifically, whether or not the ringing phone is answered it still retains its identity as a summons. That said, while a summons is an 'attention getting device' it is a specific kind that is intended to begin a conversation, whether it is answered or not. This is particularly important to make clear in regards to my later analysis of email as a conversation medium, as it has several unique features where this and other distinctions around 'attention getting device[s]' necessitate precision in their usage to get a clear view of how they map onto email, particularly in that emails often do not require an immediate response.

Another interesting aspect, particularly in comparison with email, is Schegloff's interest in the physical barrier between the summoner and answerer, which makes it more difficult to communicate what type of response a summons has garnered. This sometimes has the result of, for example, the continued knocking at the door or repeated phoning of someone, this is perceived as over-insistence and considered impolite [Schegloff, 1968]. There are also things that can be inferred from unanswered summons, particularly with phone summons like 'they weren't home.' These inferences are important in my analysis of email, where there is a potentially greater level of ambiguity.

2.3.2 Contrasting Phone and Face-to-Face

A device that Schegloff used to illuminate the particularities of summons-answer sequences is to contrast instantiations of them across mediums [Schegloff, 2004]. His comparisons between phone and face-to-face are relevant in that I am extending this comparison to email. This particular comparison helps to explain why certain aspects of each medium are unique and at times problematic or advantageous.

The first part of the summons-answer sequence is the issuing of the summons, when Schegloff compared how this works between face-to-face and on the phone he uncovered several differences. One relevant aspect to my work is how the interruption of the summons is mediated and by whom. In a face-to-face setting, much of the negotiation of when to interrupt the answerer is navigated by the summoner. In this case the summoner has many visual indicators as to whether the person is engaged in a conversation or activity, it is simply considered rude to interrupt someone mid-conversation. Therefore, they are responsible for looking at the circumstances and determining an appropriate moment for the interruption. When we contrast this to how the interruption of a summons is negotiated on the phone, much more of the responsibility is shifted to the answerer. This is due in large part to the physical barrier between the parties, as such the summoner has little responsibility in determining an appropriate moment for the interruption, other than issuing the summons at a 'reasonable'

hour.

Another aspect that is interesting, especially in the analysis of email, is the amount of information that is available to both the summoner and the answerer. On the phone, at least when Schegloff did his initial work, the ring of a phone was just that, and the only information that was available was speculative. The lack of information creates an information imbalance, where the summoner knows significantly more than the answerer about the parties and topics to be involved in the conversation (i.e. the purpose). This is quite different from a face-to-face summons where the amount of information is far more balanced, there is no visual barrier and the answerer can clearly see the summoner.

A related feature of these two mediums is the amount of information that is packaged with the summons itself. On the phone the granularity, or isolation of the summons is relatively stark. The phone rings, it contains virtually no additional information than simply to summon the person to a conversation. However, in face-to-face settings far more information can be packaged or accompanied with a summons, the most obvious being who it is (although this is not true on modern mobile phones). The summons could be packed into a request, e.g. 'John, could you do this for me', where the summons is a term of address within the request. This term of address also allows for targeted summonses, where on the phone this targeting was more or less targeted at a location instead of at a specific person. As a result in phone summons-answer sequences there is quite a lot of work that goes into the identification of the parties, sometimes it is done solely by voice recognition and is an act of intimacy [Schegloff, 1979].

This analysis of what is unique to the phone and face-to-face summonses is useful. Of course, the concept of the summons required a bit of reconfiguration when moving from face-to-face to the phone, and I require a degree more in extending it to email communication. Schegloff's work serves as a framework with which we can analyse email through contrasting similar phenomenon with other conversation media. This work still holds mostly true now with the advent of caller id and mobile telephony, however, the imbalance of information in the knowledge of the identity of the caller is a bit more redressed and this has impacted practices yet again. The impact of this change in technology has of course been investigated by a number of researchers that I now review.

2.3.3 Impact of Mobile Phones

Two clear changes that mobile telephony have brought with it are near ubiquitous caller-identification and the ability to answer the phone anywhere. These phenomena have both been studied, and both generally result in more personalized exchanges.

Weilenmann [2003], in the aptly named 'I can't talk now, I am in a fitting room,' investigates how the answerer of a mobile phone summons contextualizes and negotiates their availability in order to have a conversation. Often the exchange begins with the summoner posing the

question 'what are you doing?' which acts as the prompt where the answerer can explain their availability. Often, this is done through contextualizing their availability with their location and current activity. This helps to give the summoner information to negotiate (with the answerer) the interruptibility of the answerer.

Moreover, since the imbalance of information is much less with caller id, the answers are being tailored, as the summoner is generally known to the answerer and the answerer can assume that they are the ones being summoned [Arminen and Leinonen, 2006]. Interestingly, once the information deficit begins to close and the answerer knows the identity of the summoner the sequence of answering the phone begins to change. Instead of the opening sequence that establishes identity, the answerer does a tailored answer to begin the conversation to acknowledge that the identification sequence is unneeded. However, further validation of Schegloff's work is clearly seen when the summoner is not identified by the caller id, and the behaviour previously attributed with answering a land line phone is reverted to.

In the comparisons between face-to-face, land-line, and mobile phone openings one can see how the technologies impact how people perform these openings and begin a conversation, as well as how they in turn provide and conceal information. In this work, I further this comparison with the differences between these and email. Email, as it is a different communication medium with additional affordances and missing other affordances (like synchronous exchange) necessitates additional analysis to describe how it functions.

2.3.4 Conversation as Collaboration

In the book *Using Language*, Clark [1996] argues that people use language for collaboration, and that conversations are an integral piece to this collaboration. Clark [1996] provides an even more specific term for conversations in this context, calling them *joint actions* (p. 82). An example that Clark gives to make the distinction of an action versus a joint action is playing the piano alone versus playing a duet with another person.

Further evidence that something at least akin to conversations are occuring over email is the presence of similar collaborations occuring over email, in fact many of the threads are quite goal oriented in nature [Whittaker et al., 2007]. For this reason, it is useful and relevant to review the qualities and manners in which conversations are collaborative and these joint actions are accomplished. The framework that Clark and his collaborators outline, helps to determine when an email transitions into a conversation and in what ways conversations over email deviate from the 'basic setting' [Clark, 1996, p. 8].

Clark and Brennan [1991] define the 'basic setting' of conversations as being face-to-face, after which they go on to define the features of face-to-face conversations that shape the basic setting for conversations. As a conversation medium deviates from this set of features, it becomes increasingly *nonbasic* and may require 'special techniques and practices' [Clark, 1996, p. 11] and lack the richness of the face-to-face medium. Listed below are the features

as defined by [Clark and Brennan, 1991, p. 9–10].

1. Copresence — The participants share the same physical environment
2. Visibility — The participants can see each other.
3. Audibility — The participants can hear each other.
4. Instantaneity — The participants perceive each other's actions at no perceptible delay.
5. Evanescence — The medium is evanescent — it fades quickly.
6. Recordlessness — The participants' actions leave no record or artifact.
7. Simultaneity — The participants can produce and receive at once and simultaneously.
8. Extemporaneity — The participants formulate and execute their actions extemporaneously, in real time.
9. Self-determination — The participants determine for themselves what actions to take when.
10. Self-expression — The participants take actions as themselves.

Beyond these features that help to define conversation settings in relation to face-to-face, Clark and Schaefer [1989] expanded the basic units of conversation beyond just relaying content and proposed that they had the dual purpose of content and grounding. Where grounding is establishing a thing "as part of common ground well enough for current purposes" [Clark, 1996, p. 221]. A main point around the collaboration in conversations is in establishing this common ground. Clark performed quite a lot of work in analyzing the manner in which common ground was established, broke down, and how it was reconstructed.

Other work done by Clark were the states of understanding [Clark and Schaefer, 1989, p. 267-268]. These are particularly relevant to studying conversations over email, as the states of understanding often seem more fragile. Ballas et al. [1992] further leveraged these states of understanding in order to explicate the semantic distance between the intentions of the user and the expressions available on the interface.

- State 0: B didn't notice that A uttered anything
- State 1: B noticed that A uttered something (but B is not in State 2)
- State 2: B correctly heard content (but wasn't in State 3)
- State 3: B understood what A meant with the content presentation

In terms of how the actions are actually accomplished [Clark, 1996] action ladder (p. 153), helps to describe how actions are carried out in conversation.

- Level 4: Proposal and consideration
- Level 3: Signaling and recognition, or meaning and understanding
- Level 2: Presentation and identification
- Level 1: Execution and attention

All of these topics relate strongly to email conversations and give insight into what makes it more difficult to collaborate when stretched over the course of time and space.

2.4 Uses and Gratification Theory

The roots of Uses and Gratifications Theory can be traced back to the work of Herzog [1940, 1944], where she analyzed gratifications that consumers of radio expected to gain. Herzog [1944] interviewed housewives and identified three gratifications that they expected to gain from their listening to radio soap operas (learning, emotion, and wishful thinking). An earlier analysis Herzog [1940] performed a similar analysis where she identified additional gratifications for another radio program (competition, education, self-evaluation, and sporting). Later McQuail et al. [1972] extended this theory in analyzing voter needs in regard to mass media, specifically investigating the effects of television and newspapers on British elections.

This early body of work established a basic premise of Uses and Gratifications Theory, mainly that gratifications sought and obtained from the use of a medium helps to explain the usage of that medium (often in terms of amount of usage) [LaRose and Eastin, 2004]. The theory was later extended to take into account the set of *expected* gratifications that a user has for the usage of a medium, a slight deviation from the more strict set of gratifications sought / gratifications obtained model held previously [Palmgreen and II, 1979; LaRose and Eastin, 2004].

An additional extension in Uses and Gratification theory was in moving from using a single explanatory variable for a single session of consumption, to using a set of expected gratifications as explanatory for multiple sessions [Rubin, 1983]. This acknowledges the concept that a single session of use is able to fulfill various, multiple expected gratifications. The work that [Rubin, 1983] conducted in developing this method was in the context of television viewing.

In a move to help give more grounding and insight into how the gratifications and potential gratifications are conceived for the survey, LaRose and Eastin [2004] drew from Social Cognitive Theory [Bandura, 2001, 1989].

Uses and Gratifications theory and method have also been applied to several internet technologies. Papacharissi and Rubin [2000] applied the theory broadly to internet use, where the authors were investigating whether they could predict internet use through gratifications sought. They identified five gratifications in their work: Interpersonal Utility; Pass Time; Information Seeking; Convenience; and Entertainment. The authors were also interested in how long, in terms of years adopted, a given user had been using the internet.

Flanagin and Metzger [2001] conducted an additional study of internet use where they leveraged a Uses and Gratification approach. They were interested in how, if at all, use of the new media of the internet was changing gratifications. The authors collected their data in 1997 and 1998 from 684 individuals and treated internet use as a multidimensional technology. A primary interest, and quite relevant to this dissertation, was how the internet was functioning as a conversation medium. They found that users utilized email to get information, provide others with something, and to stay in touch. Upon constructing clusters from the survey responses that they gathered they found that email was similarly attributed to face-to-face and phone use for social gratifications. Meaning, by the late 90's email was being considered a relatively standard communication medium.

More recently Uses and Gratification Theory has been applied to chat [Leung, 2001], social networking sites [Langstedt, 2013], and Twitter [Chen, 2011].

2.5 Summary

In this chapter I have presented a review of related work in personal information management, attention and distraction, conversation analysis, and uses and gratification theory. My work draws techniques and concepts from these areas to further investigate and explain phenomena around getting lost in email. As such, the contribution of this dissertation is first in applying and extending findings from these fields through the analysis email, and second the insight gained through this application to the area of email.

Chapter 3

System and Method

In order to isolate various stages of the process of attending to email and getting lost, I conducted a series of studies that pinpointed different parts of the process. For my first study, I performed an exploratory experiment in the laboratory to determine how participants assessed the importance of individual emails (N=10), the details of which are in Section 3.1. The next investigation I undertook involved three different studies, which I detail individually:

1. a survey on email usage (N=54), Section 3.2;
2. a two-week study of email usage (N=20), Section 3.3;
3. and finally, the application of Attentional Network Test (N=9), Section 3.3

My final study was to validate my findings around the reasons for attending to email, this was done through deploying a survey that followed the Uses and Gratification Theory tradition (N=52), the details of which are in Section 3.5

Some of these studies built on each other and involved a common subset of participants, the sources that each study drew its participants from is outlined in Figure 3.1. New participants were recruited during Studies 1, 2 and 5. The population from the laboratory study in Study 1 is a completely separate set of participants than the rest of the studies. The remainder of the studies had a common subset of participants that took part in all of the studies. Where Study 4 was a subset of Study 3, which was a subset of Study 2. In the final study, a further subset of Study 4 participated as well as sending the call for participation more widely. The results for these studies are used in various parts of my analysis, each chapter details which studies it draws its results from and what data it uses.

All of the studies were approved by the IRB. Study 1 was approved under IRB 09–907 and Studies 2–5 were approved under IRB 12–664. Consult Appendix A.1) for the respective approval letters.

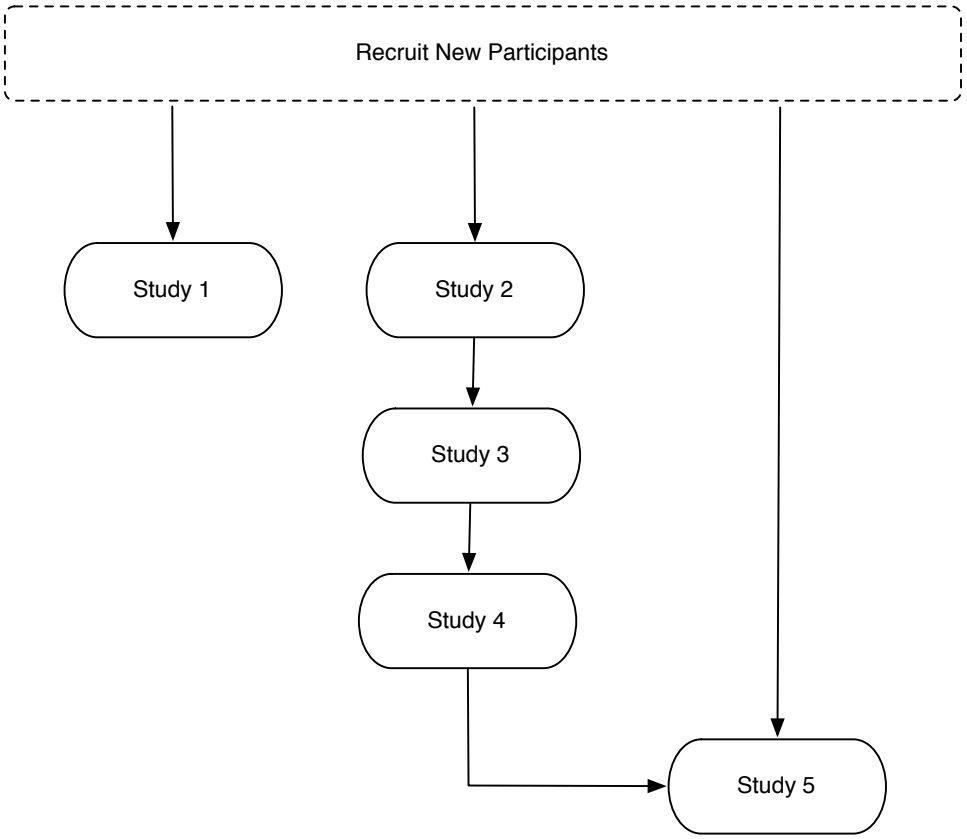

Figure 3.1: Diagram of participant source. Studies 1 and 2 drew solely on a new participant pool. While studies 3 and 4 drew solely on the existing pool. Study 5 drew on both sources.

Throughout these studies I attempt to not only divide email use into a series of events, roughly mapping to chronological usage, but also model the attributes of an email user into three groups: *precondition*, which is the representations of the email corpus when they enter into an email session (e.g. number of unread emails, number of emails sent only to the user, etc.); *predisposition*, which is the set of attributes that indicate whether or not a particular user is more susceptible to being distracted or becoming lost; and *mitigating behaviors*, such as practicing Inbox Zero, or reading every incoming message.

3.1 Study 1: Lab Experiment

To determine how participants were making decisions about the importance of an individual emails in terms of a Likert scale rating. I conducted a lab experiment where the primary measure of difficulty was the amount of time it took to make the determination. To isolate each individual decision on the messages, participants were presented with a single message

at a time. While this admittedly deviates somewhat from real-world usage, this study is specifically aimed at investigating the relative effort involved in making decisions for individual messages and not examining overall email triage strategies. In order to determine the relative importance of the components of an email message (subject, sender, body, etc.) I administered a post-experimental questionnaire as well as using an eye tracker to record the amount of visual attention spent on each component.

Ten participants were recruited through a call for participation on a graduate mailing list and no hypotheses were made based on age, profession, or gender. Three of the participants were female and seven were male, eight of the participants were graduate students primarily from Computer Science.

3.1.1 Task Design

The participants made determinations about email relevance for fifteen emails. This task involved inspecting the information contained in each email, verbally indicating that they were finished, and then rating the relevance while referring to a sheet containing the rating scale.

The equipment used in this study included an Apple computer running the Snow Leopard operating system, an Apple Cinema Display measuring thirty-inches, and an ASL MobileEye eye tracking system. All participants completed the set of tasks in the using the same display and the same eye tracking system. The large display was important for defining large hit areas for the eye tracking system. In order to put boundaries on the time spent on each task the eye tracker was used to establish when the email was first engaged with and the verbal indication that they were complete was used as the end of the time needed.

The aspects that were measured during each task involved the relevance of the email and the amount of time the rating took. The relevance of each email was gathered throughout the experiment. Participants rated each email's relevance on a five point Likert scale, ranging from 1 = Unimportant to 5 = Very Important. This variable was used to analyze the correlation between different variables and the overall relevance of an email.

The second measure was decision time, this was the amount of time between initial engagement with the email and the verbal conclusion of the decision. This time was measured by inspecting the time stamps of the different events on the video footage on post experiment analysis. This variable was used to determine the difficulty in situating the email and making a determination of relevance. Decision time was taken as a proxy for difficulty, that is, I assumed that a longer decision time was the result of a more difficult determination of relevance.

3.1.2 Post Questionnaire Design

A questionnaire was administered to each participant after the experiment. The purpose of the questionnaire was mainly around gathering information about their relationship with each sender and the level of relevance for each of the topics referenced in the emails.

The first question for a given email was the the importance of the sender, this was measured using a five point Likert scale. This scale included the values *Unimportant* to *Very Important*. This variable was used to determine the social proximity of the sender.

The second question in regards to the sender was the amount of contact the participant had with them, this was rated on a five point Likert-type scale as well. The scale included the values *Never* to *At least once a day*. Where contact was defined as any interaction both within email and outside of email.

The final question for each email was the relevance of topic, which was rated on a five point Likert scale. This scale included the values *Unimportant* to *Very Important*. This variable was used to determine the relevance of the topic and was primarily used in comparison with the effect of social proximity.

3.1.3 Procedure

Each participant first sent information over email to make determinations about various senders in their social circles and topics that they are interested in. While only subjects and topics of emails were required, participants found it easier to simply forward the requisite messages to the administrator of the experiment. This data was used to setup the experiment. Once the experiment was prepared, the participant was introduced to the study, calibrated with the eye tracking system, then performed the tasks, and administered the post questionnaire.

3.2 Study 2: Survey on Email Usage

The first stage in the main investigation of this dissertation was to deploy a survey to probe existing strategies, practices, and the circumstances of each participant. The survey focused on how participants are currently using email, with what frequency they are being distracted, why they might be distracted, and any strategies or tools that they have employed to mitigate distractions. As the different strategies and responsiblities that each participant had was quite difficult to determine from usage logs. Therefore, the data from this survey was utilized in concert with the usage logs to answer several research questions. Information gained during this phase informed some of the activities and usage patterns that were targeted during the analysis of the diary study and IMAP logs. Fifty-two participants completed usable surveys.

3.2.1 Survey Design

The deployment of this survey was done through various channels on the internet. The survey was deployed to various Virginia Tech listservs. The survey contained a link for participants to do further parts of the study. See Appendix B.2 for the contents of the survey.

3.3 Study 3: Email Usage, Diary, and Interview

To my knowledge, isolating and studying the natural occurrence of an email session and relating a diary study to the specific instances of email activity, especially across devices, has not yet been done. In order to establish the relation between the diary and a session I utilized a mixed method approach in which I directly logged email events and gathered diary entries. As such, the system that I built for this study is comprised of two parts: the email logger that recorded any changes to the email corpus; and the front-end that participants used to enroll for the study and complete diary entries.

My email logger used IMAP to log session details such as length, preconditions of the email corpus, and activities that the participant performed during the session. Similar activity logs have been used to study interactions with computers before [Iqbal and Horvitz, 2007]. More specifically, usage logs have been used to study different phenomena in email, for example, the utility of filing [Whittaker et al., 2011], the distribution of information [Fisher and Dourish, 2004], and response rhythms [Tyler and Tang, 2003].

I implemented a front-end using Django[1] that participants would use to fill out specific diary entries associated with a particular session. Diary prompts were sent to users based on their activity as measured by the email logger. More detail about the email logger and when and why I dispatched diary prompts can be found below in their respective sections.

I recruited 20 participants from our university; 12 were female and 4 were male (4 didn't report). My participants ranged from the ages of 23-37, with $\bar{x} = 25.6$ and $\sigma = 4.6$. Within my participant group 11 were graduate students, 1 was an undergraduate student, 1 was a stay at home dad, 5 were working professionals, and 2 did not report. Participants engaged in 2462 email sessions; 14 participants filled out 215 diary entries. Participants were required to be Gmail[2] users; however, all of our university email is run on Gmail, so everyone qualified. That said, participants could use whichever Gmail account they preferred. This study was approved by the universtity IRB (#12-664) and, as I am dealing with participants' personal information, whenever there was a choice between respecting my participants' privacy or making my data richer, I opted for privacy protection and used the absolute minimum

[1] https://www.djangoproject.com/

[2] Shortly after I collected data, Google announced a tabbed inbox. This featured was released after I had collected data for my study and therefore had no implication in my study. But it is clearly related and requires further study.

amount of information that I would need to answer my research questions. For enrolling in the study, participants received a five dollar gift card, and if they filled out over half of their diary prompts, they received an additional five dollar gift card. For any statistical analysis I used the R statistical package, version 3.0.

3.3.1 Procedure

To initiate the logging of their email, participants first enrolled in the study using my web application. After the participants created an account on the system, they then granted the application the proper privileges that are required to access their email. Since I made use of Gmail I was able to use OAuth[3] so that I did not have to collect or store the participants' passwords. OAuth provided an additional benefit to the participants, in that they were able to shut down access to their email at any time during the study without having to ask me. The web application also provided participants with the ability to delete any sensitive/overly private emails from the system; however, none of the participants used this feature.

Once the participants were properly enrolled in the service the study began in earnest. The primary driver for this study was the IMAP logger, in that it gathered quantitative data that was used both in the analysis and to dispatch diary prompts. The IMAP logger connected to the Gmail IMAP server every three minutes to take a snapshot of the state of the email corpus and determine if this state differed in anyway from the last snapshot.

I was able to take a snapshot of each participant's entire email corpus every three minutes because I did a bulk request on a subset of headers from the IMAP server. This bulk request was done for each email folder (or tag in Gmail), this request contained the header information (or metadata) for all of the emails in that folder. The header data for an email is comprised of items like the address it was sent to, if it had attachments, if it has been read or not, along with timestamps for when it was sent. I also ignored any activity in folders that were labeled as *Junk* or *Spam*, to ensure that I were looking at the already filtered email that the participants were receiving. I determined, empirically, that three minutes was the minimum amount of time necessary to complete the snapshot in my pilot.

Throughout the study I did not collect the body of any emails and anonymized each email address using the md5 hash function before it was stored in the database. By using this hash function I could tell that a participant had sent or received n number of emails to or from a certain address, I just did not know what the actual address was. For example, if the user received ten emails from *author@inst.tld*, I would see that they had received ten emails from *25446962*, the first eight characters of the md5 hash. At the end of the study I deleted all of the OAuth tokens granted to my application and sent an email to all participants with instructions on how to revoke the application's privileges.

Since I had snapshots of the entire email corpus every three minutes, I was able to keep track

[3] https://developers.google.com/accounts/docs/OAuth2

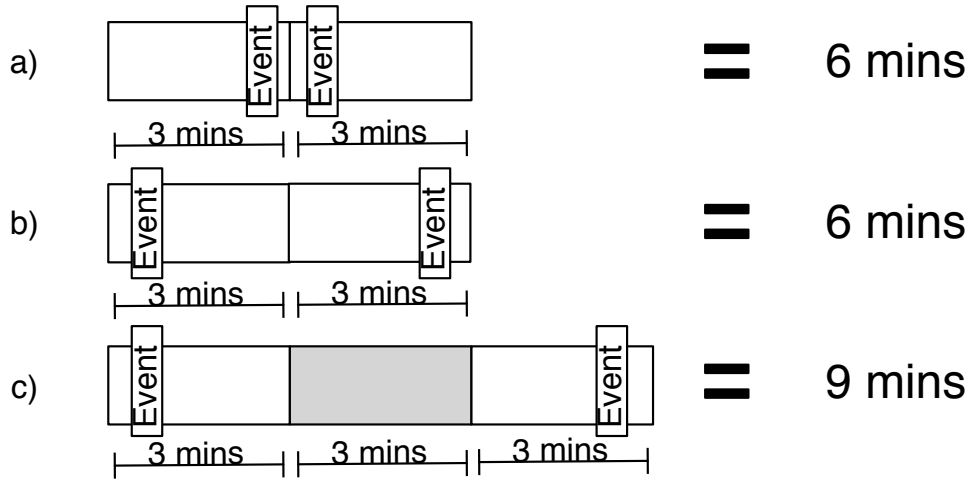

Figure 3.2: Description of how three minute intervals were used to determine length of each session.

of many aspects of the participants' email activity. I group them into three main categories:

- *Running Totals*: I kept track of several running totals that informed the preconditions for each session. I tracked the their total number of messages, unread messages, new messages since the last session, messages in the inbox, unread messages in the inbox, new messages in the inbox since last active, and number of composed / replied to messages.
- *Activity Counts*: For each session I tracked what messages they had read, deleted, composed, and replied to.
- *Interactions*: I also kept track of to whom (anonymized) they were sending/reading/replying.

How I determined whether a participant was in the *active* state, and how long they were in that state, requires further explanation. I define the *active* state as one where the participant is doing some sort of action within email, e.g. reading, moving, or composing a message. First, to determine if a participant was active, I compared snapshots gathered from my email logger to detect when the participant modified any aspects of their email corpus. So, if they had moved an email, read an email, composed an email, etc. I flagged them as being active in that three minute slice of time. Second, to determine an active email session's length, I summed these active slices of time. However, if there were a three minute inactive slice that was straddled by two active slices, then I considered that to be a contiguous block of activity. An inactive slice is one where no activity was detected, i.e. the participant did not move,

read, or compose any messages. A few different possibilities are illustrated in Figure 3.2. In Figure 3.2a, two active events occurred in a relatively short time span, however, this gets categorized as a six minute session. Contrast this with Figure 3.2b, where two active events occur in a longer time span, however, this is also categorized as a six minute session. To illustrate some of the smoothing I did see Figure 3.2c, where two events occurred in two time slices that straddled an inactive slice of time, in this case I count this as one session and it is categorized as a nine minute session. A participant was deemed inactive if there was more than three inactive time slices. The rationale behind this policy is that the changes detected by the changes in IMAP were not continuous and only signals of use. Therefore, if a participant read an email for six minutes and then read another email it should be counted as the same session even if there is a three minute slice of time where they are not flagged as active. While this method is not perfect, I feel it is a sufficient approach to capture most discrete active session.

3.3.2 Collecting Diary Entries

When the email logger detected that a period of activity had ended, then it triggered a request, in the form of a URL, to the user to fill out a diary entry through SMS. This happened at most twice a day and only during 'typical work hours' of the participant's timezone with a minimum of four hours between prompts. The diary entries were a web-based form where the participant filled out the following information: the motivation for initiating the email session, which task (if any) was interrupted by the email session, if they were distracted during the email session, and information about what constituted the email session. I opted to keep the number of text fields low, in order to decrease the amount of work for the participants. Keeping the amount of time required to fill out an individual diary relatively low was also important for us to capture the particular moment in time, I wanted to avoid the 'Heisenberg' problem Czerwinski et al. [2004].

I categorized the reported motivations for attending to email in an iterative manner where I used the words of the participant to label each entry. Once this initial set of labels was determined, I grouped entries with essentially the same motivation and used the most descriptive term. After several iterations of this process I maintained the terms of the participants and arrived at a unique set of categories. The final categories appear below:

- *Anxiety* - participants cited that they had not checked their email in a long time and were concerned if they had received something unexpected.
- *Compose a Message* - participants cited that they needed to send a message.
- *Curiosity* - participants cited that they were curious if they had received anything interesting.

- *Down Time* - when participants did not have anything in particular to do and decided to check their email.
- *Expecting Communication* - when participants were anticipating the arrival of a specific message from someone (e.g. an advisor or boss).
- *Inbox* - sometimes participants initiated a session because their inbox caught their attention.
- *Notification* - participants cited their phone buzzing or receiving a desktop notification.
- *Previous Awareness* - participants cited that someone mentioned an important email in conversation or they saw an email in a previous session.
- *Refinding* - participants sometimes went into email to find something specific, like a meeting location or a work item.
- *Routine* - many participants checked email first thing in the morning, right after lunch, or when they first arrived to work.
- *Unread Count* - participants sometimes noticed they had a few unread emails and decided to read them.
- *Not Reported* - participants sometimes put 'Nothing' for motivation or left it blank.

3.3.3 Limitations and Advantages of Email Logging and Diary Entry

My method has two limitations: first, it only captures actions that change IMAP status, therefore rereading of email is not captured; and second, rules used to automatically file incoming messages can cause false positives. The first limitation is unavoidable as re-opening an email does not change any of the flags or information in IMAP. However, if they did anything within the same three minute snapshot other than reread email, then the effect was mitigated as the session was still counted as active. So the limitation is in under-counting sessions that consist exclusively of just rereading an old email.

The second limitation, that rules can cause false positives for active status, was more complex to avoid. As I was aware of this limitation throughout my study and pilot, I developed heuristics based around the amount of time between when a message was received and when it was filed (or tagged) into a different folder. During the pilot I paid careful attention to the number of false positives and found that the above method was sufficient in reducing this number.

While these two limitations cannot be discounted, the advantages to my method are numerous. From the perspective of the participant, the advantages are as follows. Participants

are not limited to a particular client or platform, they just need to use Gmail. Due to this advantage, I was able to capture activity across all of the devices that each participant uses. The impact on the user is not heavy, there are no plugins to install and they need to only answer a short diary entry twice a day on weekdays.

In terms of the data gathered, the advantages are as follows. Through the combination of OAuth and limiting the data that I request and store I am able to maintain the privacy of the participants, while still being able to gather detailed data about them over a period of time (a challenge endemic to studies of Personal Information Management practices). The logs of user activity help to determine bounds around the different email sessions and provide further quantitative insights into the different email activities, minimizing what they had to enter in the diary. I was able to determine the entire writing process of emails since drafts are often stored in IMAP folders, and their statuses updated as they are being written. The way in which I was able to do this longer study, grabbing email data as it unfolded instead of just a full, one-time snapshot afforded greater insight into the participants' activities than many previous email studies.

3.4 Study 4: Attentional Network Test

To gather Attention Network Test (ANT) scores I recruited participants that had completed the previous phases and utilized the test developed by Fan et al. [2002]. ANT uses several different mechanisms (cues, congruency, and time) to determine different attentional traits of the participant. The test consists of a two ten minute sessions during which the participant is asked to make determinations about whether an arrow is pointing to the left or right. The program that was used to conduct the ANT by the researchers has been made available and there is a Java version that can be run either on an individual desktop or on a remote server. Upon the completion of the ANT a Microsoft Excel spreadsheet is compiled with the results of the test, these are stored on the server and coded to the participant number. Participants will be asked to take the test during a quiet time in the day and asked to email the resulting spreadsheet.

ANT is designed to test the three different attentional networks during a single task. The three networks are alerting, orienting, and executive control. The authors define alerting as "achieving and maintaining an alert state"; orienting as "the selection of information from sensory input"; and executive control as "resolving conflict among responses." These three different networks will be correlated separately with the frequency of getting lost in email.

3.5 Study 5: Uses and Gratification Survey

Uses and gratifications aims to find out what gratifications that users are expecting to gain from a media's use. These are grounded in different ways and there is not a standard method for determining the gratifications that users seek from the use of a type of media. I have primarily grounded the gratifications sought in the diary responses that I gathered during the email logging phase of my experiment. While other studies have studied email use among other media [Papacharissi and Rubin, 2000; Flanagin and Metzger, 2001], grounding email gratifications in user reported reasons in the diary entries is meant not so much to compare with other types of media but to determine the breadth of different motivations between participants in the diary study and with a larger group.

I feel that this grounding is more apt than previous methods. This is because I was able to draw the questions from the diary responses written by users. I also draw some questions from previous work in internet use [Papacharissi and Rubin, 2000].

See Appendix B.3 for the full contents of the survey.

3.6 Summary

In this chapter I have outlined the five studies that I have conducted as part of this research. Each of these studies isolated various phases and aspects of email usage. In the remainder of this dissertation these studies will be discussed in the following order.

- Chapter 4 discusses the process of attending to email and draws primarily from Studies 2 (Section 3.2) and 3 (Section 3.3), while drawing from Studies 4 (Section 3.4) and 5 (Section 3.5) as well.
- Chapter 5 discusses how participants rated the relevancy of individual emails and draws from Study 1 (Section 3.1).
- Chapter 6 discusses how users of email become lost in email and draws primarily from Study 3 (Section 3.3). While drawing from Studies 2 (Section 3.2) and 4 (Section 3.4) as well.

Chapter 4

Attending to Email

This chapter presents an analysis of both the quantitative and qualitative data that I collected. The focus of my analysis is on addressing the research questions outlined in Section 1.3. This analysis provides insight into the process the participants undertook when they attended to email.

This chapter consists of several parts. First, addressing the question of what is drawing users into email. As part of this investigation, I present an examination of how the participants' reasons (as reported in their diary entries) relate to conversations that occur on other mediums, e.g. face-to-face and phone. Second, I present evidence gathered from diary entries indicating that participants maintain a relatively high level of engagement with email. Thirdly, I leverage usage logs to determine what types of activities the participants engaged in while attending to email and which activities correlate with longer sessions. Using the length of sessions and feedback from the diary entries, I present the evidence around the negative consequences that the participants experienced for attending to email. Finally, I evidence the participants' awareness of these issues by presenting the various strategies that arose from their survey responses, diaries, and interviews.

4.1 Studies Utilized

This chapter draws from the results of:

- Study 2 – Results from the survey are used to frame the individual reasons for beginning a session in the broader context of what participants believe successful email use is and the strategies they form around to ensure it.
- Study 3 – The diary entries and IMAP logs are used to determine why participants began their email sessions and what activities lead to longer sessions.

- Study 5 – The results of the Uses and Gratifications survey is used to validate the gratifications sought from the previous studies, as well as to compare with other traditional forms of media.

4.2 What Draws Users into Email?

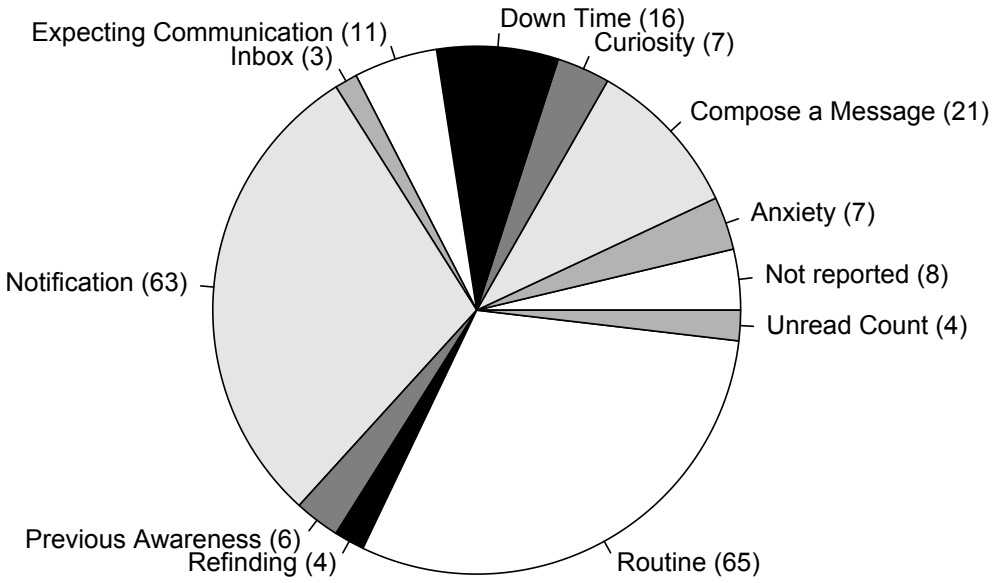

Figure 4.1: Total number of diary entries was 215, each slice of the pie has the number of occurrences in parenthesis.

My investigation into what draws users into email was primarily accomplished through examining diary entries. A main finding of this investigation is that my participants often decide to attend to email because of a fairly specific prompt. That is, instead of responding to a large unread count they instead cite notifications about an important message, or often even the *expectation* of an important message as primary factors in their decision, time and time again. The different reasons cited by users and their frequency are presented in Figure 4.1.

One unexpected result of this analysis is the relative absence of mentions of the unread count as a reason to attend to email within the diary entries. In fact, only four diary entries mentioned this, compared to roughly a third of the diary entries citing notifications as the reason for attending to email. This is interesting in that the unread count does not seem to be utilized by my participants. The apparent lack of utility of the unread count is especially stark, as email clients typically give only two methods for maintaining awareness of incoming email: first, email clients typically give some sort of aural or visual notification for individual

emails; and second, they often give a rather prominent count of unread emails. I believe the primary reason that my participants did not seem to make use of the unread count can be found in the way they *did* respond to the *summons* quality of notifications. Among my participants, they decided to attend to email based more on individual summonses to conversations, and not the overall criticality of the amount of emails or general state of their inbox. Furthermore, the absence of any type of specific, attention-getting mechanism in regards to conversation takes the meaning and power out of the unread count as a draw to a conversation.

In the remainder of this section I provide examples and further analysis of primary reasons that my participants attended to email. The purpose of this analysis is to examine and show the overarching reasons that my participants attended to email, I further group the categories of responses from Figure 4.1 more generally below. In each of the cases I highlight example diary entries.

4.2.1 Individual Notifications

Notifications about individual messages were a strong draw for attending to email. In my analysis I found that notifications functioned similarly to the *summons* in *summons-answer* sequences involved in conversational openings. Messages, particularly important messages that required some sort of response, beckoned the participants to answer them much like a ringing phone or person requesting their attention. For the diary entries in which this situation was mentioned (frequency: 63/215, session length(minutes): $\bar{x} = 7.98$ $\sigma = 20.08$), the participant usually indicated that the message was from an important collaborator or significant person in their lives, and that this was the reason for attending to email. I must note, that in my analysis I treated visual and aural notifications the same, as I did not have the granularity of data to determine which type of notification was encountered. However, based on the diary entries of the participants the notification is the piece that grabs attention, while the details that indicate the relative importance of the email are what prompt action.

Many of these quotes hint at the ongoing relationships that email helps to serve. These responses point to the participants treating emails from certain individuals as more important than others.

> **P4**: *Working on adding to a collaborative paper. New mail notification Replied to an email from a committee member.*

> **P9**: *Heard the notification on my phone, saw that it was from my supervisor, and decided to see if it was important.*

> **P12**: *I received a new email notification. I responded [. . .].*

Roughly a third of the diary entries mentioned a specific, individual notification. However, many of the diary entries also stipulate that since the notification was from someone or about something important to them that is the reason they responded. This evidences that not all notifications evoke this behavior, and there are in fact notifications that, once attended to, are subsequently ignored. The participants selectively respond to new email notifications.

4.2.2 Composing Emails

Another relatively common reason for attending email was composing an email for a collaboration or coordination (frequency: 21/215, session length (minutes): $\bar{x} = 8.20$ $\sigma = 14.42$) Many of these emails were also in reference to individuals that the participants have on ongoing relationship and possibly a work activity in common with.

P4: *Emails out the tantalum collaborative paper for additional comments.*

P16: *Sent an image to a professor*

P3: *Wrote an email to a friend and deleted facebook notifications.*

4.2.3 Routine Sessions

A typical behavior among the participants was the strategy of routine sessions (frequency: 65/215, session length (minutes): $\bar{x} = 6.37\sigma = 6.57$). These sessions were often in the morning as the first activity or after returning from a lunch break. During routine sessions participants often engaged in *pruning* [Mackay, 1988], this behavior also occurred when sessions were motivated by downtime or boredom. In this case, pruning typically involved the participants archiving (when the participants said they were deleting they were almost always archiving upon inspecting the usage logs) to clean up unimportant emails. Within these sessions participants also responded to messages that they had left from previous sessions.

Typically the diary entries for these sessions were short and not terribly detailed, indicative of the unspecified nature of these tasks, because the primary goal is to clear out the queue.

P5: *check email, delete email*

P17: *cleared out junk mail. Read important emails.*

Related to routine sessions, but more opportunistic, are sessions that are motivated by down time (frequency: 16/215, session length(minutes): $\bar{x} = 12.43$ $\sigma = 17.65$). Where participants were between tasks, not particularly involved in any task, or even bored. These sessions functioned much the same as the routine sessions and were used to sift through unimportant messages and answer any accumulated messages that required a response.

> **P17**: *deleted unwanted emails. Read one new message*

I believe that the reason these sessions exist is primarily two-fold. First, missing an important email message was clearly an ongoing concern for the participants (as explicated in the section below). Second, there is a want to 'keep up' with emails, it was clear from the survey responses that the participants heavily connected their efficacy (especially the projection of it) with email responsiveness. This harkens back to some of the 'face-work' that Goffman [1967] said served as a motivator for many conversations.

4.2.4 Attentional Networks

A significant hypothesis in this line of research, outlined in Section subsection 1.3.2, was that there were individual differences that had a measurable impact on the process of attending to email. Furthermore, I hypothesized that the Attentional Network scores, as measured by the Attentional Network Test (ANT), would be a sufficient measure to determine an effect.

This set of hypotheses was not confirmed, As seen in Figures, Figure 4.2, Figure 4.3, and Figure 4.4, there is no clear trend emerging from this data set. The strength of the other types of signals, primarily the status of the email corpus, is too strong for the more subtle individual differences (especially as measured by the ANT) to be clearly identified.

4.3 Are Participants Maintaining Engagement?

Results for my study evidence a high level of engagement with email among my participants, as well as the anxiety that can result from it. The most salient and interesting finding is that my participants cited that they attended email because they had an expectation that they had received an important email. The email in question was usually from someone important to them, e.g. a supervisor or collaborator, and the entries usually implied or mentioned some ongoing responsibility or important relationship. While these sessions were not terribly frequent (frequency: 11/215, session length (minutes): $\bar{x} = 12.89$ $\sigma = 15.03$), I believe they are indicative of the existence of a consistent, continuous engagement with email that my participants were maintaining.

Sessions triggered by these feelings where the participants did not receive the expected message (9) were very short (all but one were three minute sessions). This is presumably

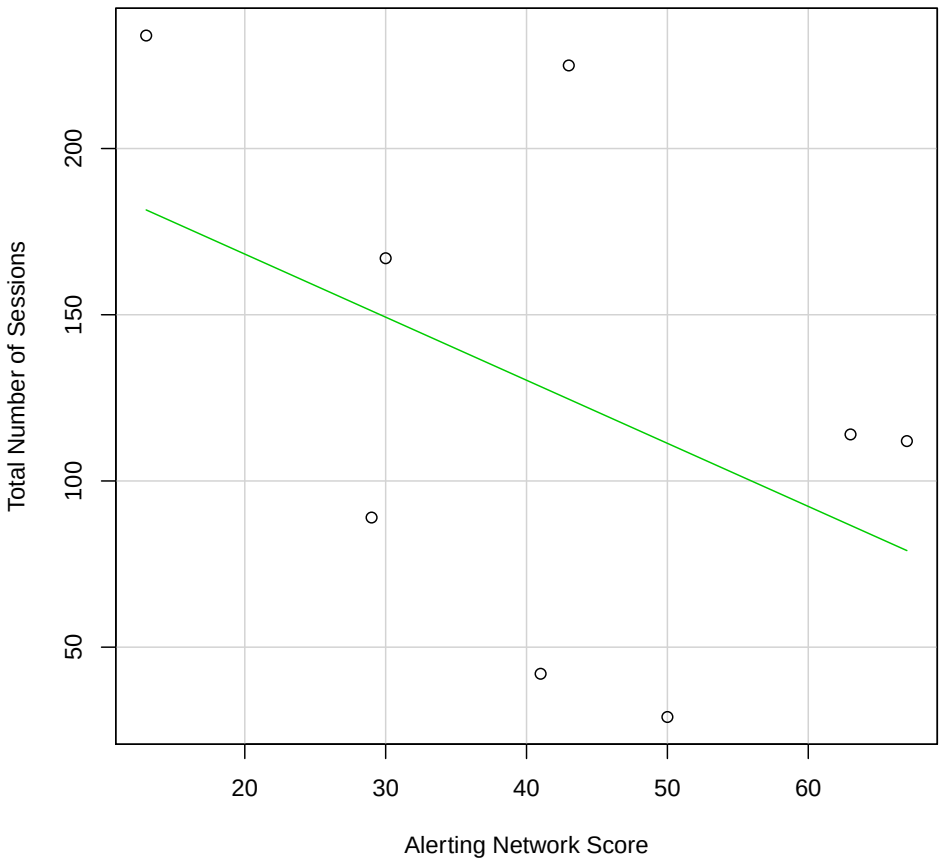

Figure 4.2: Scatter plot of participant alerting network scores vs. total number of email sessions.

because, while the participant was nervous that they may have missed an important email, it was simply not there. In fact, none of the sessions of nine minutes or more (39) involved a session where the participants expected to receive an email from a specific person and that expectation was unfulfilled.

> **P13**: *Damage control: making sure my PI didn't email*

> **P15**: *Was looking for a particular email from my professor I work for.*

> **P1**: *See if I had an email I expected from my sister*

This phenomenon also cropped up in a less direct manner when participants cited a worry or interest about receiving an unspecified email as the reason for their session. These sessions

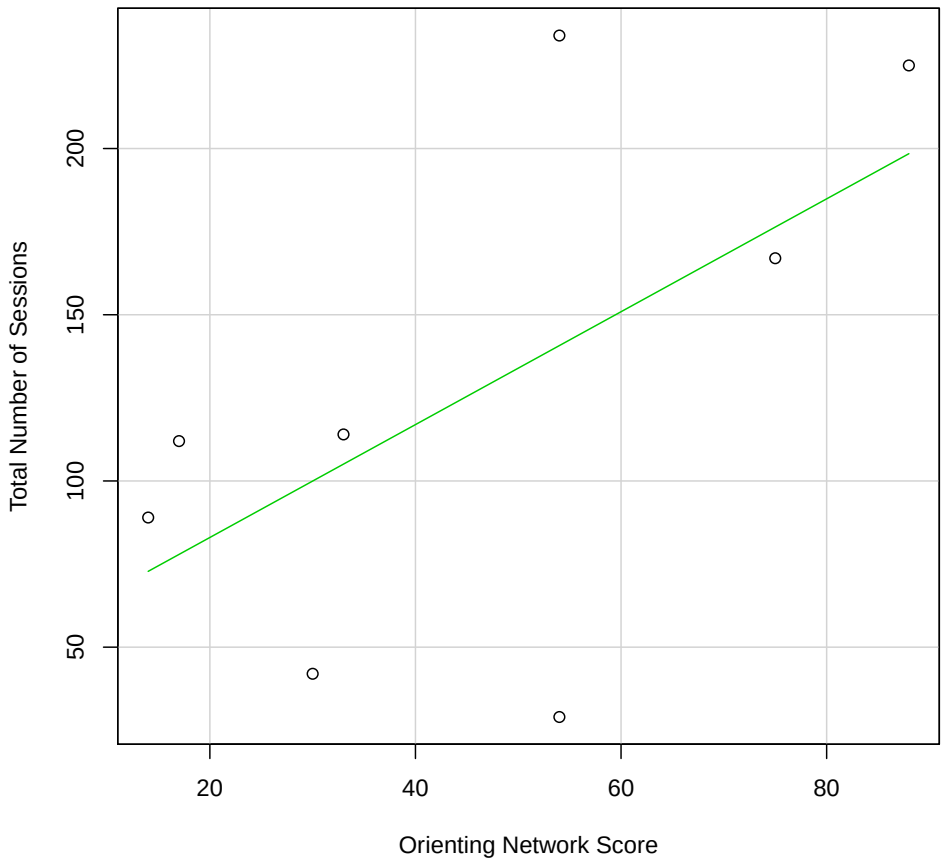

Figure 4.3: Scatter plot of participant orienting network scores vs. total number of email sessions.

were motivated by anxiety or curiosity (frequency: 14/215, session length (minutes): $\bar{x} = 5.78$ $\sigma = 6.39$), however, they were less specific about a particular reason that they were anxious. The primary reasons for these sessions instead seem to be motivated by the loss of continuous engagement with email.

> **P15**: *Checked my email. There were a ton (I had been in a meeting for a while and couldn't check my email) so I had a bunch waiting for me. Responses to some, not all. Didn't even get around to reading them all.*

Sessions that are tangentially related to this category are sessions where the participant was already aware of an important email message (frequency: 6/215, session length (minutes):

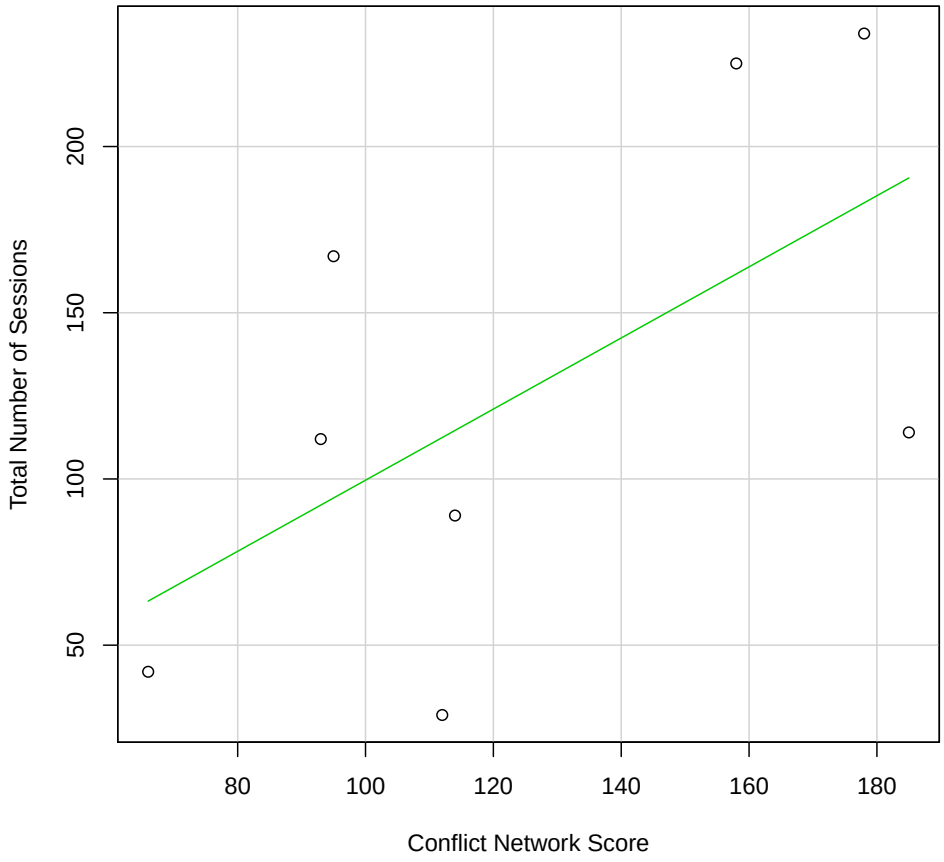

Figure 4.4: Scatter plot of participant conflict network scores vs. total number of email sessions.

$\bar{x} = 6.50$ $\sigma = 6.39$). Within these sessions there were instances where the participant had been told by someone outside of email or had seen the email in a previous session.

P11: *My advisor wanted something to be forwarded.*

Overall, 31/215 sessions can be directly attributed to reasons associated with anxiety or interest in maintaining an awareness and continuous level of engagement with the participants' email.

Participant	Sessions	Usage (mins)	Messages	Inbox	Read	Moved	Deleted	Composed	Replied
1	88	396	125	24	125	24	0	0	4
2	133	627	376	337	335	0	0	10	18
3	107	534	321	227	257	0	0	13	38
4	154	846	426	412	334	0	0	2	7
5	110	519	295	243	219	243	86	14	38
6	231	1326	909	818	208	35	4	17	36
7	40	135	546	393	42	0	0	4	1
8	166	996	443	375	240	14	14	16	17
9	96	354	109	97	109	0	0	1	4
10	223	1005	444	365	297	104	0	20	17
11	43	237	483	176	102	150	17	33	3
12	165	876	845	765	372	182	106	31	28
13	112	606	433	353	207	1	0	16	21
14	150	1332	819	475	690	220	17	65	177
15	170	828	271	271	271	0	0	1	6
16	219	2022	1720	766	910	74	14	103	124
17	16	105	299	286	59	0	0	2	7
18	128	579	199	156	96	8	0	15	15
19	97	570	482	403	328	0	0	21	57
20	14	123	34	13	25	0	0	2	1
$\bar{x}$	123.10	700.80	478.95	347.75	261.30	52.75	12.90	19.30	30.95
σ	64.20	477.22	374.88	226.88	215.30	81.36	29.28	24.92	44.43

Table 4.1: Details about the activities that participants undertook during my study.

4.4 Which Activities are Participants Undertaking?

In this section I present the activities that the participants performed throughout my study in their email sessions. Table 4.1 contains a summary of these activities as well as the mean and standard deviation for the group.

The aspects that are summarized in the table are as follows:

- *Sessions*: the number of sessions that the participant engaged in, where a session is a contiguous set of active three minute blocks
- *Usage (mins)*: the number of total minutes that they were active, this is measured in terms of adding the three minute slices where they were active
- *Messages*: the number of messages that they received and sent over the course of the

study regardless of which folder they arrived in or whether they were read or not.

- *Inbox*: the number of messages that they received in their inbox.
- *Read*: the number of messages that they read.
- *Moved*: the number of messages that were either moved or tagged, when a message received multiple tags this counter increments by one.
- *Deleted*: the number of messages that were moved to a trash folder or tag.
- *Composed*: the number of messages written, not including the messages that were written in reply to another email.
- *Replied*: the number of messages that were written as replies to another email.

Similar to previous research, I find quite a bit of diversity in the number of incoming emails and the strategies that participants develop to manage them. This is evidenced by each column having a large variance in relation to the mean.

These large variances in Table 4.1 make some of the different strategies evident. One example where there is a fair amount of variance is in the portion of messages that participants read. Some participants (1, 9, and 15) read every message that they receive, while others (2, 3, and 20) nearly read all incoming emails. However, the majority of the participants are only reading a small portion of their incoming emails.

When these messages are separated into distinct groups, e.g. read vs. unread or filed vs. unfiled, I find that many messages are never acted upon at all. Specifically, among the participants only around half of incoming messages were read, with only a few rigorously reading incoming mail. Also, I find only around 15% of messages that were received were moved or deleted, meaning 85% of messages were left in the inbox. This suggests that a large portion of email was not terribly important or pertinent to the participants, keep in mind that these numbers exclude any messages in *Junk* or *Spam* folders.

In summary, the participants read about half of their messages, delete very few of their messages, and leave the vast majority of them unfiled in the inbox. This provides insight into why I did not see many instances of the unread count as a motivating factor in the decision to attend to email. Mostly because, the majority of behaviors that I see run contrary to using a raw unread count, if they are only reading half of their email, their unread count is constantly increasing. Likely, the unread count only really stands out if you read all (or almost all) of you messages. Secondarily, there is a large amount of variance in the practices of the participants, illustrating the difficulty in developing consistently useful indicators.

These results also further evidence that different email messages have vastly different levels of importance to the participants. A subset of incoming messages is read, an even smaller subset is acted upon, and an additionally smaller subset is replied to. Therefore, many emails

do not require a reply, or are at least not taken to require one and therefore are not meant to start conversations.

4.5 What Leads to Longer Sessions?

Participant	Messages	Unread	Inbox	Inbox Unread	Inbox New	Read	Moved	Deleted	Composed	Replied
All	0.11***	0.11***	-0.11***	-0.09***	0.08***	0.60***	NA	0.24***	0.48***	0.38***

Table 4.2: Session length correlates with other user data (spearman correlation coefficients)

I was specifically interested in answering two questions in regards to session length. First, does the unread count have any quantitative bearing on how long the participants' sessions were? That is, just because they are not citing the unread count as a reason for attending email, *should* they be using this to make decisions to attend to email? Second, what activities are correlates to longer sessions?

To investigate these questions I present the results of the analysis of my logs. I present the results of a Spearman correlation by giving the correlation coefficients and their level of significance indicated by * for $p <= 0.1$, ** for $p <= 0.05$, and *** for $p <= 0.001$. I chose to use the Spearman correlation because I did not have a truly continuous measure of time. The table of these results is found in Table 4.2. This analysis informs the utility of the unread count and related indicators to estimate the length of the next session. The measures I chose to include in my analysis are described below, I limited myself to this group as I was interested in investigating two questions. First, whether or not there are easily tracked quantitative aspects of email that correlate with session length. In essence, do my participants have a reliable way to estimate the length (or level of disruption) of their next session. Second, what activities correlate with session length, to give insight into what is taking up the majority of time in email use.

The aspects of usage that I report in the table are:

- *Messages*: The total number of messages in their mail corpus at the start of the session.
- *Unread*: The total number of unread messages in their mail corpus at the start of the session.
- *Inbox*: The total number of messages in their inbox at the start of the session.
- *Inbox Unread*: The total number of unread messages in their inbox at the start of the session (this is what the unread count is based on).

- *Inbox New*: The number of new messages that have arrived in their inbox since the previous session.
- *Read*: The number of messages that they read during the session.
- *Moved*: The number of messages that they moved or tagged during the session.
- *Deleted*: The number of messages that they deleted during the session.
- *Composed*: The number of messages that they composed excluding messages that were in reply to another message during the session.
- *Replies*: The number of messages that they wrote in reply to another message during the session.

It is worth noting that *none* of the above preconditions (e.g. number of unread messages or messages only to recipient) that I measured had a strong significant correlation with session length. The preconditions that I measured were the set of preconditions that I thought users of email might reasonably have access to. These results indicate that users do not have reliable mechanisms to estimate the length of their next session, other than staying aware and engaged with their email client and incoming messages. I illustrate this through contrasting the two more salient results of my analysis, the apparent lack of utility of the unread count versus the strong, significant correlation between session length and the read count.

4.5.1 Unread Count

My analysis points to a particular reason why the unread count was not cited as a reason for attending to email. This is because the number of unread messages that a participant has is not an indication of how many *important* email messages that they had, and certainly not indicative of how long their next session is likely to be. In my analysis I found that the number of unread messages in participants' inboxes did not have a strong, significant correlation with session length.

When I ignore the unread count and instead look only at the *Inbox New*, which represents the number of new messages received since the last session, I still only see a significant, weak positive correlation of 0.08. These results suggest that the number of unread messages in your inbox, or even just the number of new messages, is not an effective means of estimating the length of the next session.

4.5.2 Longer Sessions

A clear indicator of the misleading nature of the unread count is the significant, strong correlation between the number of messages that participants read during their session and the session length ($\rho = 0.60, p < 0.001$). This correlation is particularly informative because it is a clear signal from the participants about which messages they thought were important during their session. Keep in mind that this is only capturing messages that change from an unread to a read state, which is a subset of the unread messages. We acknowledge that unread does not mean unlooked at, I just take it to indicate a different level of engagement.

Correlates between session length and archiving/deleting messages are quite weak, especially when compared to the time it takes to read a message. This is understandable, as I found that many messages are left untouched in the inbox, meaning that participants are not spending much time filing or deleting and that the bulk of work in email is in simply reading messages. Other strong correlates with session length were composing and responding to emails, other indicators for important messages. All of this points to the bulk of work in email being around reading important emails and participating in conversations.

4.6 Do Users Develop any Strategies?

In my surveys I found evidence that my participants were aware and actively managing several of the issues that I observed. Of particular note, is the strong link between email and the projection of efficacy. When my participants were asked what they considered successful about their email practices, the most common response (27/52) was that they responded quickly and promptly. One response even mentioned the etiquette around email. As not all of the respondents of this survey elected to continue as participants after this survey, I have indicated them with an 'R'. I continue to indicate the participants in the full study with a 'P'.

> **R50**: *I respond in a timely manner; I know proper e-mail etiquette*
>
> **R11**: *quick responses, readily available*
>
> **R13**: *I read all email that I receive soon after I see them, and attempt to respond promptly (within 8 hours).*

One participant engineering a method to mitigate the chance of missing an email from someone important (their advisor).

> **P7**: *Emails on phone; emails from academic advisor get filtered into her own folder.*

Another participant employed a similar method in a more general way, where they elevated the summons of certain types of messages.

> **R52**: *I filter incoming mail, and if certain keywords are used, or there are certain authors, I get a text sent to my cell phone. This helps me filter IMMEDIATELY important information to my phone, which is a "non"-smartphone. I then go and check emails on my computer or using my ipod touch.*

Some managed their level of engagement either through defined sessions or periods of ignoring email.

> **R48**: *[. . .] I do, however, do a 24-hour email hiatus once per week.*

> **R42**: *I try not to check it in first hour of day. I check once I get engrossed in some other work. This way, I just read through them in a hurry. / If I start my day by reading mails then I read a lot of them and go to their links also*

> **P13**: *I have a very organized system of how I read and respond to emails. I use flags and stars to denote which I need to respond to immediately. I also set aside time, several times a day, to read and respond to emails.*

These different strategies evidence that the participants in my study are clearly aware of several of the problematic aspects that I observed in my study. Furthermore, they are thinking about them enough to develop specific interventions to mitigate their effects. Their strategies tend to acknowledge that they understand that engagement with email leads to activity within email, which in turn breeds demands on them.

4.7 How Does Email Compare with Other Media?

When investigating reasons for email use, I was interested in how it compared with traditional media, e.g. television and radio. While there have been several studies on how the internet as a whole compared with traditional media [Flanagin and Metzger, 2001; Papacharissi and Rubin, 2000] (which included email as one aspect of usage), there have been no studies specifically examining email itself.

In order to study the relationship between email usage and more traditional media, I utilized methods and practices drawn from Uses and Gratifications Theory (UGT). The primary method that UGT draws its results from is through the correlation between survey responses and self reported usage. While, there is no definitive survey that one can use in UGT, there

are similar sets of questions and common gratifications used from study to study which I drew from. However, I was able to also draw from the gratifications sought as reported by the users in their diaries and previous surveys. This provides an additional differentiation between this survey and previous ones, in that my survey questions are more grounded in qualitative data that is standard in UGT studies. Another point of differentiation is that, for a subset of my participants, I am able to correlate the survey responses with *actual* usage statistics that I gathered in the email usage logging phase of the study.

4.7.1 Uses and Gratifications Survey

I sent out a call for participation to several Virginia Tech listserves, as well as to the participants in the previous phases of my study. Through the responses it becomes even more clear, especially when coupled with the results of the diary studies, that the primary gratifications sought for email use are work related (Figure 4.5).

Further investigation of these responses shows agreement with many of gratifications sought from the diary entries. These include keeping up to date with work activities, routine sessions, pressure to check email, and wanting to appear professional. As expected, respondents felt that email was important to their job. One new insight is that users enjoyed finding new emails, while I suspected this I had no direct evidence of this in my diary entries.

While the relative uniformity in the gratifications sought as reported by my users is certainly enlightening, it does take some of the power away from the UGT method of analysis. This is primarily because within UGT research, the responses to the various gratifications sought are correlated with the self reported usage statistics from users. Therefore, different gratifications lead to different levels of use. However, I find no evidence of correlations between the gratifications sought and levels of usage.

The relative uniformity of the responses of my survey take some of the power away from the method of analysis typically used in uses and gratification work. Within uses and gratification, the responses to the various gratifications sought are correlated with the self reported usage statistics from users. Therefore, different gratifications lead to different levels of use. However, in my findings, I find no evidence of correlations between the different gratifications sought and levels of usage.

To determine the different relationship between gratifications sought and usage, I used a similar approach as LaRose and Eastin [2004] in grouping the expected outcomes from media use into several sets. I deviate from the categorization of LaRose and Eastin [2004] by removing the Monetary Outcomes and adding several questions related specifically to email use that were drawn from my diary analysis. I have indicated each of the questions that I have added in the list below by marking them with **. These sets are constructed as:

Activity outcomes

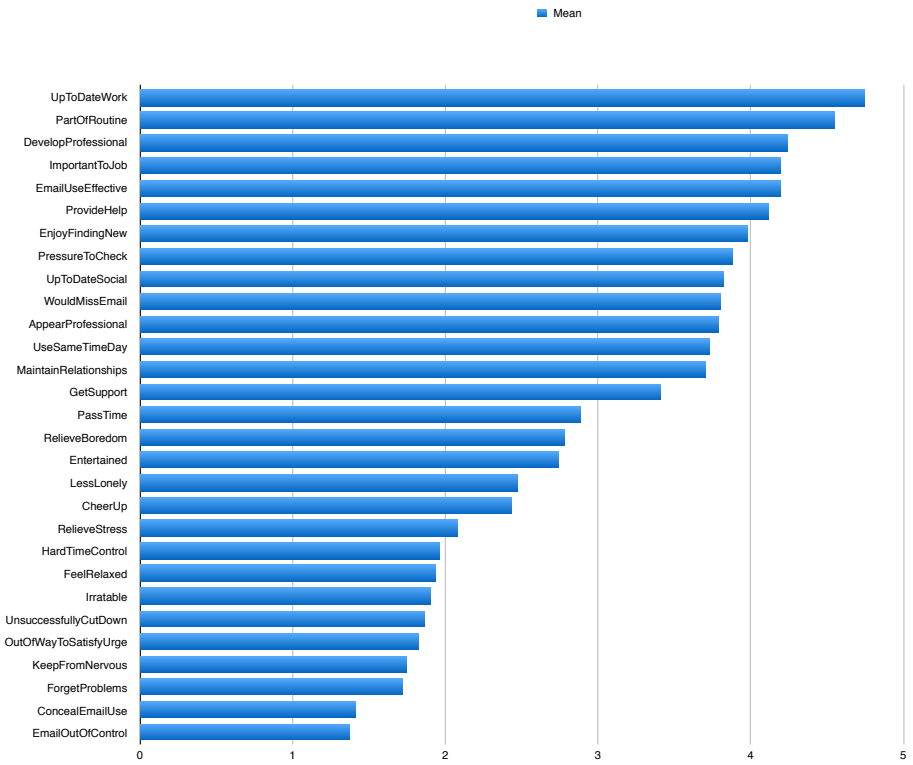

Figure 4.5: The means to the Likert scale responses for each gratification sought.

- *CheerUp* - I use email to cheer myself up.
- *Entertained* - I use email to feel entertained.

Social outcomes

- *GetSupport* - I use email to get support from others.
- *MaintainRelationships* - I use email to maintain a relationship.
- *ProvideHelp* - I use email to provide help to others.
- *UpToDateSocial*** - I use email to keep up-to-date with social activities.
- *UpToDateWork*** - I use email to keep up-to-date with work activities.

Novel Outcomes

- *EnjoyFindingNew* - I enjoy finding new emails that people have written to me.

Self Reactive Outcomes

- *RelieveBoredom* - I use email to relieve boredom.
- *RelieveStress* - I use email to relieve stress.
- *LessLonely* - I feel less lonely when I use email.
- *PassTime* - I use email to find a way to pass the time.
- *ForgetProblems* - When I use email I forget my problems.
- *FeelRelaxed* - I use email to feel relaxed.

Status Seeking

- *PressureToCheck* - I feel pressure to check email.
- *AppearProfessional* - Using email makes me appear more professional.
- *DevelopProfessional* - Email use helps to develop my professional life.
- *ImportantToJob* - Being reactive to incoming messages is important for my job.

Habit Strength

- *UseSameTimeDay* - I find myself using email at about the same time each day.
- *PartOfRoutine* - Email is part of my usual routine.
- *WouldMissEmail* - I would miss email if I could no longer access it.

Deficient Self-Regulation

- *HardTimeControl* - I have a hard time keeping my email use under control.
- *KeepFromNervous* - I have to keep using email more and more to keep from being nervous.
- *Irratable* - I get tense, moddy or irritable if I cant check my email when I want.
- *UnsuccesfullyCutDown* - I have tried unsuccessfully to cut down on the amount of time I spend in email.
- *ConcealEmailUse* - I sometimes try to conceal how much time I spend on email from my family or friends.

- *OutOfWayToSatisfyUrge* - I would go out of my way to satisfy my urge to check email.
- *EmailOutOfControl* - I feel my email use is out of control.

Efficacy

- *EmailUseEffective* - My email use is effective.

Outcomes	Pearson Coefficient
Activity	0.1462614
Social	0.04321149
Self Reactive	0.1260858
Status Seeking	0.2717956
Habit Strength	0.2775302
Deficient Self Regulation	0.2942511
Efficacy	0.06207571
Work Related	0.2321896

Table 4.3: Pearson correlation coefficients for UGT survey, no correlations were significant.

The effect of the consensus among my respondents can be seen in Table 4.3, where no significant correlation is found. This trend continues when I restrict the set of participants that I have real usage data for, in that no significant correlation is found.

This speaks to a consensus of use among my respondents and different levels of use are more to do with external factors than gratifications sought.

4.7.2 Comparison with Other Media

UGT is a useful way to investigate several different aspects of media use. In the absence of significant correlations between email usage and gratifications sought, I found a difference between email and more traditional media. Mainly, that the gratifications sought from email use have more or less converged around ones that are work related. This is somewhat in contrast to the assumptions that UGT is built upon, basically that the variance in gratifications sought can be used to predict media usage. As the data that I gathered did not exhibit this trait, it is not surprising that there was no evidence of any predictive power. That said, the results did validate the reasons/gratifications found in the diary responses for email use.

In closing, the comparison to media such as television and radio found more differences that similarities. This provides further motivation for comparing email usage more with communication media (e.g. phone), as opposed to media that are primarily ones of consumption

(e.g. television). This provides further evidence that the external factors, or the *preconditions* of the email corpus are the most significant factor in email usage. This makes sense in comparison to the phone, if one does not receive or make any calls they are not very likely to use the phone very much (for talking at least).

4.8 Discussion

When discussing how users are attending to email, I feel that it is important to look at email primarily as a communication medium. This is because the most important activities that occur in email are centered around communication and conversation-like threads. This is made clear by the amount of time that I found the participants engaging in these activities, as well as their reasons for checking email which were centered around these types of interactions. In examining emails as a conversation medium, the decisions to attend to email are influenced by similar factors as conversational openings, particularly conversational openings on the phone. Contrasting the manner in which aspects of conversational openings (especially the process of receiving a summons) function over face-to-face, phone, and email gives insight into some of the roots of the issues that I found in my study.

4.8.1 Email Messages as Summons

First, let me clearly explain what aspect of email usage I consider a summons. Schegloff [1968] called summons 'attention getting mechanisms' and I find that the manner in which notifications appear, ring, or whichever flavor they take are clearly similar to a ringing phone or a person requesting their attention. Therefore, I consider receiving a notification about an email a summons. While, Schegloff originally meant for summons to be specifically for conversational openings, I feel that the nature of email necessitates some flexibility in this aspect of its definition. This is because of the *indiscriminate* way that email clients issue notifications for email messages and the amount of noise that is typical of the email channel. Therefore, in the communication medium of email there exists the nearly guaranteed possibility of receiving a *false summons*.

To be more explicit about what I do not consider a summons, and how some conversations may lack it, let us explain some instances that are similar to a summons. I do not consider the unread count a summons, it is an indicator of the number of unread messages and does not contain the same draw or specificity that is required for a summons. The unread count is a figure against a background, if one is used to a high unread mail count it is not indicative in any precise way. However, I imagine if the user notices a shift in the unread count it becomes more distinct against the background. This, in part, is precisely what inbox management techniques like 'Inbox Zero' seek to do, make any shift in the unread count distinct against the background of email. Contrast this with a ringing phone, that may lack information

about the summoner, it is still specifically from someone requesting to begin a conversation with the answerer. Furthermore, I do not consider a single unread message in one's inbox a summons to a conversation, while it certainly shares some aspects with a summons, it simply does not satisfy the condition of being an 'attention getting mechanism.' The only thing that I consider a summons within the email channel is the notification that you have received an email from a specific person.

The fact that an email conversation can occur without a summons, is a significant difference from initiating a conversation face-to-face or over the phone. When the indiscriminate nature of issuing a summons within the email client is coupled with the large amount of noise that I found in the email channel, a reason for my participants' anxiety around missing an email and their reasons for maintaining engagement with email becomes quite evident. *There is no guarantee that a summons will be issued for a conversation in email, or that you will receive a summons if it is issued.*

4.8.2 Emails as Requests for Attention

To expand on the concept of emails as summons, I see each email as a request for some amount of attention, no matter how little attention or how remote the possibility of receiving the attention. Only a subset of these requests receive a summons from the interface and a further subset of those requests are true summons to a conversation. Part of the difficulty in using email is distinguishing summons or requests for a conversation, from relevant informational email, and spam email. As each email is a request for attention, I propose that there are roughly four groups of emails based on the level of attention that they necessitate.

- *Ignore*: Many messages that are ignored have no realistic expectation that the recipients will properly read the email, let alone respond to them. Some of these messages even explicitly say to not respond to them, other examples include spam mail and mass advertisements. In my study 45% of emails went unread (specifically 4352/9578 messages went unread).
- *Accountable Non-answer*: An accountable non-answer response is when the recipient is expected to engage with the email, but not reply to it. An example is a newsletter that is emailed to a list, where the sender expects receivers to attend to the message and keep abreast of certain topics, but not reply to the message. This is evidenced in my study by the large amount of read mail that was not replied to. More specifically of the 5226 messages read only 619 were responded to, meaning that the majority of read messages do not require a response.
- *Postponed Reply*: Some emails require a reply, but do not require an immediate reply. The responses to these emails can wait till a later session. I saw evidence of this in routine sessions, where users replied to already read messages. In the messages that

I captured both the receiving and replying (491 messages) 145 were postponed by 30 minutes or more. Of these 145 messages, 39 were postponed for more than 12 hours, and no messages were postponed for more than 24 hours.

- *Immediate Reply*: Some messages arrive beckoning an immediate response. I found evidence of this in the diaries and logs when the participants report seeing a notification and replying to it right away. I also found evidence in the logs when participants read the message and immediately replied. Of the 491 messages that I captured both the receipt and reply, 346 of them were replied to within 30 minutes, and 207 were replied to in 3 minutes or less.

4.8.3 Answering an Email Summons

What I consider to be an answer to a summons over email is not obvious and requires some additional explanation as well. In order to completely explain what I categorize as an answer, I must pull apart what happens to an email that a summons has been issued for. First, the sender composes an email that requires a reply and sends it. The next requirement for a summons to be issued is that the sender of the email must receive and acknowledge a specific notification about the email. *The answer to the summons happens when the receiver directs their attention to the notification.* However, a particularity of email is that the completion of this sequence (or whether it ever happens) is completely opaque and unknown to the sender of the email. The sender of an email does not know if a summons has been issued.

However, this sequence (the issuing and answering of the summons) by definition is non-terminal, and upon attending to the email an obligation is placed on the receiver to respond to this message. We see direct acknowledgement of this responsibility (and the opaqueness to the sender) in the anxiety over 'missing' an important email in our diary entries. The sender of the email only knows that their message has been seen and acknowledged *after* they receive the response to the email. The physical barrier between the summoner and answerer in the conversation is now even wider and contains a temporal element to it. Due to the physical and temporal barrier that is a result of the asynchronous nature of email, the single exchange of a message and its response has a number of opening sequences packed into it. This is different from the cases of phone and face-to-face, where sequences are more atomic because, as the communication is synchronous, they do not necessitate interleaving sequences.

4.8.4 Cumbersome Conversations

Another aspect of email as a conversation medium that I gain insight into through leveraging the summons-answer concept is their sometimes cumbersome nature. Each turn in a conversation over email requires the directing of attention to the conversation when another

turn has been completed by the participant. This may or may not be a summons on the interface, however, with each turn the request for attention is re-initiated and several actions must be remembered, or re-established by each participant. This is why the functionality of email threads is so useful. At each turn accountable actions must at least be recalled by the participant beginning their part of the turn. *The re-initiation of an email conversation at each turn, coupled with the requisite interleaving of sequences, can make email conversations cumbersome and difficult.*

4.8.5 Determining Interruptibility

The manner in which a summons is dispatched and answered within email points to an interesting contrast between the different mediums of face-to-face, phone, and email. This contrast is in the transition of the responsibility in determining interruptibility shifting from the summoner to the answerer. In face-to-face conversations Schegloff [2004] notes that a great deal of the decision on the interruptibility of the answerer is done by the summoner. It is simply rude to interrupt people in the middle of a conversation or activity. This is less true when issuing a summons over the phone, in that the only real decision is what time is reasonable to make a call. However, it is not beyond expectation (especially before answering machines and caller id) that you will have to call the person back later. Move to email and nearly all of the decisions for interruptibility transfer to the answerer. It is completely acceptable to email someone at 3AM (contrary to Schegloff's phone example). Instead it is considered far more socially unacceptable (as evidenced in my survey results and diary entries) to take time to respond to an email. *In this way the receiver, or answerer, of the summons is now almost entirely responsible for determining (or constructing) the appropriate moment for the interruption, as well as maintaining engagement with email as to not miss any conversations.*

4.9 Conclusion

My findings suggest that email is disruptive to users' work and lives, even when they are not directly engaged with it. Email usage has many of its users in a state of anticipation that can cause anxiety or at least pique curiosity. The lack of proper notifications or signals to make informed decisions to attend to email adds to this problem. While some of my findings uphold intuition and commonly held beliefs, my principled investigation into these matters has increased the depth of understanding of these phenomena. My contribution to this field of research is in bringing focus to email as a conversation medium and situating common problems within CA.

Through the lens of CA, I am able to explain in what manner many of the commonly known problems with email are in fact problematic. Take for example the unread count, through

my analysis I have established that this mechanism is not being used by my participants and, situated within CA, am able to cite their lack of summons as a root. Other studies have established the anxiety around email [Wainer et al., 2011; Chase and Clegg, 2011; Reinke and Chamorro-Premuzic, 2014], my analysis has found that much of this anxiety is rooted in the lack of a reliable mechanism to receive summons and the worry that a user has 'missed' an important email. Furthermore, I found that this was an important worry as the projection of ones efficacy is highly linked to the promptness with which they respond to important messages.

In contrast to the large concern with email triage [Freed et al., 2008; Whittaker et al., 2004; Venolia and Neustaedter, 2003; Nardi et al., 2002; Cselle et al., 2007; Faulring et al., 2010; Vacek, 2014], I found that my participants were well suited to locating important messages (or the lack thereof). I found this through the explicit linking of diary entries with usage sessions, where I found that when users were expecting an important message the sessions were quite short, suggesting that they did not spend very long looking for this message. I also found that 'pruning' sessions were also quite short, suggesting that the rating of non-important messages was quite efficient.

Additionally, as a result of my study I am able to give insight into my original questions.

What aspects of email grab user attention and draw them in? The pressure, whether real or imagined, involved around promptly responding to emails that are part of a conversation is a key factor in drawing users into email. Couple this with the non-deterministic nature of how summons are issued within the email client and it is easy to see the reasons for routine sessions, anxiety over missing email, and the draw of the notifications.

What level of engagement with email do users maintain while not using the application? I find evidence for a relatively high level of engagement with email. This is evidenced by the anxiety over missing an important email and the simple requirement imposed on users by the interface lacking mechanisms to assist in maintaining engagement with email.

What activities are they doing and what takes longer? As one might expect reading, composing, and replying to messages is what leads to longer sessions. Interestingly, pruning messages (deleting or archiving) is not associated with longer sessions. My participants seem rather well suited to finding the messages that mattered to them. Perhaps the focus around triaging messages [Freed et al., 2008; Whittaker et al., 2004; Venolia and Neustaedter, 2003; Nardi et al., 2002; Cselle et al., 2007; Faulring et al., 2010; Vacek, 2014] is more about making it more obvious that you have received an important message.

What are the consequences of attending to email? Users became further distracted than they originally intended in 23% of my diary entries. I call this *getting lost in email*. This in turn could have more negative implications in the cost of resuming their work [Mcfarlane, 1997a; Czerwinski et al., 2000a; Cutrell et al., 2001a; Franke et al., 2002a; Adamczyk and Bailey, 2004; Mark et al., 2008; Hemp, 2009]. It seems to me (and my participants through their strategies) that engagement with email leads to additional email activity, which leads

to additional demands on users time.

Do users develop different strategies that indicate awareness of these different factors? I saw that users employ a number of strategies, similarly to previous research and their recommendations [Chase and Clegg, 2011; Hemp, 2009; Bradley et al., 2013]. From as basic to just saying they respond promptly, to having routine sessions, and to even turning off the notifications on their phone. The combination of the strategies that I saw my users develop, I feel, is a clear indicator of awareness and concern for the very issues that I encountered in my study. Moreover, as the majority of these strategies (with the exception of projecting an image of responsiveness [Tyler and Tang, 2003]) are around the *limiting* of attention paid to email, I see this as evidence to the destructive draw of email and somewhat contrary to several functional directions of email (e.g. always-on access and push notifications).

I do not address the efficacy of one strategy over the other, however, I hypothesize that (similarly to previous PIM studies [Jones, 2007; Teevan et al., 2007]), there are various strategies that users employ and prefer for themselves.

4.10 Recommendations

My study points to a broad need to remember and refocus on email as a communication medium and functionality that assists email users in communicating and maintaining their relationships. Many activities occur in email (work, task management, etc.), this is perfectly reasonable as one place that communication occurs is in email. Put more simply anything that I am doing, I can communicate about that activity through email, as it is a rich communication medium. While much research has focused on the individual activities that occur in email, researchers and designers must keep in mind that these activities are accomplished through communication. Supporting this communication and the conversations that support them is vital to making email less stressful for its users. Perhaps the current trend of adding functionality to email clients, which often has the effect of increasing the complexity and number of decisions involved in triage, should be reexamined, and the intuitions behind them affirmed. My findings, coupled with other recent research (i.e. Whittaker et al. [2011] showed that the advantages of filing may not be exactly as assumed), suggest new functionality is not representative of where the bulk of time in email is spent.

There is of course functionality being proposed and research being done along these lines. MinEMail [Rector and Hailpern, 2014], for example is trying to elevate important notifications to an SMS message. However, I suggest that functionality to limit the notifications that are issued for non-conversational emails be investigated as well. Also, based on my CA of email, I believe that putting tools for determining urgency, escalation, etc. in the hands of the sender is problematic. As CA informs us, these decisions are a matter for the two parties to determine and the acceptance of the status by the recipient is crucial. If these decisions were solely in the hands of the senders, then the result is recipients to treat them much like

the 'boy who cried wolf.'

Expecting an email. The anxiety that my participants felt around email points clearly at two things: first, that email, or at least the expectations around it, is being moved from an asynchronous to a synchronous communication medium; second, that email has several deficiencies in this regard that can be mitigated with a few changes. This move, of email from asynchronous to synchronous, and the expectations around it, are evidenced in a number of my findings, but most starkly in the number of emails that were *immediately* replied to (207/491), as well as in the amount of anxiety and import that my participants placed on sending prompt responses to emails.

Another recommendation that I have is to remove the ephemeral nature around summons, by reducing the indiscriminate nature that notifications are issued by and receiving notifications for conversation based emails. One aspect that could also reduce the anxiety of my participants around the expectation of an email, is to provide functionality to elevate the notification, or summons, to a particular sender that they are anticipating. This set of functionality could help to remove the ephemeral, indiscriminate, and non-deterministic nature of the summons, which is one of the primary sources of anxiety among my participants. Note that this is different from establishing an entirely new inbox for important people, similar to Apple's VIP inbox[1].

Channels of communication. As there are clearly emails that have different levels of importance, I feel that they should be more clearly distinguished within the email channel. A recent example of functionality that is moving towards this direction is Gmail's tabbed inbox[2], which groups messages into *Primary, Social, Promotions, Updates, and Forums.* Further study is required to see if further modifications to the unread count in the new Gmail interface would have an impact on attention to email.

Simply put, email tools must do a better job of letting users manage the relationships and conversations within their email, instead of it requiring them to maintain ever vigilant to any change.

[1] http://support.apple.com/kb/PH11728

[2] https://support.google.com/mail/answer/3055016?hl=en

Chapter 5

Attending to Messages

This chapter presents the results of a laboratory experiment that investigates the process of determining the relevance of different email messages. Presumably, the more relevant a message is, the more likely the participant would be to read the message, which in the previous chapter was found to be a strong correlate with session length. In this way the study helps to fill in another piece of the process of attending to email. Specifically, this study examines the first part of the email triage process, by considering that recipients first need to understand what the email is about, situate this information in regards to themselves, and finally determine the relevance of the email for processing. In the previous chapter, I found that much of the work involved in email is around reading and writing messages. This often involved an ongoing relationship, in which the responsibilities associated with managing the relationship were cited as a cause of stress. Following this line of thought, this research focuses on the effect of the strength of this relationship on the difficulty associated with determining the relevance of an individual email message.

To measure the relationship to the sender, I used a Likert scale ranging from *Unimportant* to *Very Important*. Presumably, more important relationships are built on an established common ground, which makes determining the relevance of an email from an important person easier. I also prompt participants for the amount of contact that they have with the person, ranging from *Never* to *At least once a day*. To measure the difficulty of determining relevancy I use the amount of time it takes to make the determination.

As such, there are two primary goals for this research, first, quantifying the effect of the relationship between the recipient and sender on the difficulty of determining relevance; and second, to better understand which information the recipients use to make determinations about the relevance of an email.

Secondarily, this study informs the relationship between the different components of each email (e.g. sender and topic) and its overall importance. This study also informs the general effect of the relevancy of a message and how difficult, in terms of the length of time, it

is to make a determination about the importance of different categories of email. More specifically, it answers the question of whether it is quicker (and perhaps therefore easier) to decide an email is irrelevant or relevant.

The results of the study help to provide a better understanding of how the relationship between the recipient and the sender effects the ability of an individual to make a determination about an email message's relevance.

The operating hypothesis of the study is that participants would be able to decide very quickly on the relevancy of an email sent by individuals on the extremes of the scale. That is, emails sent by *Very Important* individuals and *Unimportant* individuals would be the quickest decisions. This would be because someone that is very important to the recipient would likely send very important emails, and someone that is not very important would not. Furthermore, the most difficult determinations about relevance would be emails sent by individuals in the middle, as this represents the largest amount of ambiguity. My presumption is that users would need to fully engage with an email from a sender that they are acquainted with, because they would not be sure either from simply reading the sender email address and they would have a reduced amount of common ground that would preclude the ability to skim the subject and body. Some exceptions to this may be someone that occupies multiple facets to the sender (e.g. someone that is both a coworker and friend).

The contents of this chapter are as follows. First, I address the question of how the relationship as measured by the post-questionnaire effected the length of determining relevance. Following this, I look at the relationship between the relevance of the components of the email and its overall relevance. I then revisit the log data to validate and compare these laboratory findings with the session details. Finally, I discuss my interpretation of these findings and discuss their implications.

5.1 Studies Utilized

This chapter draws from the results of:

- Study 1 – The primary source of data in this chapter is drawn from the laboratory study, these results are used to interrogate how decisions about relevancy are made on individual emails.
- Study 3 – The IMAP logs are used to verify and compare some of the findings in usage data.

5.2 Relationship Strength and Decision Length

The primary question that this study is interrogating is the effect of the relationship between the sender on decision length. To test my hypothesis of acquaintances being the most difficult to make determinations for I performed several analyses on the gathered data.

Analysis using a Shapiro-Wilk test showed that the variables were of non-normal distribution. Therefore, a Spearman correlation matrix was used to determine any correlations of interest. The average time that it took for participants to make a determination on relevance was 6.37 ($\sigma = 6.15$).

A negligible correlation was found between the sender relationship and decision time ($\rho = 0.25, p = 0.0017$). The smoothness plot of these points is relatively flat, suggesting that there is no effect of sender relationship, in terms of the participants' rating of importance, on the amount of time that it takes to determine the relevance of an email message Figure 5.1.

A follow up question to this, is that even if a sender was not deemed *important* by a participant, perhaps they had a large amount of contact with the sender. One would think that the more contact a person has with a sender, the easier it would be to make a determination about the relevance of their emails. However, I find no evidence to support this hypothesis ($\rho = 0.01, p = 0.89$). The smoothness plot of this data also reveals a flat trend, Figure 5.2, suggesting that the amount of contact with a person does not have an effect on the amount of time that it takes to determine the relevance of an email message.

Much the same trend is found when looking at the relevance of the topic itself ($\rho = 0.25, p = 0.0019$). However, there is a significant, weak positive correlation between the overall relevance of the email and reponse time ($\rho = 0.33, p < 0.0001$). Suggesting that there is a slight increase in the amount of time it takes to determine the relevance for an relevant email versus an irrelevant email, Figure 5.3.

Overall, these findings suggest that neither the sender nor the topic has any relationship with response time in making a determination about email. The overall relevancy of an email seems to have very little effect on the amount of time it takes to determine relevancy.

5.3 Overall Relevance of Email

Given that I found no evidence of a relationship between the relevance of an email and the relationship between the sender and recipient of an email, a following question is how the relationship between the sender and recipient impacts the overall relevance of an individual email.

I again used a Spearman correlation to interrogate this question. As expected, there is a relationship between the relevance of the sender and the overall relevance of an email

($\rho = 0.405, p < 0.0001$), Figure 5.4. However, there was no evidence for a strong relationship between the amount of contact with a sender and the overall relevance of an email ($\rho = 0.282, p < 0.001$), Figure 5.5. Going further, the relevance of the topic of an email shows the strongest correlation with the overall relevance of the email ($\rho = 0.612, p < 0.0001$), Figure 5.6.

This all seems to make intuitive sense, the content of an email is centered most around the topic of the email. For example, I may get a joke from a close family member that I may not consider relevant, while I may get a job offer or a call for participation from someone that I am unacquainted with. Generally, one gets more emails about a relevant topic from relevant people, this is after all most likely why they are relevant people. Finally, just because you see someone a lot does not necessarily mean that you find them relevant, it may just be a question of circumstance.

5.4 Comparing Laboratory Findings with Usage Data

Given the data that I gathered in my usage study, I am able to explore the nature of relationships in email to some degree.

One aspect that I can provide insight for is the number of unique senders (as defined by their email address) that participants read emails from. This data is provided in Table 4.1. There is a high standard deviation in relation to the mean, showing the amount of variation between the different senders. Participant 16 read 239 emails from unique senders, reading by far the largest diversity of senders. While, participant 20 read emails from only 5 individuals. When I compare this with the overall activities from Table 4.1, participant 16 is one of the heaviest users of email and participant 20 one of the lightest. This suggests the number of relationships that one participates in over email impacts the usage of email and confirms intuition.

A second aspect that the usage logs can give insight into is the distribution of read emails among the unique senders. For my participants in the usage study, the number of emails read by participants drops steeply after the top few senders. This is illustrated by Figure 5.7, where the number of emails received from each sender is represented in logarithmic scale and each participant is represented by a different line. In this graph the steep drop-off is quite evident, where the participants have only read one or two emails from the majority of unique senders.

5.5 Discussion

The results of this study did not support the initial hypothesis. In fact, no strong correlation was found between any of the measures and the decision time. However, there were some

Participant	Unique Senders
20	5
18	23
7	24
4	29
11	29
9	34
17	35
2	53
13	53
19	61
3	63
6	63
15	74
5	76
1	82
10	82
8	84
14	114
12	136
16	239
$\bar{x}$	67.95
σ	51.55

Table 5.1: The number of unique senders that participants read emails from, ordered by number of unique senders.

significant correlations found between several of the variables and overall relevance, e.g. the topic of the email and the sender of the email.

That said, there are several limitations of this study that may impact these findings. First, important variables were not examined during this study require further investigation. An example of such a variable is the length of the email. Secondly, temporal context (e.g. an email about a current project or an email that was received during a specific time in the day) may play an important role in determining the relevance of an email. Lastly, since participants had already made determinations about the email and handled them an additional time for experiment preparation, their familiarity with the email was artificially high. If this were true they would be using more retrospective recollection then prospective, which could skew the results.

Even given these limitations, it seems that there is not a great discrepancy between the amount of time it takes to determine the relevance of an email. The results suggest that,

generally speaking, what is taking up the decision time is simply consuming the information. There are likely emails that do take more time, some of these can be seen in the graph as outliers, but for the most part a cursory engagement with the content of the email is sufficient for making a determination of relevance.

So it seems that the determination of relevance is fairly constant amongst emails and takes roughly the same amount of time to contextualize the email in working memory. Perhaps the determining factors of decision time are simply how distributed the information is amongst the different fields of the email, i.e. the topic refers to the sender and the date, and the amount of information contained within the email, i.e. number of topics and detail. The results that suggest this is that upon inspection of the emails that took much longer (around an order of magnitude longer in fact) were all of considerable length and contained multiple references to topics in them. This seems to lead to the direction that the most important determining factor in decision time is the amount of information that needs to be situated by the recipient.

One unexpected result of this study was the correlation found between topic relevance and overall relevance. Upon further reflection, however, this makes intuitive sense. The overriding heuristic that recipients of emails use in making a determination about email is not if the email is important to someone else, but instead, if this email is important to them. For instance, if someone receives and email with a job offer from a relatively unknown individual, the email is still very relevant to the recipient. On the other hand, if someone receives a joke that has been forwarded from a close member in his or her social circle, the email is still unimportant.

Even when taking into consideration the effect on relationships on amount of time it takes to decide how relevant an email is, relationships clearly matter in email use. That the number of senders participants read varies widely and indicates different levels of usage is one aspect of this. That there are few relationships that the participant exchanged a great deal of emails with indicates that there are some functionality enhancements that may be possible, with relatively little effort.

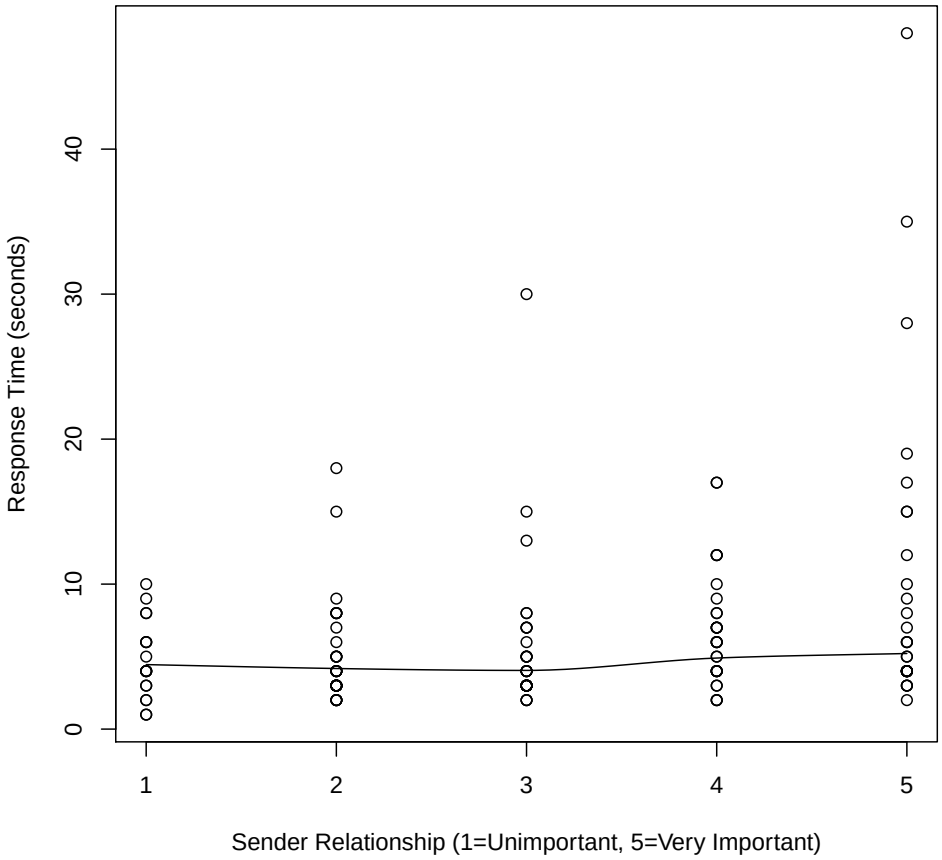

Figure 5.1: The amount of time participants needed to rate the relevance of each email. Each dot represents a single rating of an email. The smoothness curve shows the flatness of the average across the senders relevance.

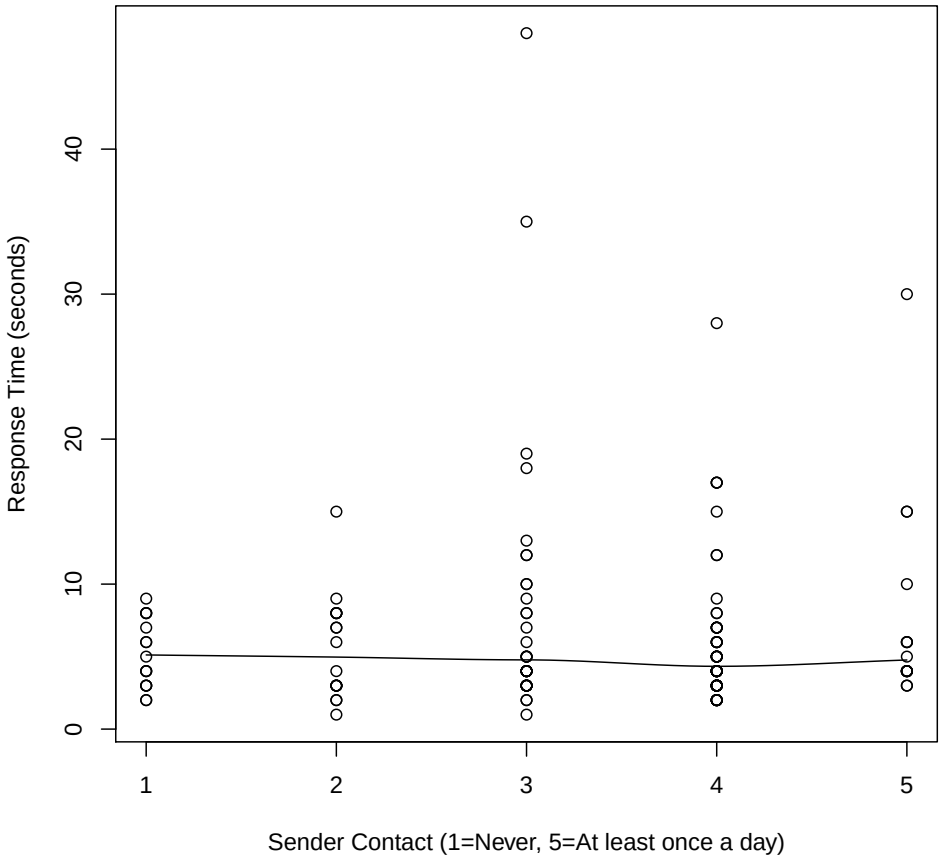

Figure 5.2: The amount of time participants needed to rate the relevance of each email. Each dot represents a single rating of an email. The smoothness curve shows the flatness of the average across the amount of contact the participant had with the sender.

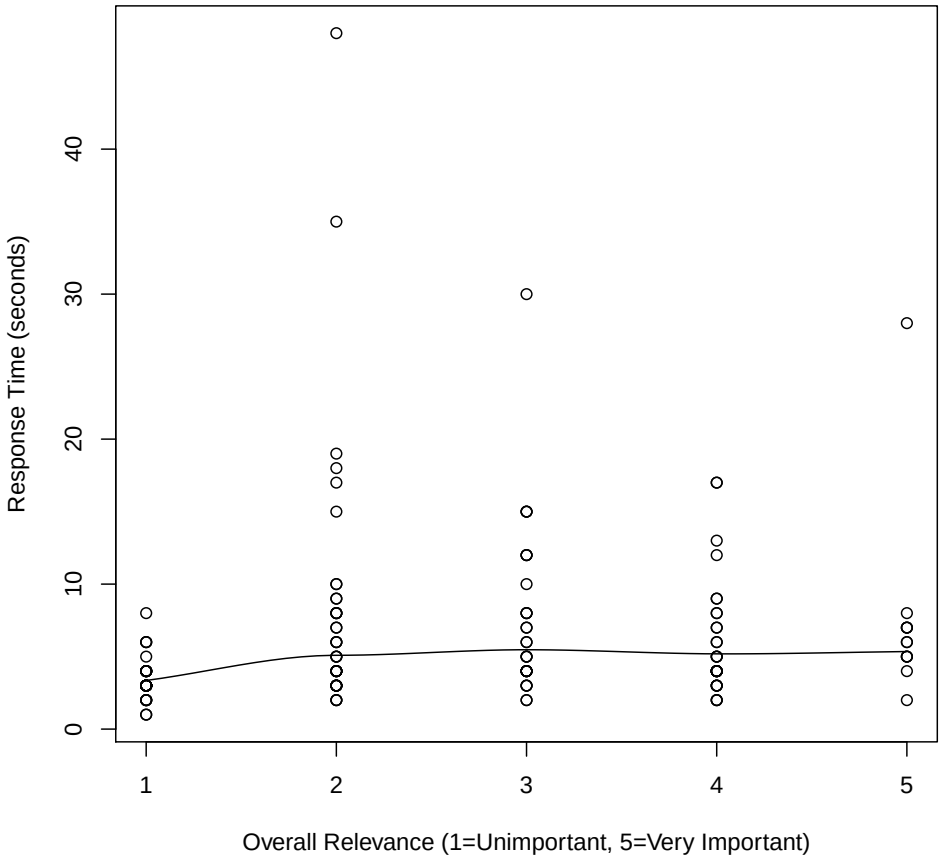

Figure 5.3: The amount of time participants needed to rate the relevance of each email. Each dot represents a single rating of an email. The smoothness curve shows the flatness of the average across the overall relevance of the email.

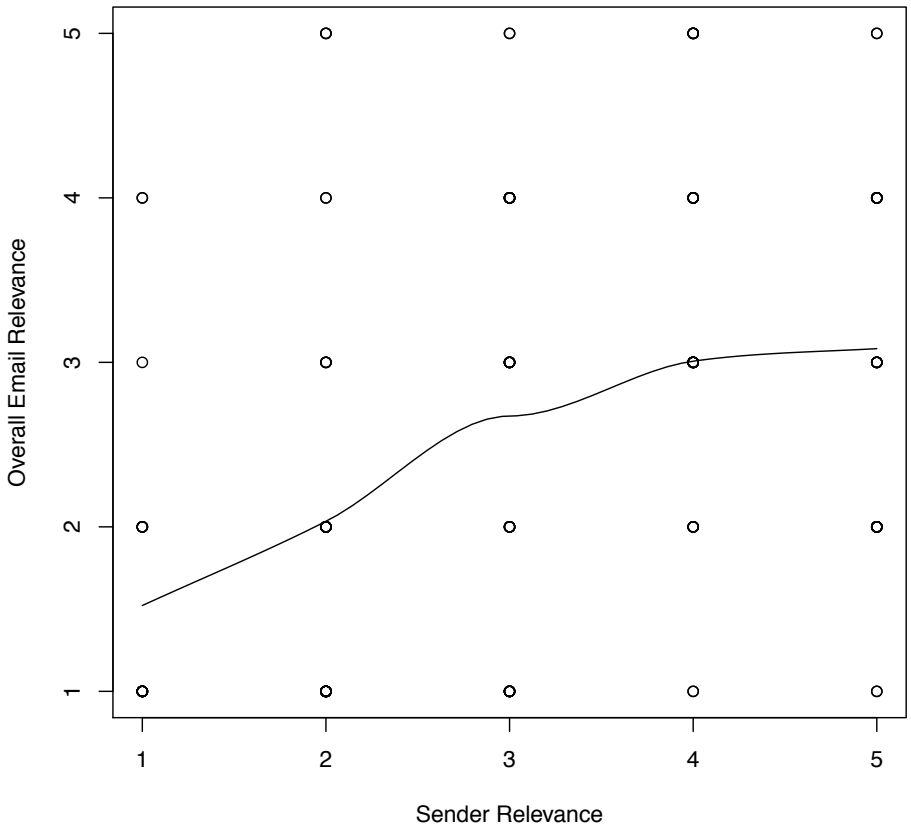

Figure 5.4: The relationship between sender relevance and overall email relevance is shown here. Each dot represents a single rating of an email. The smoothness curve shows the correlation between the two aspects of email relevance.

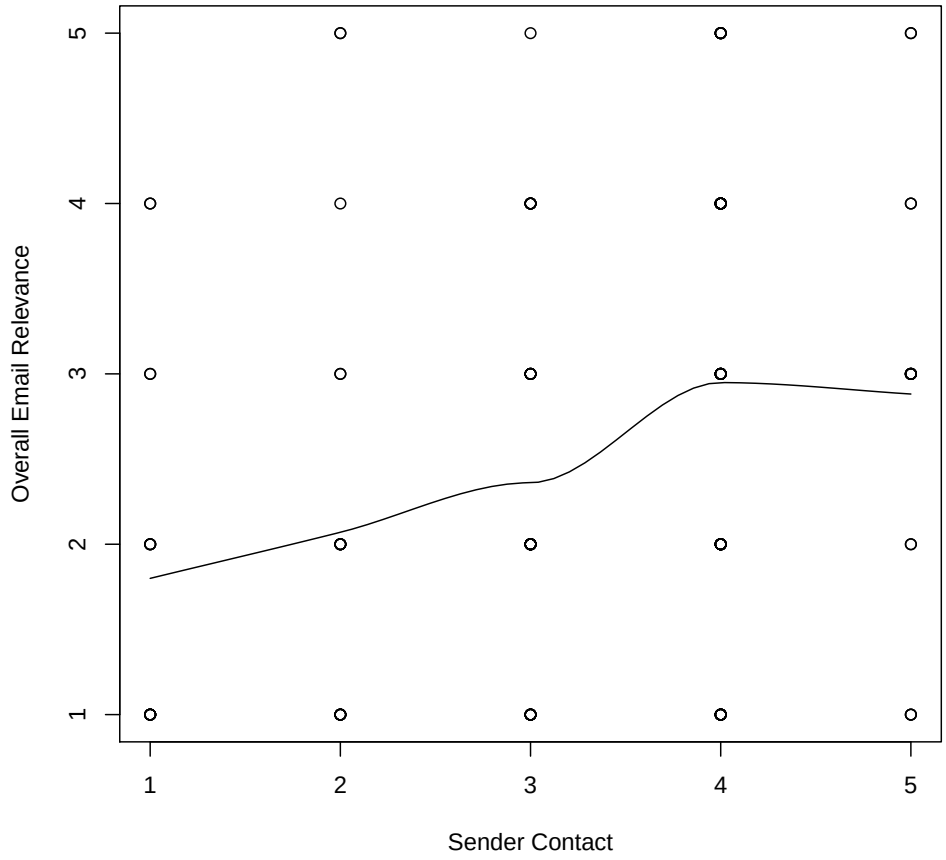

Figure 5.5: The relationship between the amount of contact with the sender and overall email relevance is shown here. Each dot represents a single rating of an email. The smoothness curve shows the correlation between the two aspects of email relevance.

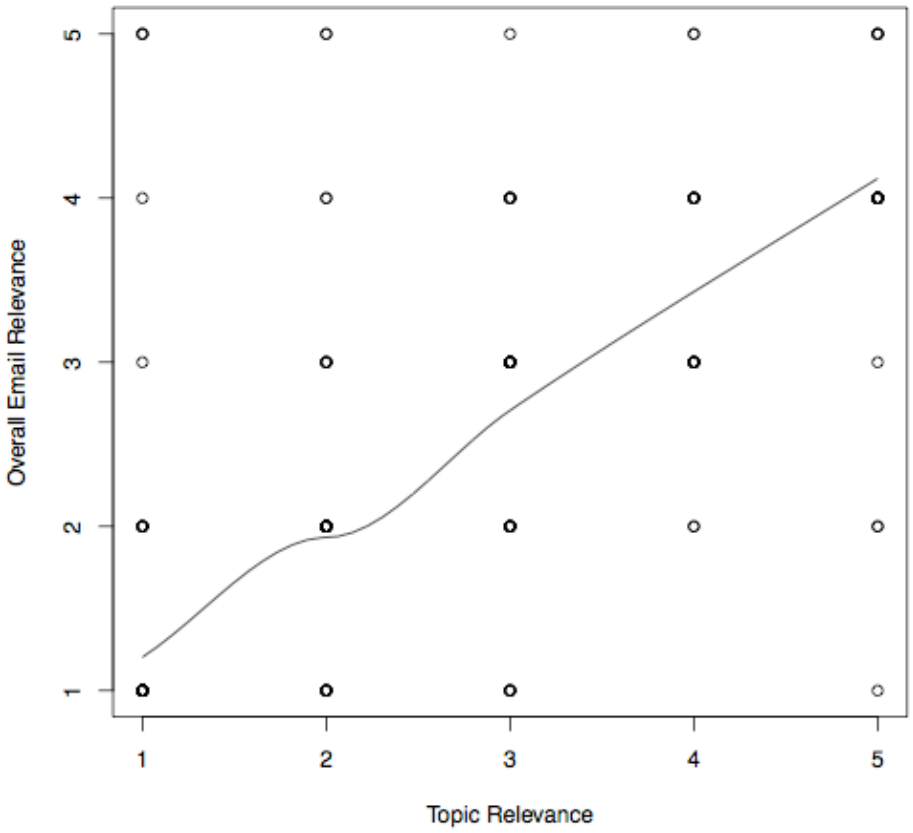

Figure 5.6: The relationship between the topic relevance and overall email relevance is shown here. Each dot represents a single rating of an email. The smoothness curve shows the correlation between the two aspects of email relevance, note that this is a stronger relationship than between the sender relevance and overall email relevance.

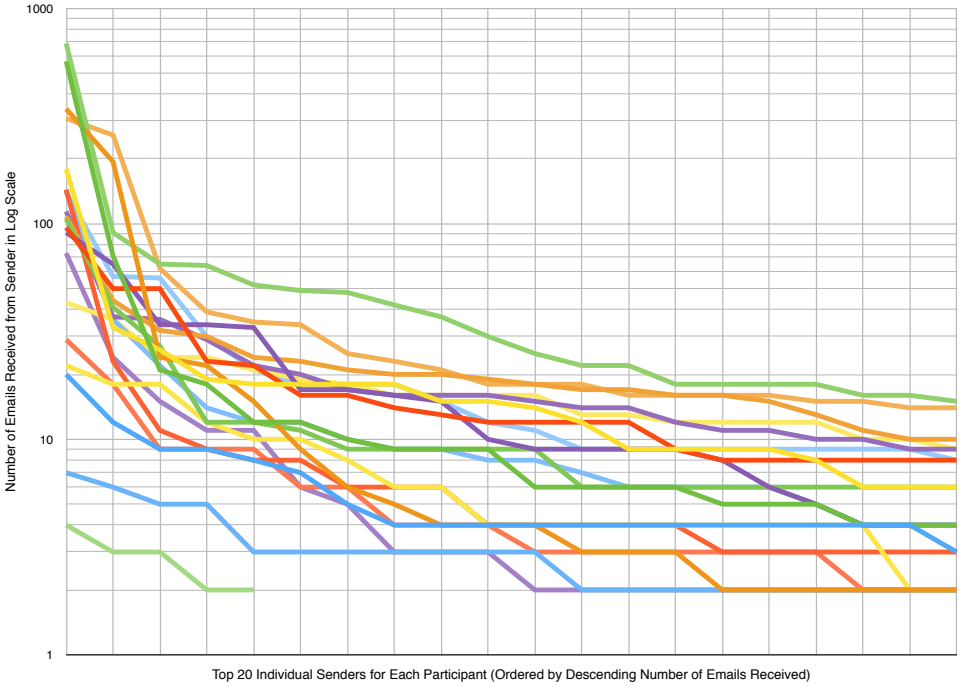

Figure 5.7: The number of read emails each participant read from unique senders.

Chapter 6

Getting Lost in Email Sessions

In this chapter I add to the body of research around email through my investigation into how email has the ability to draw its users down a path of interaction, almost against their will. I isolate a particular aspect of this disruption, which is a phenomenon that I call *getting lost in email*. This is the process of becoming further distracted from the original intent of an email session, or a loss of agency over attention during an email session. This concept is similar to chains of diversion [Iqbal and Horvitz, 2007] and work on interruptions [Czerwinski et al., 2004]. However, my work is more focused on email, and how it leads to chains of diversion. That is, what is the specific pull that the email medium has on its users attention. My belief is that *getting lost in email* is a contributing factor to the feeling of being overloaded by email, simply because if a user is unable to predict the amount of potential work that awaits them in their email client, then it can become a source of tension (as seen in Chapter 4).

My hypothesis into how participants become lost in email is by encountering a series of emails that require (or at least are thought to require) some form of immediacy in their response, this takes email users down a path of interactions that is difficult to resist. This path leads users, unexpectedly, into more work than they had anticipated. Meaning that users are pulled into email in a less deliberate, more situational manner.

To investigate these hypotheses I look at how the different factors that I measured throughout my study influence the frequency of getting lost. This gives insight into whether and how users are getting lost in email. In order to isolate the different factors that may be impacting getting lost in email, I categorize them in three groups *Predispositions, Preconditions, and Mitigating Behaviors*. *Predispositions* refers to the variability that may exist between participants in their response to similar conditions, e.g. some participants may become lost with the same number of unread emails and others may not. *Preconditions* refers to the state of the email corpus at the moment before the session began, as well as the state of the individual (e.g. upcoming deadlines). Lastly, *Mitigating Behaviors* are strategies that the user has developed to manage email.

My investigation yields several findings. First, I establish that users are in fact getting lost in email with fair frequency. Second, I find that there are no reliable indicators given to users to predict how long their next email session will be. Instead, they become lost by encountering a series of emails that require (or at least are thought to require) immediacy in their response. This takes email users down a path of interactions that is difficult to resist. This path causes users, unexpectedly, to enter into a longer session than they had anticipated. Lastly, participants developed strategies to cope with getting lost, which shows both awareness of the problem and its nature. The different aspects of my research, coupled with previous findings about attending to email (Chapter 4) give insight into how users can get lost in email and why they might be frustrated with it.

My initial hypotheses around this phenomena were met with a varying degree of confirmation. First, I hypothesized that users of email were *getting lost* to some degree, while this was confirmed my set of participants reported a higher degree of getting lost than I anticipated. My second hypothesis was that the email state would have the greatest effect on getting lost (as well as frequency and duration of use). While this hypothesis was also confirmed, I expected that the number of unread messages would have some amount of correlation with the number of times getting lost, which was unconfirmed. However, I did anticipate that there was a lot of noise within the email channel and expected that the number of relevant unread messages in the inbox would be more indicative of getting lost than just the raw unread count. My hypotheses around the ability of ANT to correlate or explain individual differences were not confirmed, as I found no evidence to support any relationship.

In this chapter I first detail the methods in my analysis, I then organize my investigations into a series of questions around the phenomenon of getting lost in email, and finally I frame the answers to these questions in terms of *Predispositions, Preconditions, and Mitigating Behaviors*.

6.1 Studies Utilized

This chapter draws from the results of:

- Study 2 – Results from the survey are used to illustrate the pressure to maintain an image of responsiveness that participants seemed to feel.
- Study 3 – The diary entries and IMAP logs are used to determine why participants began their email sessions, whether or not they became lost, and what activities lead to becoming lost.
- Study 4 – The results of the ANT are discussed and do not provide any evidence for individual differences.

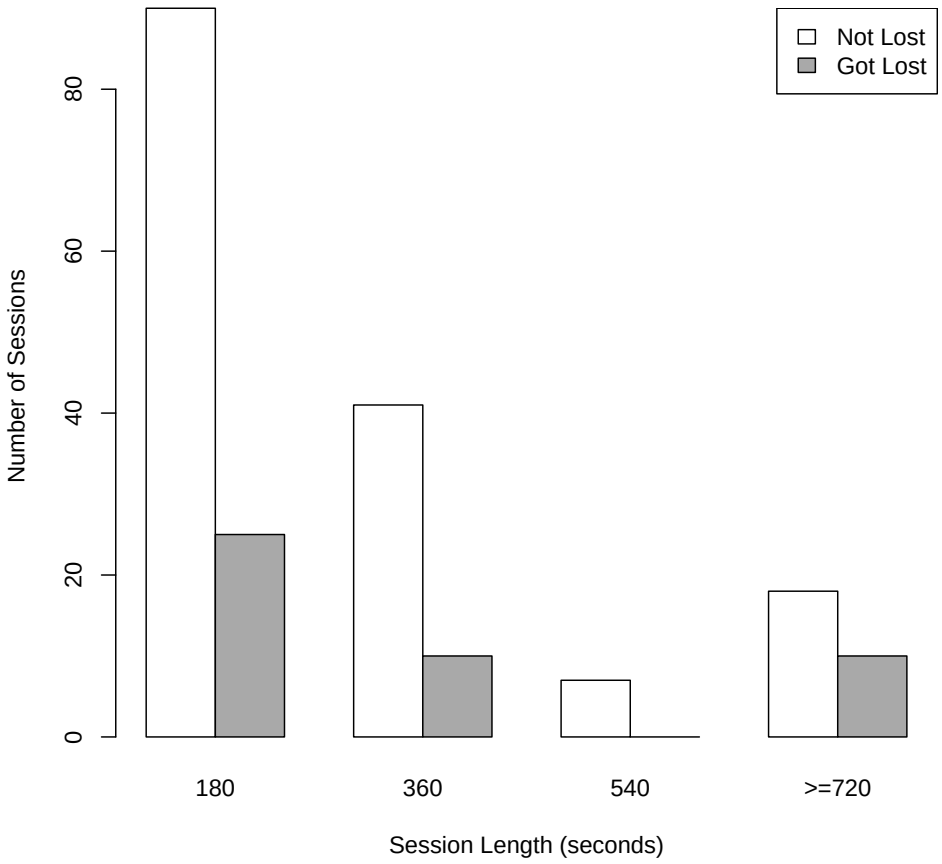

Figure 6.1: Different session lengths and how often they got lost.

6.2 Are Users of Email *Getting Lost*?

Of the 14 participants in my study that completed diary entries, 9 (64%) reported that they *got lost in email*. Participants reported being lost in 23% (47/204) of all diary entries. This means, that in the email sessions that participants were *prompted* and *responded* to diary prompts, they reported *getting lost* 23% of the time.

Interestingly, and unexpectedly, participants reported *getting lost in email* during both short and long sessions. Figure 6.1 shows the breakdown of sessions by length and the number of sessions where they reported being lost versus not. Surprisingly, there were many cases where participants reported being lost in short, three minute sessions. However, these cases only comprised 21% of the total number of three minute (180 seconds) sessions. This is in contrast to the proportion of sessions greater than or equal to 12 minutes (720 seconds),

where participants reported becoming lost in 57% of the sessions. As a session becomes quite long, it has a higher probability to get out of hand and the user getting lost.

There were a surprising number of very short sessions where the participant became lost. Therefore, during a more detailed analysis where I looked specifically at these entries, I found that participants often reported being further distracted by falling into chains of diversion [Iqbal and Horvitz, 2007]. These chains took them outside of email and thus outside my ability to track their activity. So it is possible that the short email sessions could in fact be part of longer chains of diversion and I was able to capture just the beginning of it. The quotes below are accompanied by details of what occurred during the session, these diary entries represent short sessions where participants reported getting lost.

> **P1**: *I was expecting an email to my work account that hadn't arrived so I checked my personal (gmail) account. It wasn't there either so I just archived a new email in the inbox that I didn't care about.*
>
> **Session**: *Participant didn't read any email, only moved emails. There was no unread email.*

> **P4**: *Checked incoming email, saved a bunch of attachments for an event later tonight.*
>
> **Session**: *Participant read 19 messages.*

> **P5**: *[J]ust email, paid online bill*
>
> **Session**: *Read 1 message*

> **P13**: *Thesis work, TA jobs*
>
> **Session**: *Participant read 2 messages, composed 3 messages, and replied to 2 messages.*

> **P14**: *I read a couple emails, which had links to articles so I read the articles too.*
>
> **Session**: *Participant read a lot of messages (or at least marked them as read), 68 messages in fact.*

> **P15**: *Checked my email. There were a ton (I had been in a meeting for a while and couldn't check my email) so I had a bunch waiting for me. Responses to some, not all. Didn't even get around to reading them all.*
>
> **Session**: *Read 11 messages, responded to a few. All messages marked as read.*

	β	SE	Odds Ratio	z-stat
Intercept	-1.320**	0.427	0.267	0.002
Interrupted	1.107**	0.420	3.025	0.008
Length	0.002**	0.001	1.002	0.003
Replies	0.933*	0.400	2.541	0.020
Composed	-0.684*	0.286	0.505	0.017
Read	-0.035	0.098	0.966	0.724
moved	-0.035	0.049	0.965	0.470
Inbox new	0.120*	0.058	1.127	0.037
Total emails	-0.0003*	0.0001	0.999	0.036
Total unread	0.0002	0.0002	1.000	0.494
Emails to you	-0.069	0.276	0.934	0.804
Emails only to you	-0.111	0.286	0.895	0.698

Table 6.1: Binary logistic regression against getting lost (* $p <= 0.1$, ** $p <= 0.05$, *** $p <= 0.001$.)

6.3 How are Users Becoming Lost?

Table 6.1 shows the results of a Binary Logistic Regression [McCullagh and Nelder, 1990] using *Got Lost* as the dependent variable. The model was found to fit significantly better than the null model using the likelihood ratio test ($p < 0.001$) with a log likelihood of $-91.29154(df = 12)$, furthermore the model correctly predicted 79% of the responses. The model shows that the most important variables, relative to the others within the model, are whether or not a participant was *Interrupted*, the number of *Replies* written, and the number of *Composed* messages written.

Examining the *Odds Ratios* for these three variables reveals their relationship to whether or not participants *Got Lost*. If a participant began the session under the condition of being *Interrupted*, they were 3.025 times more likely to *Get Lost*. For each message that they replied to during their session, they were 2.54 times more likely to *Get Lost* (e.g. the more a participant replied to messages the more likely that they *Got Lost*). In contrast, for each message that a participant *Composed*, they were 0.5 times less likely to *Get Lost*. Perhaps, the purposeful act of going to email to compose a message creates a more focused path of interaction. As opposed to engaging with the list of emails and replying to them, which tends to pull participants towards further interactions.

Surprisingly, the number of emails read, new, or otherwise was not found to have a strong effect. This can be attributed to the large amount of noise that I observed in email. That is, of all of the email that my participants received, roughly a third (32%) of emails went unread, Figure 6.2. Keep in mind that this is not counting any of the spam or junk emails. Furthermore 73% of messages remain in the Inbox and were not acted upon, Figure 6.3.

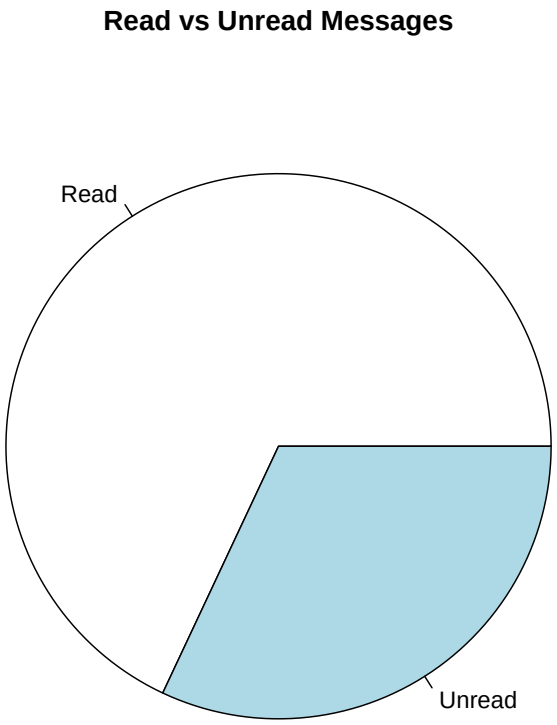

Figure 6.2: Amount of messages read vs. unread.

6.3.1 Maintaining an Image of Responsiveness

Further insight into why participants were more likely to become lost in sessions where they were replying to emails can be gained from the various survey responses. In the survey one question prompted them for what is successful about their email habits. While the original intent of this question was to probe more about their email management practices, it instead revealed a more interesting insight into the perception of email etiquette. During the analysis of the survey answers it became clear that there is a clear pressure felt by the participants to maintain an image of responsiveness [Tyler and Tang, 2003; Fisher and Dourish, 2004]. These responses speak to the pressures that users feel when they encounter an email that needs a response, further showing how certain emails can function similar to a summons (Section 4.8.1). Below are a series of example responses, the language favorably comparing their promptness with others' lack of it is particularly striking in these responses.

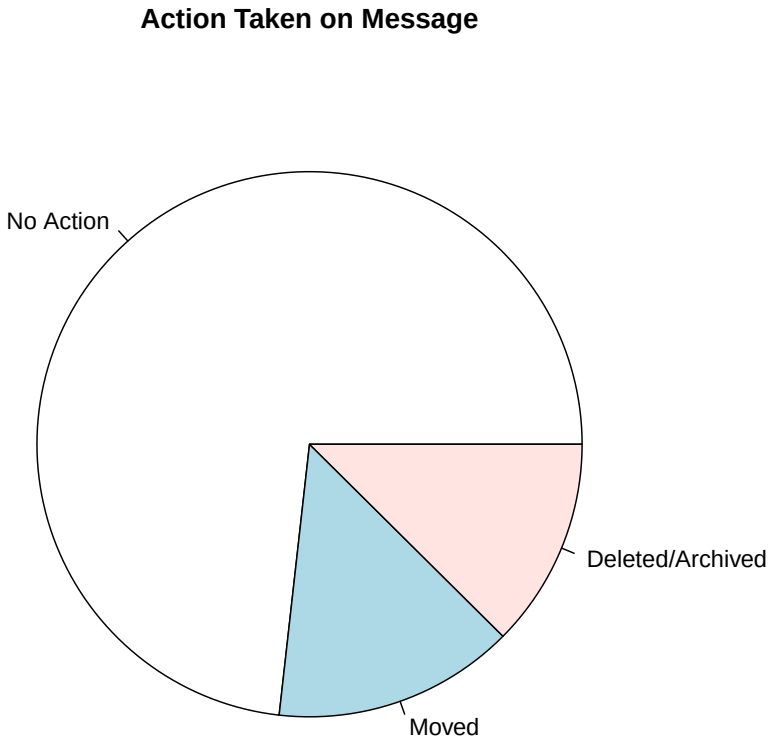

Figure 6.3: Amount of messages that have a filing action taken on them.

R50: *I respond in a timely manner; I know proper e-mail etiquette*

R6: *Reading my emails regularly.*

P6: *I tend to read, file, and respond to each important email in a very timely manner.*

R11: *quick responses, readily available*

R12: *Read and respond as soon as possible, and sort them into appropriate folders.*

R13: *I read all email that I receive soon after I see them, and attempt to respond promptly (within 8 hours).*

P19: *I try to respond within a day. However, some people don't think that is quick enough. I also have emails well-organized into archive folders.*

P10: *I am prompt in responding to emails, and in reading important ones.*

P11: *I respond to necessary emails in a timely manner.*

P12: *I have a folder management system which works very well for storing emails and finding them again if necessary. I read and respond to emails everyday such that the sender of the email never has to wait more than 24 hours for a response (unless I am on vacation).*

R24: *I read all my emails, unlike most people, so I don't miss out on anything.*

P21: *I file my emails in a manor that allows me to find importnat emails again in the future. I also read my emails in a timely manner so as not to miss any important information.*

P48: *I try to keep my inbox relatively clear, and respond to emails quickly and efficiently, so they don't back up. I also file things with the labels in Gmail, which helps me find things later.*

6.3.2 Impact of Session Initiation

Figure 6.4 shows the proportion of diaries that reported getting lost vs. not getting lost in relation to the reason for initiating the session. This figure shows that the chance for getting lost is relatively similar between all sessions. In fact, the majority of the reasons are within 15 percentage points of the global average of 23% (i.e. Refinding at 33%, Anxiety at 22%, Expecting Communication at 36%, Down Time at 26%, Compose a Message at 23%, Notification at 26% and Routine at 17%), the only real outlier is Curiosity at 8%, perhaps this is because these sessions were less directed and more open to whatever tasks lay waiting in their inbox.

Based on these results the reason for initiating a session does not seem to have a large impact on the probability to become lost during the subsequent session. Note that while the reason for initiating a session does not have an impact, the manner in which it was started does. As previously mentioned, whether or not the session was an interruption to another activity did have an effect.

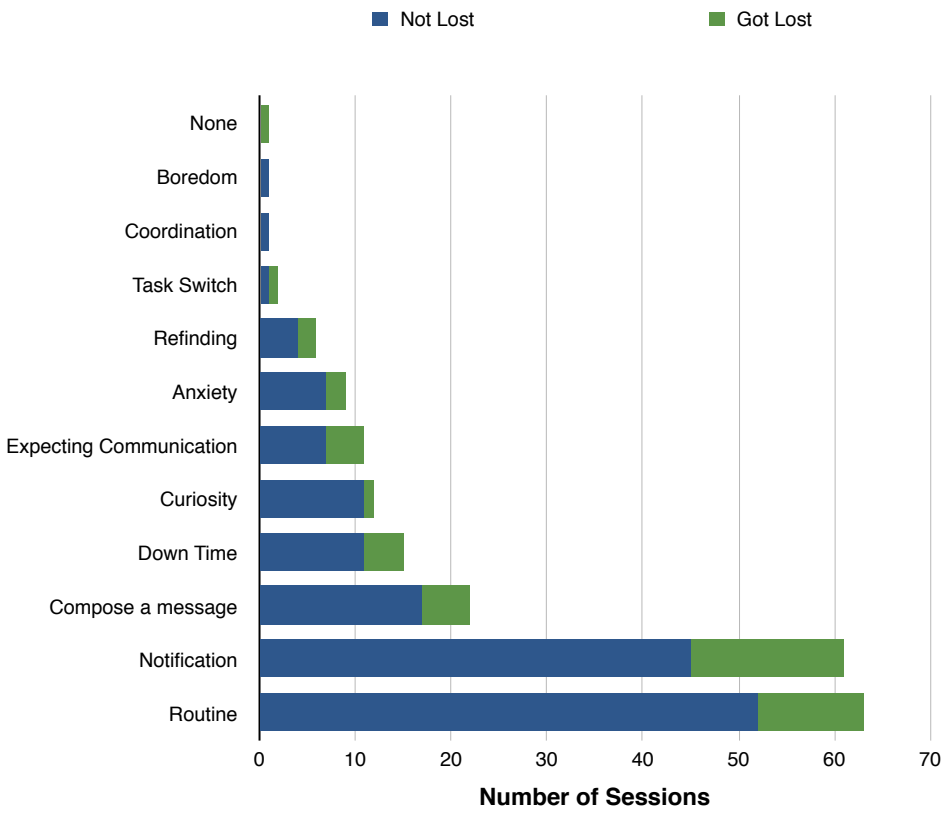

Figure 6.4: Different reasons for starting sessions and how often they got lost.

6.4 The Role and Nature of Mitigating Behaviors

The participants in my study were clearly aware of the problematic nature of email. The majority of the email strategies they reported were around the management of time instead of emails. Respondents go so far as to structure not only their email use to minimize their email time, but also structure their work day around email to avoid problematic usage. While, I reported in the previous section the clear evidence that users maintained an image of responsiveness, in these responses we see them defining success in email more as limiting the time spent.

Some respondents mentioned how they structure their work day around email. This first quote mentions how they take care to structure their access to email so that they are not tempted to spend too much time reading everything that gets sent to them

> **R42**: *I try not to check it in first hour of day. I check once I get engrossed in some other work. This way, I just read through them in a hurry. If I start my day by reading mails then I read a lot of them and go to their links also*

Another quote mentions how this participant sets aside time several times a day to read and respond to email.

> **P13**: *I have a very organized system of how I read and respond to emails. I use flags and stars to denote which I need to respond to immediately. I also set aside time, several times a day, to read and respond to emails.*

Some users structure their email use in such a way as to help manage their time and attention spent on email. This participant mentions how they separate facets of their identity between email and Facebook.

> **P26**: *I think I spend an appropriate amount of time emailing. I use emails almost only for work and use facebook messages for social messaging.*

Other respondents outlined the way in which they make more important messages more salient than others, helping them to direct their attention only to the most important messages.

> **R31**: *Keeping important reminders and "to do" emails in my inbox (but everything else in subfolders) keeps my professional life much more organized and helps keep me on task.*

> **R22**: *I manage them in folder so I know which ones are important and they go directly to the folders and the rest unread doesn't matter to me.*

> **P18**: *I'm not sure how to measure success. I would say using the gmail labels and folder system helps me find emails and to remember which ones need to be looked at soon (like the ones labeled 'scholarship' need to get looked at sooner than some others).*

> **R39**: *I flag emails that require action for later reference and act on email immediately so I don't forget to do it.*

Others, structure usage of email to avoid wasting time in email and to be efficient.

> **R35**: *I deal with the emails as required within a reasonable time. Usually I only deal with a particular piece of email once. It either gets filed, deleted, or responded to. Once I've responded to an email, I will file it away. The reply will then generate a new email in my inbox.*

> **R40**: *access to email through phone and computer, label use, and quick response*

These various strategies show that the participants were aware of the issues with management of their attention or use of time as relates to email.

6.5 The Effect of Preconditions

One of my primary hypotheses in this research is that the state of the email corpus had the greatest effect on email usage. In Section 4.5.2 I outlined that, while the unread count was a poor indicator of session length, the number of messages read was a strong correlate with session length. Previously in this Chapter (Section 6.3), I also outlined how the number of messages that a user replied to was a primary indicator to whether or not the participant had become lost during that session. Clearly based on these findings email state has a clear effect on what happens in individual sessions. An additional question is whether or not there is a more global relationship between aspects of email use and the frequency of engaging with email.

When examining the correlations, Table 6.2, between the total measures for participants over the course of the study with both the number of times sessions that I captured and total usage time a slightly different pattern emerges. Again it is evident that the raw count of new messages that the participants received throughout the study is not a correlate for either total time spent or number of sessions. One difference emerges in the number of email sessions, in that participants that engage in deleting or moving emails (*pruning* sessions), engage with email more often and for more total time. This is not surprising, even though it runs contrary to the relationship to the length of *individual* sessions. Thus, the correlates around total usage are around messages that have actions associated with them (read, deleted, moved, composed, replied) and this indicates that participants spend overall more time in email.

This means that the effect of email state on email use is slightly different than I initially imagined. That is, while it is true that email state has a large effect on the duration and frequency of use, it is not true that the simple number of new messages received seems to have an effect. This is inline from the previous finding where read messages was a predictor of getting lost and not new or unread messages.

6.6 Evidence of Predisposition

A hypothesis that did not yield any results was that the Attentional Network Test (ANT) would correlate in some way with email use, particularly getting lost. When tested for correlation with different totals of aspects of email use, they did not yield any meaning results, Table 6.3, none of the coefficients were significant.

The lack of relationship is further seen when examining the plots of the ANT scores, for example against the total duration of email use, Figures 6.5, 6.7, 6.6. No pattern emerges from my data and the plots are more or less distributed in scatter shot.

Even though ANT did not yield results, I wanted to determine if there were any *indications* of individual differences between the participants in my study. To do this, I examined

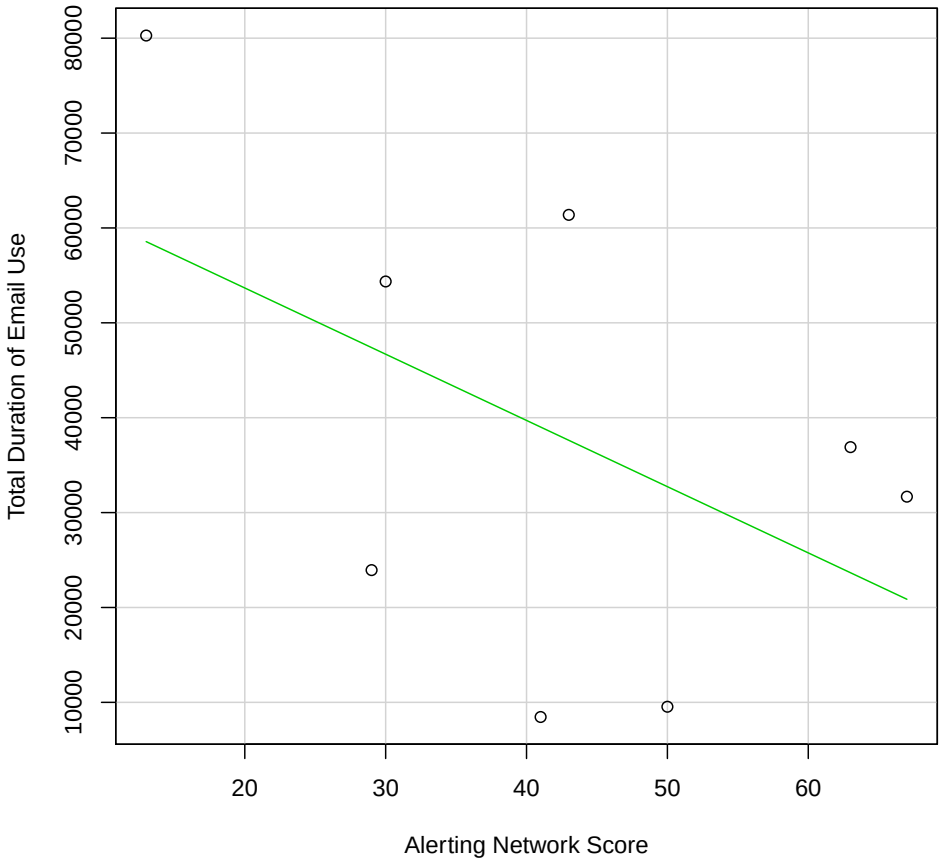

Figure 6.5: Scatter plot of participant alerting network scores vs. total duration of email use. Each dot represents a participant.

correlations for the individual participants, Figure 6.8. When examining the individual correlations with session length there is a similar pattern within some aspects (read, composed, replied) which are all are significant correlations for each of the participants. However, the strength of that correlation varies widely. This seems to suggest that there are individual differences in how our participants responded to similar situations. However, more detailed analysis is required, as well as a different method for detecting or categorizing the aspects of the individual participants for this to be proven.

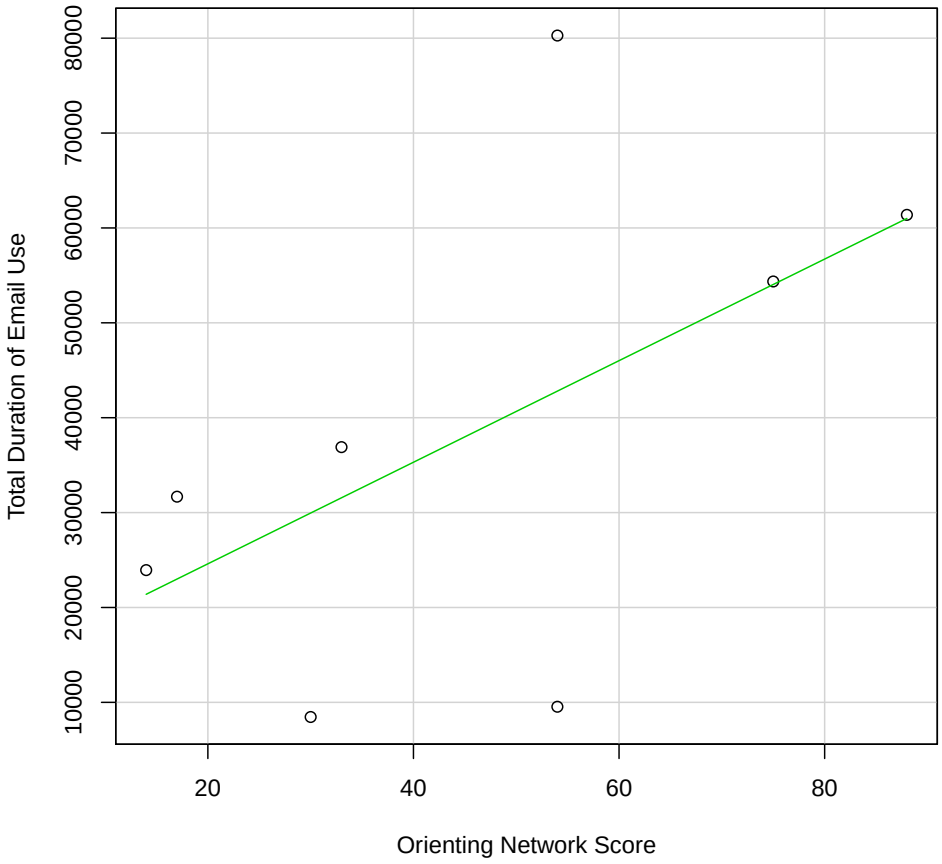

Figure 6.6: Scatter plot of participant orienting network scores vs. total duration of email use. Each dot represents a participant.

6.7 Conclusion

When I began this study, I imagined that it would be difficult to capture sessions where participants *got lost* in an email session. That I captured so many of these sessions speaks somewhat to the effectiveness of the method that I employed, but speaks in a much larger part to the unexpectedly high frequency that participants found themselves doing more within email than they had anticipated.

The raw count of email (unread or not) was not found to influence whether or not participants became lost. This seems to be due to the large amount of noise the participants received. Likewise, filing and deleting messages seems to be a relatively easy thing for our participants to do, as it was not found to cause users to become lost.

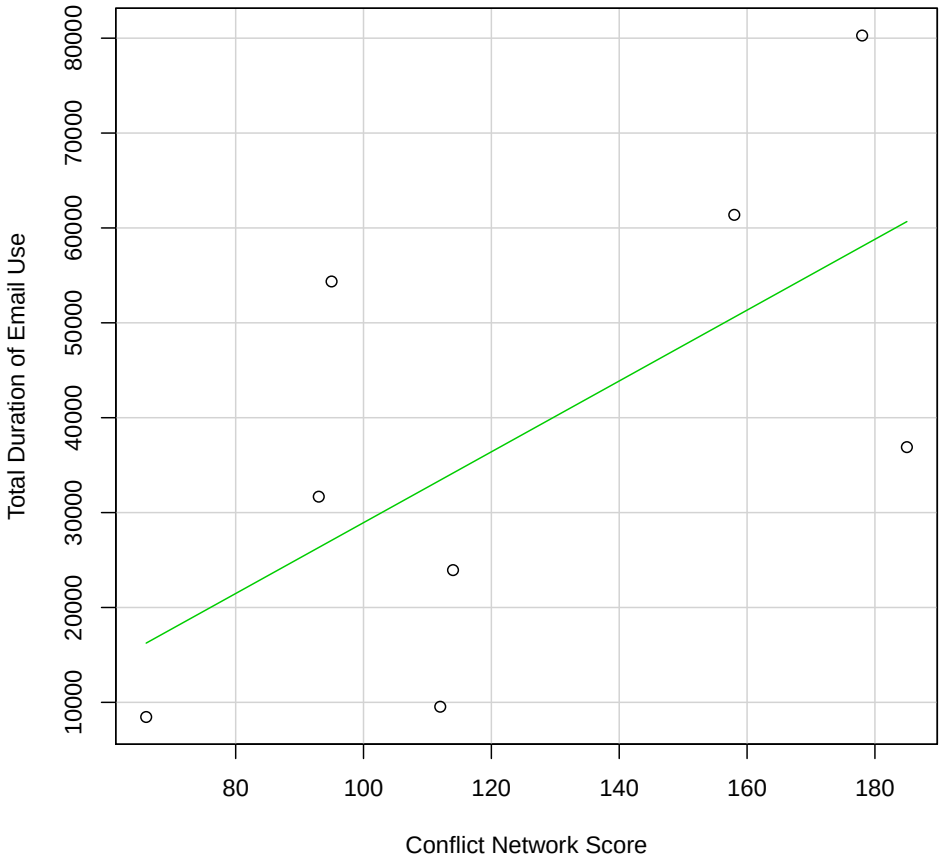

Figure 6.7: Scatter plot of participant conflict network scores vs. total duration of email use. Each dot represents a participant.

Instead I found that the number of emails awaiting a reply was a primary reason for becoming lost in email. Furthermore, sessions that began because of an interruption were also more likely to result in getting lost. Likely this is representative of a similar phenomenon, where the interruption is because of a notification for an email that requires a response. These findings lines up well with my previous analysis in Section 4.8, where I used Conversation Analysis (CA) to frame emails as both summons and requests for attention. Clearly, emails that require a reply are closer to conversations and function similarly to summons once they are encountered (either through a notification or viewing in the inbox). In both of these cases it is clear that email, particularly emails that require a response, have the ability to pull its users down a path of further interaction. Emails that required a response compelled participants to reply to them, much like an first-turn utterance compels a response utterance in more conventional conversations.

I did not find any evidence to support my primary hypothesis that the scores gathered from ANT would help to explain the differences. However, I did find several differences that suggest that these differences are there. First, there was a large variation in the number of times that participants reported being lost, and second, there was a large variance in the correlation between common aspects (e.g. number of read or replied to emails) and session length. More investigation into these differences is needed to determine their root causes.

The different strategies that participants outlined show that much of the problem around email is in managing the tension between the perceived social responsibility of promptly responding to email (similar to the findings in Section 4.6) and limiting ones engagement with email. Perhaps, the lengths participants went to in managing their engagement with email belays some of the misconception of others expectations for prompt replies.

	sessions	total time	new msgs	read msgs	total msgs	deleted msgs	moved msgs	composed msgs	replied
sessions	NA	0.98***	0.15	0.57**	0.34	0.67***	0.49*	0.61**	0.53*
total time	0.98***	NA	0.13	0.55**	0.34	0.73***	0.52*	0.59**	0.54*
new msgs	0.15	0.13	NA	0.49*	0.55**	0.26	0.24	0.42	0.36
read msgs	0.57**	0.55**	0.49*	NA	0.80***	0.51*	0.54*	0.70***	0.61**
total msgs	0.34	0.34	0.55**	0.80***	NA	0.35	0.66**	0.54*	0.47*
deleted msgs	0.67***	0.73***	0.26	0.51*	0.35	NA	0.76***	0.60**	0.70***
moved msgs	0.49*	0.52*	0.24	0.54*	0.66**	0.76***	NA	0.56**	0.68***
composed msgs	0.61**	0.59**	0.42	0.70***	0.54*	0.60**	0.56**	NA	0.93***
replied	0.53*	0.54*	0.36	0.61**	0.47*	0.70***	0.68***	0.93***	NA

Table 6.2: Correlation matrix for overall activity.

	Got Lost	Sessions	Duration
Alert	0.0361472	-0.3333333	-0.2857143
Orienting	0.0363643	0.547619	0.6190476
Conflict	0.4819627	0.5389318	0.5988131

Table 6.3: Correlation between Attention Network Test Scores and aspects of email use

Individual Session Duration Correlation Matrix

Participant	df	total_num_emails	total_num_unread	new_since_last_active	inbox_num_unread	inbox_num_emails	inbox_new_since_last_active	read_messages	deleted_messages	moved_messages	composed_messages	replied_to
2	86	-0.2633441*	0,145704	NA	0,145704	-0,18229	*NA*	*0.6980595****	*-0,1536986*	NA	0,04479881	NA
3	131	0,05064768	-0,000633728	0.2247808**	-0,001140719	0,05702367	*0.2247808***	*0.1949301**	*-0,09008922*	NA	0.4288605***	0.2565408**
4	105	-0,1217109	-0,1162429	-0,07354947	-0,1593344	-0,1028582	*-0,07354947*	*0.7514535****	*0,08745748*	NA	0.8085896***	0.6638122***
6	152	0,02064279	0,03125585	0,07724868	0,03125585	0,01955297	*0,0145599*	*0.6957519****	*-0,005251456*	NA	0.3747621***	0.2429693**
7	108	0,07224282	0,1561037	0,009836706	0,1561037	0,0004046398	*0,0146437*	*0.5755086****	*0.2499496***	NA	0.3084379***	0.3806283***
9	229	0,08494257	-0,0143832	-0,01090873	-0,1087716	0,08283481	*0,0006480438*	*0.6214629****	*0,07367773*	NA	0.4788327***	0.2730171***
10	38	0,002982373	-0,02466808	0,3884504	-0,1992286	0,06374907	*0.4236593***	*0.5361196****	*0,0310058*	NA	-0,1587768	-0,06052275
11	164	0,08277246	0,0212384	0,03837886	-0,118	0,07549979	*0,03837886*	*0.6143401****	*0.2816472****	NA	0.5860781***	0.4264719***
12	94	-0,07538401	NA	NA	NA	-0,06539988	*NA*	*0.6215842****	*0,08260043*	NA	0.4154406***	0.4213046***
13	221	0,07543968	0.14291*	0,05697161	0,02406429	-0,1472788	*0,04462151*	*0.193028****	*-0,03642332*	NA	0.217851***	0,1570102
14	41	-0,1975418	-0,2088797	0,1340009	-0,2256628	0,05191958	*-0,05009196*	*0.5659415****	*0,09403304*	NA	0.3977664**	NA
15	163	-0,08435774	-0,02466594	0,1024294	0,032699	-0,03711327	*0,07906637*	*0.4327926****	*0,105041*	NA	0.4770801***	0.4292172***
16	110	-0,1350788	-0.1911107*	0,1131138	-0.2241422*	0,1744196	*0,142431*	*0.9038561****	*0,1036261*	NA	0.7974923***	0.5251557***
17	148	0,005399365	-0,06110465	-0,03750205	-0,1437935	-0,08182418	*-0,02909236*	*0.2827888****	*0,05662228*	NA	0.3138514***	0.2844961***
19	168	-0,1062146	NA	NA	NA	-0,1062146	*NA*	*0.6857502****	*NA*	NA	0,09155472	0,1118503
20	217	-0,01429777	-0,09532505	0,04095914	-0,08682635	-0,04199302	*0,05100563*	*0.4836121****	*0,09110887*	NA	0.5910998***	0.3323111***
21	14	-0,1615245	-0,4462044	0,3558583	-0,3387458	0,01844152	*0,466953*	*-0,0143557*	*0,4458627*	NA	0,01193475	-0,0110577
23	126	0,1065252	-0,07262771	-0,0434132	-0,07262771	0,1592244	*-0,0434132*	*0.707336****	*0.1728511**	NA	0.6669664***	0.5249068***
26	95	-0,1884435	-0,2012012	-0,04029636	-0.2012012*	-0,1758845	*-0,03620186*	*0.7085213****	*0,1947204*	NA	0.4474466***	0.3808788***
27	12	0,2672277	NA	NA	NA	0,09164119	*NA*	*0,5184717*	*0,9761561*	NA	0.9839146***	0.8632364***

* (0.05) **(0.01) ***(0.001)

Figure 6.8: Individual correlations are similar, but the strengths are different.

Chapter 7

Conclusion

In this dissertation I have investigated *getting lost in email*. As part of this investigation I have targeted several different points of the process in email use, as well as exploring the applicability of different theories on email use. In this chapter I discuss my findings in a holistic way.

In the first section I outline the answers to the research questions that I set out to investigate in this dissertation. In the second section I give an overview of the process of attending to email and getting lost chronologically. This is followed by an overview of the themes that I have uncovered in my research. Finally, I give my recommendations for email clients and outline future work in the area of PIM.

7.1 Research Questions

7.1.1 RQ 1: When and how are users deciding to attend to email; specifically, is it the result of user predisposition, preconditions of email, mitigating behaviors, or social obligations?

To answer this question there were several aspects of email use that I needed to explore. I hypothesized that users would engage with email for a complex set of reasons and that email sometimes pulls its users down a path of interaction. My findings support that there is a complex mixture of reasons that participants checked email, this is evidenced by the numerous reasons cited in the diary entries, Section 4.2. However, I did not anticipate how heavily social aspects of email use weigh on the decisions to attend to email. I initially assumed that email use would be greatly driven mechanically by the notifications that prompt email use. While the mechanical nature of notifications certainly plays a role in attending to email, the notifications that were mentioned in the diaries played more on social obligations

to reply to a message than a simple mechanical interruption that takes participants attention against their will, Section 4.2.1. While the mechanical interruption of a popup box or sound may capture attention for a few seconds, they do not seem to draw users down a path of interaction in and of themselves.

In fact, the same can be said about two of the three groups of features that I hypothesized would impact email usage. For instance, in the *Preconditions* of the email corpus I found that none of the simple, easily measurable preconditions impacted session length (Section 4.5). That is, the raw counts like unread email, number of new emails, or even the profile of the senders had a measurable effect on usage statistics. However, the length and outcome of individual sessions were primarily impacted by the number of read emails and the number of replies written. While it is somewhat plainly true that the more emails that a user reads, the longer their session will be, it *is* striking than none of the other preconditions gives insight into this. Suggesting that the social side of email use is complex. When looking at *Mitigating Behaviors*, many of the behaviors were around the limiting of engagement with email, Section 6.4. That is, my participants sought to limit the moments in the day that they could encounter an email that drew them in. I had expected that there would be more, obvious strategies like *Inbox Zero*, that would have an effect on email use. The few such strategies that I found had no measurable impact on session length. Finally, while I did not find any theory behind the *Predisposition* to email use, there does seem to be some differences (Section 6.6), however, these are outweighed by the social *Preconditions* of the email corpus.

An additional hypothesis that I had at the beginning of this research was that users of email were being distracted by spurious notifications. However, I did not capture any incidents of this happening in my diary study. However, based on the relative ease that participants exhibited in finding relevant emails and how short pruning sessions were (Sections 4.5, 5), I do not believe that spurious notifications lead to long sessions. The second or so of interruption may indeed be damaging to ones cognitive ability or attention, but it does not lead to the massive interruptions that I sought to investigate in this study. Notifications only lead to these destructive sessions when they are about an email that is of some value to its recipient. That is, only when it beckons to be answered. This hypothesis is therefore not confirmed.

A related hypothesis or assumption, that is made by many email researchers, is that users are having trouble filtering through messages to find the ones that are relevant to them. This assumption has impacted the rather large amount of research around email triage and does not seem to be true, for my participants at least. Individual decisions around email relevancy are short, Chapter 5, and there was no evidence from my diaries or logs that finding relevant emails is particularly difficult. Likewise, this was not mentioned in the survey responses. Perhaps, email triage is only a problem for exceptionally heavy users of email.

Lastly attentional network scores simply did not have a measurable impact on email use, Section 6.6.

7.1.2 RQ 2: What is the level of engagement that users are maintaining with email when not actively using email and how does this feature in their decision to attend to email?

From my investigation it is clear that participants maintained a high level of engagement with email when not actively using it, Section 4.3. I initially hypothesized that users of email maintain a background engagement with email throughout the day, and this was confirmed. However, I uncovered more about the nature of this background engagement, in that it was focused to a large degree on the anticipation of getting an email that they might miss, which is highly linked to their want to project their efficacy to others through prompt replies. I think this anticipation serves as an explanatory factor for why some users focus on triage, basically, a 'clean' inbox amplifies the signal of a new email.

Another hypothesis was that users are aware of the last time they checked email and that longer periods of inactivity can cause anxiety. In my diary study I found evidence that users are aware of how long it has been since they last checked email, and at times this seems to be a driving factor in checking it. The anxiety however, is more often about single emails from a particularly important person as opposed to the inbox entering an increasingly unknown state. The insight that I have gained from this investigation helps to outline why there have been conflicting reports in the effect of frequently checking email and anxiety. In one study, Dabbish and Kraut [2006] found that more frequently checking email reduced email related stress, while in another study, Bradley et al. [2013] found that frequently checking email increased email related stress. I propose that these can both be true, checking email reduces stress in the short term as it alleviates unknowns like, 'did I receive that email yet.' Whereas, it seems that email use begets email use, through actively controlling email use users may discover that having to respond to an email **right now** is not quite as important as they may have thought.

7.1.3 RQ 3: Once users have decided to attend to email, what are the activities, predispositions, or preconditions that correlate with longer sessions and how do these relate to getting lost?

My hypotheses for this question followed closely to that of Research Question One, I expected that entering an email session would be determined by the *Preconditions* as determined by email state and that getting lost would be determined by the *Predisposition* of the participant. This set of hypotheses was unconfirmed. First, the reasons for starting an email session were quite varied, and there were very few mentions of the email state as the reason for starting a session, Section 4.2. Instead, the diary entries were focused on routine or a more internal motivation like anxiety or boredom. Second, instead of the predispositions of

the participant being the primary predictor of getting lost it was the email state that had the most power in predicting whether or not a participant would become lost. Therefore, it seems that checking email was often determined by some intrinsic reason for checking, whereas what happened during the session was primarily determined by what was in the inbox.

My additional, more specific, hypothesis around attending to email was that users with more responsibilities would check email more often. While, I did not have direct evidence in terms of a quantitative measure, responsibilities were mentioned in a number of the diary entries. Therefore, this seems plausible but remains unconfirmed.

I also hypothesized that the *Preconditions* of email specifically impacted getting lost. The primary factor that I thought would be involved in getting lost was the number of important messages, this was in fact the primary indicator of session length (in terms of read messages being a strong correlate with session length). However, this was not a strong indicator of whether or not a participant would become lost, instead a subtly different factor was a strong indicator of becoming lost, messages that required a reply (Section 6.3).

7.1.4 RQ 4: Are the gratifications that users expect out of their email use related to personal or professional reasons and how do these help to predict email use?

For this question I hypothesized that email use was more around professional activities, mostly because social activities with friends and family have migrated away from email over the years. This hypothesis, that email is centered mostly around professional activities, is confirmed. This was evident in the UGT survey (Section 4.7), where professional activities were cited more often that personal. This was also evident in the first survey (Section 6.3.1), when respondents cited projecting their efficacy through prompt replies and projecting a professional impression to others. This was again evidenced in the diary entries, where concern over professionalism was made obvious as well.

7.2 Overview of Process

In this section I tie together all of the pieces of my research. Each study targeted different points of time in the process of engaging with email and becoming lost. I outline the process in roughly the chronological order that they occur.

7.2.1 Maintaining Engagement

Throughout their day users of email are maintaining a level of engagement with email, even when they are not actively using email. A reason for this is the combination of the poor indicators available to them and their want to respond promptly to important emails. This is evidenced by participants' diary responses.

Users of email are aware of the constant engagement that they have with email and some try to minimize it. There is a tension in email use between users desire to be prompt in responding to email and the need to limit their engagement in order to lessen the damage to their attention. This is evidenced by the strategies for email that participants reported in survey responses.

7.2.2 Attending to Email

Users are drawn into email by a combination of different factors. These include notifications for individual messages, expectations around receiving a message, or states like boredom. Users also make very conscious decisions to attend to email as part their daily routine or to compose a message to someone. These are all seen in their diary responses.

Many of the decisions to attend to email are around messages and communications with individuals, instead of responding to a large unread count or the general status of the inbox. Notifications for certain emails act as summons. While, many of the expectations that draw users in are around missing a conversation, which can be attributed to the manner in which summons function (or not) on email. A primary reason for these various phenomena is the users' desire to maintain an image of responsiveness. Compounding this, is that there are no accurate predictors for session length or importance, other than determining which messages will be read or replied to, as seen in the analysis of the usage logs.

7.2.3 Activities in the Client

Once users enter email their activities are composed of moving, deleting, reading, replying, and composing. Triaging does not seem to take up an inordinately large amount of time, as sessions that were comprised of deleting or moving did not take very long. This is true even though there is quite a bit of noise in terms of email to be dealt with. There was also no mention of trouble finding an email in the diary entries. Additionally, determining relevancy of email in my lab study only consisted of a few seconds or less, which was constant across different types of emails. For these reasons, I am not confident that email triage is quite as problematic for the majority of users as previous research assumes.

The activities that did take a long time are reading, writing, and to a lesser extent composing. Reading was the strongest correlate for session length. While, replying to messages was the

activity that most lead to getting lost.

There were clearly different types of sessions from the activities: pruning sessions were ones where messages were deleted or moved; composing sessions were more focused and other activities did not occur as much; sessions that were an interruption pulled participants into more activity; and undirected sessions (especially when there were messages that awaited replies) pulled participants down a path.

All that said, when looking over a longer period of time (as opposed to individual sessions) participants that received more email did spend more time in email over the course of the study.

7.3 Themes

7.3.1 Applying Conversation Analysis to Email Use

When discussing how users are attending to email, I feel that it is important to look at email primarily as a communication medium. This is because the most important activities that occur in email are centered around communication and conversation-like threads. This is evidenced by the large proportion of time that I found participants engaged in these activities. Additionally, participants' reasons for checking email were centered around these conversation interactions. By framing emails as a conversation medium, it becomes apparent that the decisions to attend to email are influenced by similar, if not the same, factors as conversational openings (bearing a particular similarity with conversational openings on the phone). Furthermore, by contrasting the manner in which aspects of conversational openings, particularly the process of receiving a summons function over face-to-face, phone, and email gives insight into the roots of many issues that I encountered in my study.

First, I need to reiterate what aspect of email usage I consider to be a summons. Schegloff [1968] called summons 'attention getting mechanisms' and I find that the manner in which notifications appear, ring, or whichever flavor they take are clearly similar to a ringing phone or a person requesting their attention. Therefore, I consider receiving a notification about an email a summons. Of course, Schegloff intended summons to be specifically for conversational openings, which at the time of his original studies was always true of a ringing telephone. In present phone usage, there exists the possibility of a ringing telephone to be from an automated system, which certainly has many features of a summons in the way it grabs attention and beckons to answer it, but lacks one key feature – it is not meant to start a conversation. This rather rare feature of summons over the phone, is prevalent and extremely relevant to summons over email. This prevalence is due to the large amount of noise that exists on the email channel and the *indiscriminate* nature that email clients issue notificaitons for email messages. Therefore, in the case of summons of email, there exists the nearly guaranteed possibility of receiving what I am terming a *false summons*. Which

represents one of the idiosyncrasies of email that gives rise to anxiety over missing a *true summons*.

To be more explicit about what I do not consider a summons, and how some conversations may lack it, I must outline aspects of email use that are similar to a summons but lack key features. I do not consider the unread count a summons, it is an indicator of the number of unread messages and does not contain the same draw or specificity that is required for a summons. The unread count is a figure against a background, if one is used to a high unread mail count it is not indicative in any precise way. It does not contain enough information to draw a user into a specific conversation. However, I imagine if the user notices a shift in the unread count it becomes more distinct against the background, and the user may be able to reason (much like a ringing phone) about who the email might be from. This, in part, is precisely what inbox management techniques like 'Inbox Zero' seek to do, make any shift in the unread count distinct against the background of email. Contrast this with a ringing phone, that may lack information about the summoner, it is still specifically from someone requesting to begin a conversation with the answerer. Furthermore, I do not consider a single unread message in one's inbox a summons to a conversation, while it certainly shares some aspects with a summons, it simply does not satisfy the condition of being an 'attention getting mechanism.' The only thing that I consider a summons within the email channel is the notification that you have received an email from a specific person to begin a conversation.

The fact that an email conversation can occur without a summons, is another significant difference from initiating a conversation face-to-face or over the phone. When the indiscriminate nature of issuing a summons within the email client is coupled with the large amount of noise that we found in the email channel, a reason for my participants' anxiety around missing an email and their reasons for maintaining engagement with email becomes quite evident. *There is no guarantee that a summons will be issued for a conversation in email, or that you will receive a summons if it is issued.*

7.3.2 Predisposition, Preconditions, and Mitigating Behaviors

In my analysis I separated relevant aspects of email use into several sets of features. These sets of features helped me to isolate and compare what factors played which roles in different phenomenon, and specifically how they impacted a specific research question. These roughly group into three sets of features:

- **predispositions**, which includes aspects measured by the Attentional Networks tests (Alerting, Orienting, and Executive Control), as well as, situational aspects (how many projects the participant is involved in, upcoming deadlines, etc.);
- **preconditions**, including aspects such as number of unread messages, number of messages replied to, diversity of senders, reasons for initiating the session, or if this was an interruption.

- **mitigating behaviors**, including reading habits, filing habits, or strategies.

While I believe that this framework did fulfill my goal of isolating aspects of individuals, their email use, and measuring their impact, for email use at least an additional facet around social activities needs to be added. The social facet of email use had a large role, we do not use computers in a vacuum and this has to be taken into account.

7.3.3 Email as a Metacontextual Tool

The majority of PIM tools, especially email, are fundamentally different from more primary, focused interfaces like document based applications (Word, Excel, etc.). PIM tools are *meta-contextual*, in that they interleave multiple facets or contexts of a users life and work. Whereas, an application such as Word typically involves working on a document that belongs to a single context. This adds to emails ability to pull its users down a path of unintended interactions, and is a feature of computer applications that should make their designers increasingly aware of aiding their users in managing their attention.

7.4 Recommendations

Over the course of this research I have come to believe that while there are certainly several features that can be tweaked or implemented to improve email, the fundamental problems are around the status, etiquette, and practices in email.

There are several features, some of which have recently been deployed by either Apple or Google, that may alleviate a portion of different problems experienced in email. Recognizing that there are different types of emails, as noted in my analysis of the different requests for attention, is certainly being done by Google right now. Their different categories can roughly be mapped to the different levels of attention. Further research needs to be done as to whether a further level of specificity can be achieved (and accepted) by email users in terms of which emails require a reply. Another recommendation that I have is to provide different paths of interaction into email, Apple (among some other email clients) has also recognized this insofar as replying to an individual message and given the ability to reply directly in a notification in order to avoid going into the inbox. Perhaps this could go further into having different modes for pruning, composing, replying, etc. There is certainly some research and functionality being developed and deployed around making notifications for specific emails more prominent. Rector and Hailpern [2014] developed an additional layer of notification for important emails, and Apple has created a VIP inbox, as well as the ability to mark that you are expecting a reply to a message that you are sending. However, I believe that these features will only impact email in small ways. With all of the major changes experienced over the decades in the transition from land phones to mobile phones,

the essential experience and practice of talking on a phone has remain mostly static, the largest change being the removal of the identification work in the opening sequence due to the advent of caller id.

Email is first and foremost a communication medium, this means that many activities happen through email. This sometime leads to the allure that because an activity happens on email it is an email activity (or the primary email activity) and that email should be more specifically molded to that activity. So far all of these efforts have failed. Instead, it is emails flexibility, lack of focus, and simplicity that leads to its success. Email is not restrictive in what an author can put into an email, nor should it be. Users of email use it to communicate about any and all activities or topics, imposing restrictions onto email will only hamper the application and frustrate its users. Instead any new features should be around making communication easier, not restricting or focusing around a type of activity that email contains.

When I set out to study email use, I endeavored to find a way to assist email users to better direct their attention within email. Certainly the way that notifications are issued is not good enough, and this likely can be improved through analyzing usage patterns and applying either machine learning or heuristics to message display. It will be difficult to perfect the issuing of notifications, but easy to at least improve upon them. However, email's draw on our attention comes more from the pressures of our relationships than it does from the application itself. How else can you explain the engagement or anxiety with email that its users feel even when they are away from the computer. The problem with email is us, not the application. Therefore I tend to believe that a change in etiquette or practice is more likely to alleviate the woes of email than changes in the application itself. The email interface, by itself, can only moderately reduce the anxiety around feeling that one needs to immediately respond to prompt emails to positively project their professionalism.

7.5 Implications

In this dissertation I have established that the participants in my study did in fact get lost in email with fair frequency. They are anxious about missing email because email clients do not properly support aspects of conversations, particularly Summons-Answer sequences. This leads to conversations that can occur without summons, as well as becoming cumbersome as they must be re-initiated at each turn. Furthermore assumptions around the importance of triage and email management need to be re-examined, as my work suggests that the problems around triage may not be as widespread as previously assumed. The implications of my findings still need to be verified with a wider population, it very well may be that the particular behaviors of my population were different and this impacted my conclusions.

7.6 Future work

There are several areas that require further research based on this work.

First, I have found some preliminary evidence of individual differences, however, as the mechanical aspects of notifications were not the primary mechanism for getting lost or coming to be in a longer session of usage, ANT did not give any meaningful results. Perhaps, individual differences in terms of the perception of the importance of email, the desire to project professionalism, or some more social factor is more appropriate to detect the individual differences that were suggested in my findings.

Second, while relationships certainly play a significant role in email use, their nature is not fully uncovered by my research. Investigation into the types of relationships that email supports and how these translate outside of email is needed. Additionally, I would like to investigate how emails to or from familiar versus unfamiliar people differ.

Third, a better understanding of how conversations unfold through email is necessary to determine what improvements can be made. Particularly, an analysis of how users interleave conversation pairs [Sacks et al., 1992, p. 4] in email exchanges, each email often seems to contain multiple 'halves' of these units. This represents a potentially large difference between phone or face-to-face conversations and may be another source of confusion in email.

Lastly, do users also *get lost* in other types of social media (e.g. Twitter, Facebook). If so, do users *get lost* in similar ways to email?

Furthermore, additional research is needed into how the anxiety over immediately responding to an email is reciprocated by the original sender. Are email users putting an undue burden on themselves, or is their perception correct?

Appendices

Appendix A

IRB Documents

A.1 IRB Approval Letters

VirginiaTech

Office of Research Compliance
Institutional Review Board
2000 Kraft Drive, Suite 2000 (0497)
Blacksburg, Virginia 24061
540/231-4991 Fax 540/231-0959
e-mail moored@vt.edu
www.irb.vt.edu

FWA00000572(expires 1/20/2010)
IRB # is IRB00000667

DATE: November 2, 2009

MEMORANDUM

TO: Tonya L. Smith-Jackson
Benjamin Hanrahan

Approval date: 11/2/2009
Continuing Review Due Date:10/18/2010
Expiration Date: 11/1/2010

FROM: David M. Moore

SUBJECT: **IRB Expedited Approval:** "Effect of Social Proximity on Email Triage Decision Time" , IRB # 09-907

This memo is regarding the above-mentioned protocol. The proposed research is eligible for expedited review according to the specifications authorized by 45 CFR 46.110 and 21 CFR 56.110. As Chair of the Virginia Tech Institutional Review Board, I have granted approval to the study for a period of 12 months, effective November 2, 2009.

As an investigator of human subjects, your responsibilities include the following:

1. Report promptly proposed changes in previously approved human subject research activities to the IRB, including changes to your study forms, procedures and investigators, regardless of how minor. The proposed changes must not be initiated without IRB review and approval, except where necessary to eliminate apparent immediate hazards to the subjects.
2. Report promptly to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.
3. Report promptly to the IRB of the study's closing (i.e., data collecting and data analysis complete at Virginia Tech). If the study is to continue past the expiration date (listed above), investigators must submit a request for continuing review prior to the continuing review due date (listed above). It is the researcher's responsibility to obtain re-approval from the IRB before the study's expiration date.
4. If re-approval is not obtained (unless the study has been reported to the IRB as closed) prior to the expiration date, all activities involving human subjects and data analysis must cease immediately, except where necessary to eliminate apparent immediate hazards to the subjects.

Important:
If you are conducting **federally funded non-exempt research**, please send the applicable OSP/grant proposal to the IRB office, once available. OSP funds may not be released until the IRB has compared and found consistent the proposal and related IRB applicaton.

cc: File
Department Reviewer:Thurmon E. Lockhart
T. Coalson 0118

Office of Research Compliance
Institutational Review Board
North End Center, Suite 4120, Virginia Tech
300 Turner Street NW
Blacksburg, Virginia 24061
540/231-4606 Fax 540/231-0959
email irb@vt.edu
website http://www.irb.vt.edu

MEMORANDUM

DATE: March 18, 2014

TO: Manuel A Perez-Quinonez, Benjamin Vincent Hanrahan, Robert John Beaton, Nai-Ching Wang, Michael Stewart

FROM: Virginia Tech Institutional Review Board (FWA00000572, expires April 25, 2018)

PROTOCOL TITLE: Investigating Email Practices

IRB NUMBER: **12-664**

Effective March 17, 2014, the Virginia Tech Institution Review Board (IRB) Chair, David M Moore, approved the Amendment request for the above-mentioned research protocol.

This approval provides permission to begin the human subject activities outlined in the IRB-approved protocol and supporting documents.

Plans to deviate from the approved protocol and/or supporting documents must be submitted to the IRB as an amendment request and approved by the IRB prior to the implementation of any changes, regardless of how minor, except where necessary to eliminate apparent immediate hazards to the subjects. Report within 5 business days to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

All investigators (listed above) are required to comply with the researcher requirements outlined at:

http://www.irb.vt.edu/pages/responsibilities.htm

(Please review responsibilities before the commencement of your research.)

PROTOCOL INFORMATION:

Approved As:	**Expedited, under 45 CFR 46.110 category(ies) 7**
Protocol Approval Date:	**September 24, 2013**
Protocol Expiration Date:	**September 23, 2014**
Continuing Review Due Date*:	**September 9, 2014**

*Date a Continuing Review application is due to the IRB office if human subject activities covered under this protocol, including data analysis, are to continue beyond the Protocol Expiration Date.

FEDERALLY FUNDED RESEARCH REQUIREMENTS:

Per federal regulations, 45 CFR 46.103(f), the IRB is required to compare all federally funded grant proposals/work statements to the IRB protocol(s) which cover the human research activities included in the proposal / work statement before funds are released. Note that this requirement does not apply to Exempt and Interim IRB protocols, or grants for which VT is not the primary awardee.

The table on the following page indicates whether grant proposals are related to this IRB protocol, and which of the listed proposals, if any, have been compared to this IRB protocol, if required.

A.2 Informed Consent

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY
Informed consent form for participants of Research Project Involving Human Subjects

Title of the Project: Effect of Social Proximity on Email Triage Decision Time

Principal Investigator: Dr. Tonya Smith-Jackson

Co-Investigators: Ben Hanrahan

I. **The Purpose of this Research/Project**
The purpose of conducting this study is to determine the effect and importance of situating an email message based on the social proximity of the sender to the recipient. This information will help to provide a better understanding of how knowledge of the social context of an individual email message effects the ability of an individual to make judgements about email messages.
NOTE: This project is an evaluation of the impact of sociality on information decisions and not of your performance as an individual.

II. **Procedures**
If you choose to participate in the evaluation activities, we will ask you to sign one informed consent document (this document). You will keep a copy for yourself.

Preparatory Questionnaire: At this stage you will be given the informed consent form to read over before filling out a preparatory questionnaire, the purpose of this questionnaire will be to gather sample data about your social map and email usage. The completion of this questionnaire is assumed to be the implicit giving of informed consent.

Experiment Session: During this stage you will again be given the informed consent to read over and ask any questions that you may have, if you continue to give your informed consent then you will sign the form and the experiment will start. The experiment will last around 20-30 minutes and will compromise reading emails while wearing an eye tracker and being observed by the researcher.

Post Questionnaire: After completing the experiment a short questionnaire will be given to determine additional information about your email usage.

All data from this project will be analyzed and used for evaluation and to determine the effect of sociality on information decisions. Our goal is to more fully understand the role of sociality in information decisions that may help us to develop future tools or principles. Any information provided by you will be confidential.

III. **Risks**
Risks to you for participating in this study are minimal. We will make every effort to avoid interfering with your daily schedule, and will stick to the agreed-upon time schedule. Actual participation in this evaluation is not likely to cause any harm.

IV. **Benefits of the Project**
You will probably not gain any direct benefits as a result of your evaluation activities. We will also provide information to you if you desire to be kept informed about future projects.

V. **Confidentiality**
We assure confidentiality to all participants, and any data collected will be completely confidential. A code number will be assigned to each participant's questionnaires and observations and only this number will be associated with the data. A master list with a participant's name and contact email will be kept separately from the data in a private and locked location.

VI. **Compensation**
There is no monetary compensation for participation in the evaluation activities.

VII. **Freedom to Withdraw**
Participation in the evaluation is voluntary and the decision about whether you wish to participate is strictly your own. You may discontinue participation at any time without penalty or loss of benefits to which you are otherwise entitled. Withdrawal from the evaluation activities will not result in any adverse effects.

VIII. **Approval of Research**
This research project has been approved by the Institutional Review Board for Research Involving Human Subjects at Virginia Polytechnic Institute and State University and by the Departments of Electrical and Computer Engineering and Industrial and Systems Engineering (College of Engineering).

IX. **Participant's Responsibilities**

Upon signing this form below, I voluntarily agree to participate in the evaluation. I have no restrictions to my participation in the evaluation.

X. **Participant's Permission**

I have read and understand the Informed Consent and conditions of this evaluation. All of my questions have been answered. I give consent to participate.

_____ _____

Participant's Signature Date

Should I have any questions about the evaluation or its conduct, I may contact:

Ben Hanrahan Email:smithjack@vt.edu Phone: (540) 529-1776

Dr. Tonya Smith- Jackson Email:smithjack@vt.edu Phone: (540) 231-4119

Dr. David M. Moore, Chair, IRB Email : moored@vt.edu Phone: (540) 231-4991

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY
Informed consent form for participants of Research Project Involving Human Subjects

Title of the Project: Investigating Email Practices

Principal Investigator: Dr. Manuel Perez-Quinones

Co-Investigators: Ben Hanrahan
Bobby Beaton
Nai-Ching Wang

I. **The Purpose of this Research/Project**
This experiment is meant to provide insights into the day-to-day email practices of users. This is an exploratory study that will inform both future studies and the design of future enhancements to email. **NOTE: This project is an investigation of existing email practices and not an evaluation of your performance as an individual.**

II. **Procedures**
If you choose to participate in the evaluation activities, we will ask you to sign one informed consent document (this document). You will keep a copy for yourself.

Pre Questionnaire: A short (~15 minutes) questionnaire will be administered over email to gather details about your email practices and preferences.

Observational Stage: Before this stage begins you will again be given the informed consent to read over and ask any questions that you may have, if you continue to give your informed consent then you will sign the form and the observation will start. You will sign into our web application and grant us privileges to log your email activity (note: we will use the OAuth protocol so that we do not store your log in information and you can shut our access off at anytime). The email logging will only involve the headers of the email (sender, subject, and metadata) not the actual content (attachments or body) and you will be able given the chance to delete any sensitive emails before analysis begins.

Interview Session: You may be asked to participate in a short interview session either over Skype or in person.

Any information provided by you will be confidential.

III. **Risks**
Risks to you for participating in this study are minimal. We will make every effort to avoid interfering with your daily schedule, and will stick to the agreed-upon time schedule. Actual participation in this evaluation is not likely to cause any harm. In the case that a sensitive email is received or sent you will have the ability to delete this email without the assistance of the experiment administrators.

IV. **Benefits of the Project**
A potential benefit to you is, if you request it, is a summary of your email habits. We will also provide information to you if you desire to be kept informed about future projects.

V. **Confidentiality**
We assure confidentiality to all participants, and any data collected will be completely confidential. A code number will be assigned to each participant's questionnaires and observations and only this number will be associated with the data. A master list with a participant's name and contact email will be kept separately from the data in a private and locked location with no way to pair it back to the code for that participant's data.

VI. **Compensation**
There is no monetary compensation for participation in the evaluation activities.

VII. **Freedom to Withdraw**
Participation in the evaluation is voluntary and the decision about whether you wish to participate is strictly your own. You may discontinue participation at any time without penalty or loss of benefits to which you are otherwise entitled. Withdrawal from the evaluation activities will not result in any adverse effects.

VIII. **Approval of Research**
This research project has been approved by the Institutional Review Board for Research Involving Human Subjects at Virginia Polytechnic Institute and State University and by the Departments of Electrical and Computer Engineering and Industrial and Systems Engineering (College of Engineering).

IX. **Participant's Responsibilities**
Upon signing this form below, I voluntarily agree to participate in the evaluation. I have no restrictions to my participation in the evaluation.

X. **Participant's Permission**
I have read and understand the Informed Consent and conditions of this evaluation. All of my questions have been answered. I give consent to participate.

_____ _____
Participant's Signature Date

Should I have any questions about the evaluation or its conduct, I may contact:

Ben Hanrahan	Email: bhanraha@vt.edu	Phone: (540) 947-1034
Dr. Manuel Perez-Quinones	Email: perez@cs.vt.edu	Phone: (540) 231-2646
Dr. David M. Moore, Chair, IRB	Email: moored@vt.edu	Phone: (540) 231-4991

Appendix B

Questionnaires and Surveys

B.1 Lab Study Questionnaires

B.1.1 Prepartory Questionnaire

Please provide the From and Subject fields of the last 15 email threads that you have received. Preferable, the list of senders should be unique.

B.1.2 Post Questionnaire

Rank the amount of contact you have with each person (This question was asked for each sender):
(Not Close) 1 2 3 4 5 (Very Close)

Rank the relevance of the following topics to yourself (This question was asked for each topic)
(Not Very Relevant) 1 2 3 4 5 (Very Relevant)

Explain how you decide if an email is important or not.

What kind of email do you find the most difficult to make a decision for?

What kind of email do you find the easiest to make a decision for?

B.2 Email Usage Survey

Demographics

Consent Information

This survey will ask you several questions about your email management habits and experiences. Upon completion of this survey you will be asked to further participate in an email logging activity (note that we only store anonymized data with no identifying information for emails).
If you choose to participate in the full experiment and are one of the first 20 participants to register you will receive a $5.00 Starbucks gift card. At the end of the study, all participants will be entered into a raffle to win a $50.00 Amazon gift card, and participants that have completed at least 20 (or half, whichever value is smaller) diary entries will be entered twice.

--

If you have any questions or comments about this study feel free to contact:
Ben Hanrahan at bhanraha@vt.edu.

This study has been approved by the Virginia Tech Institutional Review Board which protects human subjects in research. If you have questions about this research or its conduct, research subjects' rights, or who to contact in the event of a research-related injury to the subject., you may contact:

David M. Moore
Chair, Virginia Tech Institutional Review Board for the Protection of Human Subjects
Office of Research Compliance
2000 Kraft Drive Suite 2000 (0497)

Blacksburg, VA 24060
Phone: 540-231-4991
Email: moored@vt.edu

IRB Number: 12-664

--

By beginning the survey, you acknowledge that you have read this information and volunteer to participate in this research, with the knowledge that you are free to withdraw your participation at any time without penalty.

By beginning the survey you agree that you are 18 years of age or older.

In what year were you born?

Please provide the following information (Progress 1/6)

Please indicate your gender.

- ○ Male
- ○ Female
- ○ Other

How long have you been using email?

- ○ Less than a year
- ○ 1-2 years
- ○ 2-5 years
- ○ 5-10 years
- ○ More than 10 years

Number of emails

The following questions ask about the number of emails for various facets of your email use. Please pick the response that best estimates your usage (Progress 2/6).

Please estimate how many messages you receive each work day.

- ○ Less than 10
- ○ 10-20
- ○ 21-50
- ○ 51-100
- ○ More than 100

Please estimate how many emails are currently in your inbox.

- ○ Less than 10
- ○

- [ ] 10-50
- [ ] 51-100
- [ ] 101-500
- [ ] More than 500

Please estimate how many emails are currently unread in your inbox.

- [ ] Less than 10
- [ ] 10-50
- [ ] 51-100
- [ ] 101-500
- [ ] More than 500

Provide an estimate of how many emails you compose each day.

- [ ] Less than 1
- [ ] 1-5
- [ ] 6-20
- [ ] 21-50
- [ ] More than 50

How many important emails do you receive each, where important means that you need to either read or respond to the email.

- [ ] Less than 10
- [ ] 10-20
- [ ] 21-50
- [ ] 51-100

- More than 100

How many emails do you respond to each day.

- Less than 1
- 1-5
- 6-20
- 21-50
- More than 50

Length of usage

The following questions ask about the amount of time you spend on various email tasks. Please pick the response that best estimates your usage (Progress 3/6).

How many minutes do you spend reading email each day?

- Less than 10
- 10-30
- 31-60
- 61-120
- More than 120

How many minutes do you spend composing email each day?

- ○ Less than 10
- ○ 10-30
- ○ 31-60
- ○ 61-120
- ○ More than 120

How many minutes do you spend filing or deleting email each day?

- ○ Less than 10
- ○ 10-30
- ○ 31-60
- ○ 61-120
- ○ More than 120

Feelings towards email use

The following make a statement about your feelings towards your email usage. Please choose the response that best represents your agreement with the statement (Progress 4/6).

Email is very important to my work.

Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
○	○	○	○	○

I am very frustrated by my email use.

Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
○	○	○	○	○

I consider my email habits successful.

Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
○	○	○	○	○

What about your email habits is successful?

Email Practices

The following questions ask you about your current email practices, please provide the answer that best represents your practices (Progress 5/6).

What email client do you use

Do you set aside a specific period of time each day for email management

- ○ Yes
- ○ No

Do you receive a notification when you get a new email

- ○ Yes
- ○ No

Do you usually read an email as soon as it arrives?

- ○ Yes
- ○ No

Do you utilize any rules to filter emails from your inbox

- ○ Yes
- ○ No

Do you have multiple email accounts

- ○ Yes
- ○ No

Do all of your email accounts get forwarded to one place?

- Yes
- No

Do you have a mobile device that you check email with?

- Yes
- No

Please describe any email practices that you do that you would consider unique.

Work conditions

The following questions ask about your various work conditions, please provide the answer that best describes your conditions (Progress 6/6).

How many projects are you involved in, where a project is a distinct set of activities and deadlines.

- None
- 1
- 1-5
- 5-10
- More than 10

Do any people report to you

- Yes
- No

Do you have any deadlines in the next month that you are working towards?

- Yes
- No

Block 6

Thank you for taking the survey, if you would like to participate in the next part of this study, please provide your email address below and visit http://emailstudy.cs.vt.edu. Note that the first 20 participants

will receive a $5.00 gift card to Starbucks and all participants will be entered in a raffle for a $50.00 Amazon gift card.

B.3 Uses and Gratification Survey

Default Question Block

Consent Information
This survey will ask you several questions about why you use email. This study has been approved by the Virginia Tech Institutional Review Board which protects human subjects in research. If you have questions about this research or its conduct, research subjects' rights, or who to contact in the event of a research-related injury to the subject., you may contact:

If you have any questions or comments about this study feel free to contact:
Ben Hanrahan at bhanraha@vt.edu.

David M. Moore
Chair, Virginia Tech Institutional Review Board for the Protection of Human Subjects
Office of Research Compliance
Phone: 540-231-4991
Email: moored@vt.edu

IRB Number: 12-664

--

By beginning the survey, you acknowledge that you have read this information and volunteer to participate in this research, with the knowledge that you are free to withdraw your participation at any time without penalty.

By beginning the survey you agree that you are 18 years of age or older.

Could you please provide your email address?

What year were you born in?

Please indicate your gender

- ○ Male
- ○ Female
- ○ Prefer not to report

What best describes your current work situation?

- ○ Student
- ○ Graduate Student
- ○ Professional
- ○ Faculty
- ○ Other

How many hours each weekday do you use email?

For the following questions please rate your level of agreement with each statement.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
I use email to cheer myself up.	○	○	○	○	○
I use email to feel entertained	○	○	○	○	○
I use email to keep up-to-date with work activities.	○	○	○	○	○
I use email to keep up-to-date with social activities.	○	○	○	○	○
I enjoy finding new emails that people have written me.	○	○	○	○	○
I use email to get support from others.	○	○	○	○	○
I use email to maintain relationships.	○	○	○	○	○
I use email to provide help to others.	○	○	○	○	○
I use email to relieve boredom.	○	○	○	○	○
I use email to relieve	○	○	○	○	○

stress.					
I feel less lonely when I use email.					
I use email to find a way to pass the time.					
When I use email I forget my problems.					
I use email to feel relaxed.					
I feel pressure to check email.					
Using email makes me appear more professional.					
Email use helps to develop my professional life.					
Being reactive to incoming messages is important for my job.					
I find myself using email at about the same time each day.					
Email is part of my usual routine.					
I would miss email if I could no longer access it.					
I have a hard time keeping my email use under control.					
I have to keep using email more and more to keep from being nervous					

being nervous.

I get tense, moody or irraable if I can't check my email when I want.	○	○	○	○	○
I have tried unsuccessfully to cut down on the amount of time I spend in email.	○	○	○	○	○
I sometime try to conceal how much time I spend on email from my family or friends.	○	○	○	○	○
I would go out of my way to satisfy my urge to check email.	○	○	○	○	○
I feel my email use is out of control.	○	○	○	○	○
My email use is effective.	○	○	○	○	○

Appendix C

Analysis Scripts

C.1 Utility.R

```
readData <- function(fileName) {
    data = read.table(fileName, header=T, sep=',')

    return(data)
}

cleanDiary <- function(data) {
    data$what_task_interrupted <- factor(data$what_task_interrupted)
    data$session_initiated <- factor(data$session_initiated)

    data$sender_activity <- data$num_emails_from_senders +
       data$num_emails_sent_senders

    # quantile(diary_logs$length_since_last_session)
    # 0%       25%       50%       75%      100%
    # 360.00   4635.00 17191.00 25832.75  65534.00
    data$inactive_length_quartile <-
        ifelse(data$length_since_last_session <= 4635, 1,
            ifelse(data$length_since_last_session <= 17191, 2,
                ifelse(data$length_since_last_session <= 25832.75, 3, 4)))
    data$inactive_length_quartile <- factor(data$inactive_length_quartile)

    # quantile(diary_logs$inbox_new_since_active)
    #  0%    25%   50%   75%  100%
    #  0.00  1.00  3.00  7.25 34.00
    data$inbox_new_since_active_quartile <-
        ifelse(data$inbox_new_since_active <= 1, 1,
            ifelse(data$inbox_new_since_active <= 3, 2,
                ifelse(data$inbox_new_since_active <= 7.25, 3, 4)))
```

```
    data$inbox_new_since_active_quartile <- factor(
        data$inbox_new_since_active_quartile)

    return(data)
}

get_formatted_coef <- function(r, p) {
    if (is.na(p)) {
        return("NA")
    }

    sig_string = ''
    if (p > 0.05) {
        sig_string = ''
    } else if (p > 0.01) {
        sig_string = '*'
    } else if (p > 0.001) {
        sig_string = '**'
    } else {
        sig_string = "***"
    }

    return(paste(sprintf("%.2f", r), sig_string, sep=""))
}
```

C.2 IMAP Logger

```
### ImapLoggerCorrelationsSessionFrequency.r
#### Create the table of correlations for session frequency and various
    measures
library(Hmisc)
source("analysis/utility.r")
data = readData("analysis/data/participant_summary.csv")

data_matrix <- data.matrix(data)
data_corrs <- rcorr(data_matrix, type="spearman")

cat('number_of_sessions',
    '&', 'total_duration',
    '&', 'new_messages_in_inbox',
    '&', 'read_messages',
    '&', 'total_messages',
    '&', 'deleted_messages',
    '&', 'moved_messages',
    '&', 'composed_messages',
    '&', 'replied_to',
    '\\\\\n', file="analysis/figures/6_participant_cor_matrix.txt", append=
        FALSE)
```

```
cat('number_of_sessions', '&',
    get_formatted_coef(r=data_corrs$r[12], p=data_corrs$P[12]), '&',
    get_formatted_coef(r=data_corrs$r[22], p=data_corrs$P[22]), '&',
    get_formatted_coef(r=data_corrs$r[32], p=data_corrs$P[32]), '&',
    get_formatted_coef(r=data_corrs$r[42], p=data_corrs$P[42]), '&',
    get_formatted_coef(r=data_corrs$r[52], p=data_corrs$P[52]), '&',
    get_formatted_coef(r=data_corrs$r[62], p=data_corrs$P[62]), '&',
    get_formatted_coef(r=data_corrs$r[72], p=data_corrs$P[72]), '&',
    get_formatted_coef(r=data_corrs$r[82], p=data_corrs$P[82]), '&',
    get_formatted_coef(r=data_corrs$r[92], p=data_corrs$P[92]), '&',
    '\\\\\n', file="analysis/figures/6_participant_cor_matrix.txt", append=
        TRUE)
cat('total_duration', '&',
    get_formatted_coef(r=data_corrs$r[13], p=data_corrs$P[13]), '&',
    get_formatted_coef(r=data_corrs$r[23], p=data_corrs$P[23]), '&',
    get_formatted_coef(r=data_corrs$r[33], p=data_corrs$P[33]), '&',
    get_formatted_coef(r=data_corrs$r[43], p=data_corrs$P[43]), '&',
    get_formatted_coef(r=data_corrs$r[53], p=data_corrs$P[53]), '&',
    get_formatted_coef(r=data_corrs$r[63], p=data_corrs$P[63]), '&',
    get_formatted_coef(r=data_corrs$r[73], p=data_corrs$P[73]), '&',
    get_formatted_coef(r=data_corrs$r[83], p=data_corrs$P[83]), '&',
    get_formatted_coef(r=data_corrs$r[93], p=data_corrs$P[93]), '&',
    '\\\\\n', file="analysis/figures/6_participant_cor_matrix.txt", append=
        TRUE)
cat('new_messages_in_inbox', '&',
    get_formatted_coef(r=data_corrs$r[14], p=data_corrs$P[14]), '&',
    get_formatted_coef(r=data_corrs$r[24], p=data_corrs$P[24]), '&',
    get_formatted_coef(r=data_corrs$r[34], p=data_corrs$P[34]), '&',
    get_formatted_coef(r=data_corrs$r[44], p=data_corrs$P[44]), '&',
    get_formatted_coef(r=data_corrs$r[54], p=data_corrs$P[54]), '&',
    get_formatted_coef(r=data_corrs$r[64], p=data_corrs$P[64]), '&',
    get_formatted_coef(r=data_corrs$r[74], p=data_corrs$P[74]), '&',
    get_formatted_coef(r=data_corrs$r[84], p=data_corrs$P[84]), '&',
    get_formatted_coef(r=data_corrs$r[94], p=data_corrs$P[94]), '&',
    '\\\\\n', file="analysis/figures/6_participant_cor_matrix.txt", append=
        TRUE)
cat('read_messages', '&',
    get_formatted_coef(r=data_corrs$r[15], p=data_corrs$P[15]), '&',
    get_formatted_coef(r=data_corrs$r[25], p=data_corrs$P[25]), '&',
    get_formatted_coef(r=data_corrs$r[35], p=data_corrs$P[35]), '&',
    get_formatted_coef(r=data_corrs$r[45], p=data_corrs$P[45]), '&',
    get_formatted_coef(r=data_corrs$r[55], p=data_corrs$P[55]), '&',
    get_formatted_coef(r=data_corrs$r[65], p=data_corrs$P[65]), '&',
    get_formatted_coef(r=data_corrs$r[75], p=data_corrs$P[75]), '&',
    get_formatted_coef(r=data_corrs$r[85], p=data_corrs$P[85]), '&',
    get_formatted_coef(r=data_corrs$r[95], p=data_corrs$P[95]), '&',
    '\\\\\n', file="analysis/figures/6_participant_cor_matrix.txt", append=
        TRUE)
cat('total_messages', '&',
    get_formatted_coef(r=data_corrs$r[16], p=data_corrs$P[16]), '&',
    get_formatted_coef(r=data_corrs$r[26], p=data_corrs$P[26]), '&',
```

```
67      get_formatted_coef(r=data_corrs$r[36], p=data_corrs$P[36]), '&',
68      get_formatted_coef(r=data_corrs$r[46], p=data_corrs$P[46]), '&',
69      get_formatted_coef(r=data_corrs$r[56], p=data_corrs$P[56]), '&',
70      get_formatted_coef(r=data_corrs$r[66], p=data_corrs$P[66]), '&',
71      get_formatted_coef(r=data_corrs$r[76], p=data_corrs$P[76]), '&',
72      get_formatted_coef(r=data_corrs$r[86], p=data_corrs$P[86]), '&',
73      get_formatted_coef(r=data_corrs$r[96], p=data_corrs$P[96]), '&',
74      '\\\\\n', file="analysis/figures/6_participant_cor_matrix.txt", append=
            TRUE)
75  cat('deleted_messages', '&',
76      get_formatted_coef(r=data_corrs$r[17], p=data_corrs$P[17]), '&',
77      get_formatted_coef(r=data_corrs$r[27], p=data_corrs$P[27]), '&',
78      get_formatted_coef(r=data_corrs$r[37], p=data_corrs$P[37]), '&',
79      get_formatted_coef(r=data_corrs$r[47], p=data_corrs$P[47]), '&',
80      get_formatted_coef(r=data_corrs$r[57], p=data_corrs$P[57]), '&',
81      get_formatted_coef(r=data_corrs$r[67], p=data_corrs$P[67]), '&',
82      get_formatted_coef(r=data_corrs$r[77], p=data_corrs$P[77]), '&',
83      get_formatted_coef(r=data_corrs$r[87], p=data_corrs$P[87]), '&',
84      get_formatted_coef(r=data_corrs$r[97], p=data_corrs$P[97]), '&',
85      '\\\\\n', file="analysis/figures/6_participant_cor_matrix.txt", append=
            TRUE)
86  cat('moved_messages', '&',
87      get_formatted_coef(r=data_corrs$r[18], p=data_corrs$P[18]), '&',
88      get_formatted_coef(r=data_corrs$r[28], p=data_corrs$P[28]), '&',
89      get_formatted_coef(r=data_corrs$r[38], p=data_corrs$P[38]), '&',
90      get_formatted_coef(r=data_corrs$r[48], p=data_corrs$P[48]), '&',
91      get_formatted_coef(r=data_corrs$r[58], p=data_corrs$P[58]), '&',
92      get_formatted_coef(r=data_corrs$r[68], p=data_corrs$P[68]), '&',
93      get_formatted_coef(r=data_corrs$r[78], p=data_corrs$P[78]), '&',
94      get_formatted_coef(r=data_corrs$r[88], p=data_corrs$P[88]), '&',
95      get_formatted_coef(r=data_corrs$r[98], p=data_corrs$P[98]), '&',
96      '\\\\\n', file="analysis/figures/6_participant_cor_matrix.txt", append=
            TRUE)
97  cat('composed_messages', '&',
98      get_formatted_coef(r=data_corrs$r[19], p=data_corrs$P[19]), '&',
99      get_formatted_coef(r=data_corrs$r[29], p=data_corrs$P[29]), '&',
100     get_formatted_coef(r=data_corrs$r[39], p=data_corrs$P[39]), '&',
101     get_formatted_coef(r=data_corrs$r[49], p=data_corrs$P[49]), '&',
102     get_formatted_coef(r=data_corrs$r[59], p=data_corrs$P[59]), '&',
103     get_formatted_coef(r=data_corrs$r[69], p=data_corrs$P[69]), '&',
104     get_formatted_coef(r=data_corrs$r[79], p=data_corrs$P[79]), '&',
105     get_formatted_coef(r=data_corrs$r[89], p=data_corrs$P[89]), '&',
106     get_formatted_coef(r=data_corrs$r[99], p=data_corrs$P[99]), '&',
107     '\\\\\n', file="analysis/figures/6_participant_cor_matrix.txt", append=
            TRUE)
108 cat('replied_to', '&',
109     get_formatted_coef(r=data_corrs$r[20], p=data_corrs$P[20]), '&',
110     get_formatted_coef(r=data_corrs$r[30], p=data_corrs$P[30]), '&',
111     get_formatted_coef(r=data_corrs$r[40], p=data_corrs$P[40]), '&',
112     get_formatted_coef(r=data_corrs$r[50], p=data_corrs$P[50]), '&',
113     get_formatted_coef(r=data_corrs$r[60], p=data_corrs$P[60]), '&',
```

```
    get_formatted_coef(r=data_corrs$r[70], p=data_corrs$P[70]), '&',
    get_formatted_coef(r=data_corrs$r[80], p=data_corrs$P[80]), '&',
    get_formatted_coef(r=data_corrs$r[90], p=data_corrs$P[90]), '&',
    get_formatted_coef(r=data_corrs$r[100], p=data_corrs$P[100]), '&',
    '\\\\\n', file="analysis/figures/6_participant_cor_matrix.txt", append=
        TRUE)
```

```
### ImapLoggerCorrelationsSessionLength.r
#### Create the table of correlations for session length and various measures

source("analysis/utility.r")
csv_data = readData("analysis/data/all_sessions.csv")

csv_data = subset(csv_data, session_duration > 180)
print(cor.test(~ total_num_emails + read_messages, data=csv_data, subset=
    participant==2)$p.value)
print(cor.test(~ total_num_emails + read_messages, data=csv_data, subset=
    participant==2)$estimate)
print(cor.test(~ total_num_emails + read_messages, data=csv_data, subset=
    participant==3)$p.value)
print(cor.test(~ total_num_emails + read_messages, data=csv_data, subset=
    participant==3)$estimate)
print(cor.test(~ total_num_emails + read_messages, data=csv_data, subset=
    participant==4)$p.value)
print(cor.test(~ total_num_emails + read_messages, data=csv_data, subset=
    participant==4)$estimate)
print(cor.test(~ total_num_emails + read_messages, data=csv_data, subset=
    participant==6)$p.value)
print(cor.test(~ total_num_emails + read_messages, data=csv_data, subset=
    participant==6)$estimate)
print(cor.test(~ total_num_emails + read_messages, data=csv_data, subset=
    participant==7)$p.value)
print(cor.test(~ total_num_emails + read_messages, data=csv_data, subset=
    participant==7)$estimate)
print(cor.test(~ total_num_emails + read_messages, data=csv_data, subset=
    participant==9)$p.value)
print(cor.test(~ total_num_emails + read_messages, data=csv_data, subset=
    participant==9)$estimate)
print(cor.test(~ total_num_emails + read_messages, data=csv_data, subset=
    participant==10)$p.value)
print(cor.test(~ total_num_emails + read_messages, data=csv_data, subset=
    participant==10)$estimate)
print(cor.test(~ total_num_emails + read_messages, data=csv_data, subset=
    participant==11)$p.value)
print(cor.test(~ total_num_emails + read_messages, data=csv_data, subset=
    participant==11)$estimate)
print(cor.test(~ total_num_emails + read_messages, data=csv_data, subset=
    participant==12)$p.value)
print(cor.test(~ total_num_emails + read_messages, data=csv_data, subset=
    participant==12)$estimate)
print(cor.test(~ total_num_emails + read_messages, data=csv_data, subset=
```

```
    participant==13)$p.value)
print(cor.test(~ total_num_emails + read_messages, data=csv_data, subset=
    participant==13)$estimate)
print(cor.test(~ total_num_emails + read_messages, data=csv_data, subset=
    participant==14)$p.value)
print(cor.test(~ total_num_emails + read_messages, data=csv_data, subset=
    participant==14)$estimate)
print(cor.test(~ total_num_emails + read_messages, data=csv_data, subset=
    participant==15)$p.value)
print(cor.test(~ total_num_emails + read_messages, data=csv_data, subset=
    participant==15)$estimate)
print(cor.test(~ total_num_emails + read_messages, data=csv_data, subset=
    participant==16)$p.value)
print(cor.test(~ total_num_emails + read_messages, data=csv_data, subset=
    participant==16)$estimate)
print(cor.test(~ total_num_emails + read_messages, data=csv_data, subset=
    participant==17)$p.value)
print(cor.test(~ total_num_emails + read_messages, data=csv_data, subset=
    participant==17)$estimate)
print(cor.test(~ total_num_emails + read_messages, data=csv_data, subset=
    participant==19)$p.value)
print(cor.test(~ total_num_emails + read_messages, data=csv_data, subset=
    participant==19)$estimate)
print(cor.test(~ total_num_emails + read_messages, data=csv_data, subset=
    participant==20)$p.value)
print(cor.test(~ total_num_emails + read_messages, data=csv_data, subset=
    participant==20)$estimate)
print(cor.test(~ total_num_emails + read_messages, data=csv_data, subset=
    participant==21)$p.value)
print(cor.test(~ total_num_emails + read_messages, data=csv_data, subset=
    participant==21)$estimate)
print(cor.test(~ total_num_emails + read_messages, data=csv_data, subset=
    participant==23)$p.value)
print(cor.test(~ total_num_emails + read_messages, data=csv_data, subset=
    participant==23)$estimate)
print(cor.test(~ total_num_emails + read_messages, data=csv_data, subset=
    participant==26)$p.value)
print(cor.test(~ total_num_emails + read_messages, data=csv_data, subset=
    participant==26)$estimate)
print(cor.test(~ total_num_emails + read_messages, data=csv_data, subset=
    participant==27)$p.value)
print(cor.test(~ total_num_emails + read_messages, data=csv_data, subset=
    participant==27)$estimate)
```

```
### ImapLoggerRegression.r
#### generate the binary logistic regression model for getting lost

library(aod)
source("analysis/utility.r")
data = readData("analysis/data/diary_logs.csv")
data <- cleanDiary(data)
```

```
8
9  generateBinaryModel <- function(data) {
10     # generate model
11     model = glm( got_lost ~
12     # conditions for starting the session
13         was_task_interrupted +
14         #inactive_length_quartile +
15         # length_since_last_session +
16         # what_task_interrupted +
17         # session_initiated +
18
19     # email session details
20         session_length +
21         num_emails_replied +
22         num_email_written +
23         read_count +
24         moved_count +
25         # deleted_count +
26
27     # email corpus condition
28         # tag_count +
29         # inbox_num_emails +
30         # inbox_num_unread +
31         # inbox_new_since_active_quartile +
32         inbox_new_since_active +
33         total_num_emails +
34         total_num_unread +
35         # new_emails_since_last_session +
36
37         num_emails_to_field +
38         num_emails_only_to_you
39         ,
40         data = data,
41         family = "binomial"
42         )
43
44     return(model)
45 }
46
47 got_lost_model <- generateBinaryModel(data)
48 summary(got_lost_model)
49 exp(got_lost_model$coefficients)
50
51 wald.test(b=coef(got_lost_model), Sigma = vcov(got_lost_model), Terms = 4)
52
53 with(got_lost_model, null.deviance - deviance)
54
55 with(got_lost_model, df.null - df.residual)
56
57 with(got_lost_model, pchisq(null.deviance - deviance, df.null - df.residual,
       lower.tail = FALSE))
```

```

logLik(got_lost_model)
```

```
### ImapLoggerSessionBreakdown.r
#### Generate the plots for session types where participants got lost vs. not lost

source("analysis/utility.r")
data = readData("analysis/data/diary_logs.csv")

session_lost <- table(data$got_lost, data$session_initiated)

#order(session_lost)
#barplot(as.matrix(session_lost), beside=TRUE, col=c("white", "darkgrey"), las=2)
#legend("topleft", c("Not Lost", "Got Lost"), fill=c("white", "darkgrey"))

pdf("analysis/figures/6_session_lost.pdf")
reason <- c('None', 'Anxiety', 'Boredom', 'Compose a message', 'Coordination', 'Curiosity', 'Down Time', 'Expecting Communication', 'Notification', 'Refinding', 'Routine', 'Task Switch')
not_lost <- c(session_lost[1,1], session_lost[1,2], session_lost[1,3], session_lost[1,4], session_lost[1,5], session_lost[1,6], session_lost[1,7], session_lost[1,8], session_lost[1,9], session_lost[1,10], session_lost[1,11], session_lost[1,12])
got_lost <- c(session_lost[2,1], session_lost[2,2], session_lost[2,3], session_lost[2,4], session_lost[2,5], session_lost[2,6], session_lost[2,7], session_lost[2,8], session_lost[2,9], session_lost[2,10], session_lost[2,11], session_lost[2,12])
got_lost.data <- data.frame(reason, not_lost, got_lost)
got_lost.sorted <- got_lost.data[order(got_lost.data$got_lost),]

barplot(got_lost.sorted, beside=TRUE, col=c("white", "darkgrey"), las=2)
legend("topleft", c("Not Lost", "Got Lost"), fill=c("white", "darkgrey"))
dev.off()
```

```
### ImapLoggerSessionLength.r
#### Generate the plots for session length where participants got lost vs. not lost

source("analysis/utility.r")
data = readData("analysis/data/diary_logs.csv")

# need to clean up the table, hard coding is easiest
table(data$got_lost, data$session_length)
# num columns = 180, 360, 540, >720
length_lost <- matrix(c(11+79, 1+4+36, 7, 1+8+4+1+1+1+1+1,
                        2+23,  5+5,    0, 2+1+2+2+1+1+1),
                        ncol=4, byrow=TRUE)
colnames(length_lost) <- c("180", "360", "540", ">=720")
```

```
rownames(length_lost) <- c("Not Lost", "Got Lost")
length_lost <- as.table(length_lost)

pdf("analysis/figures/6_length_lost.pdf")
barplot(as.matrix(length_lost), beside=TRUE,
        col=c("white", "darkgrey"),
        xlab = "Session Length (seconds)",
        ylab = "Number of Sessions")
legend("topright", c("Not Lost", "Got Lost"), fill=c("white", "darkgrey"))
dev.off()
```

C.3 Attentional Network Test

```
### GenerateANTGraphs.r ###
#### Generate plots/graphs for the ANT score correlations

library(car)

source("analysis/utility.r")
data = readData("analysis/data/participant_summary_ant.csv")

pdf('analysis/figures/4_alert__num_sessions.pdf')
scatterplot(data$Alert,
            data$number_of_sessions,
            smoother = FALSE,
            boxplots = "",
            xlab = "Alerting Network Score",
            ylab = "Total Number of Sessions")
dev.off()

pdf('analysis/figures/4_orient__num_sessions.pdf')
scatterplot(data$Orienting,
            data$number_of_sessions,
            smoother=FALSE,
            boxplots = "",
            xlab = "Orienting Network Score",
            ylab = "Total Number of Sessions")
dev.off()

pdf('analysis/figures/4_conflict__num_sessions.pdf')
scatterplot(data$Conflict,
            data$number_of_sessions,
            smoother=FALSE,
            boxplots = "",
            xlab = "Conflict Network Score",
            ylab = "Total Number of Sessions")
dev.off()

```

```
pdf('analysis/figures/4_alert__duration.pdf')
scatterplot(data$Alert,
            data$total_duration,
            smoother=FALSE,
            boxplots = "",
            xlab = "Alerting Network Score",
            ylab = "Total Duration of Email Use")
dev.off()

pdf('analysis/figures/4_orient__duration.pdf')
scatterplot(data$Orienting,
            data$total_duration,
            smoother=FALSE,
            boxplots = "",
            xlab = "Orienting Network Score",
            ylab = "Total Duration of Email Use")
dev.off()

pdf('analysis/figures/4_conflict__duration.pdf')
scatterplot(data$Conflict,
            data$total_duration,
            smoother=FALSE,
            boxplots = "",
            xlab = "Conflict Network Score",
            ylab = "Total Duration of Email Use")
dev.off()
```

C.4 Uses and Gratification Theory

```
### UgtMean.r
#### Calculate the means of the gratifications sought

source("analysis/utility.r")
data = readData("analysis/data/Uses_and_Gratifications_of_Email_clean.csv")

means <- c(mean(data$CheerUp),
           mean(data$Entertained),
           mean(data$UpToDateWork),
           mean(data$UpToDateSocial),
           mean(data$EnjoyFindingNew),
           mean(data$GetSupport),
           mean(data$MaintainRelationships),
           mean(data$ProvideHelp),
           mean(data$RelieveBoredom, na.rm=TRUE),
           mean(data$RelieveStress),
           mean(data$LessLonely),
           mean(data$PassTime),
           mean(data$ForgetProblems),
```

```
            mean(data$FeelRelaxed),
            mean(data$PressureToCheck),
            mean(data$AppearProfessional),
            mean(data$DevelopProfessional),
            mean(data$ImportantToJob),
            mean(data$UseSameTimeDay),
            mean(data$PartOfRoutine),
            mean(data$WouldMissEmail),
            mean(data$HardTimeControl),
            mean(data$KeepFromNervous),
            mean(data$Irratable),
            mean(data$UnsuccessfullyCutDown),
            mean(data$ConcealEmailUse),
            mean(data$OutOfWayToSatisfyUrge),
            mean(data$EmailOutOfControl),
            mean(data$EmailUseEffective))
labels <- c('Cheer Up', 'Entertained', 'Up to Date Work',
            'Up to Date Social', 'Enjoy Finding New', 'Get Support',
            'Maintain Relationships', 'Provide Help', 'Relieve Boredom',
            'Relieve Stress', 'Less Lonely', 'Pass Time',
            'Forget Problems', 'Feel Relaxed', 'Pressure to Check',
            'Appear Professional', 'Develop Professional', 'Important to Job',
            'Use Same time each Day', 'Part of Routine', 'Would Miss Email',
            'Hard Time to Control', 'Keep from Nervous', 'Irratable',
            'Unsuccesfully Cut Down', 'Conceal Email Use', 'Out of Way to
               Satisfy Urge',
            'Email out of Control', 'Email use Effective'
            )

for (i in 1:29) {
    print(labels[i])
    print(means[i])
}
```

```
### UgtCorrelation.r
#### Correlate the gratifications sought with the reported use

source("analysis/utility.r")
data = readData("analysis/data/Uses_and_Gratifications_of_Email_clean.csv")

data$Activity <- data$CheerUp +
    data$Entertained +
    data$UpToDateWork +
    data$UpToDateSocial +
    data$EnjoyFindingNew
data$Social <- data$GetSupport +
    data$MaintainRelationships +
    data$ProvideHelp
data$SelfReactive <- data$RelieveBoredom +
    data$RelieveStress +
    data$LessLonely +
```

```
    data$PassTime +
    data$ForgetProblems +
    data$FeelRelaxed
data$StatusSeeking <- data$PressureToCheck +
    data$AppearProfessional +
    data$DevelopProfessional +
    data$ImportantToJob
data$HabitStrength <- data$UseSameTimeDay +
    data$PartOfRoutine +
    data$WouldMissEmail
data$DeficientSelfRegulation <- data$HardTimeControl +
    data$KeepFromNervous +
    data$Irratable +
    data$UnsuccessfullyCutDown +
    data$ConcealEmailUse +
    data$OutOfWayToSatisfyUrge +
    data$EmailOutOfControl

cor.test(data$Activity, data$HoursDayEmail)

cor.test(data$Social, data$HoursDayEmail)

cor.test(data$SelfReactive, data$HoursDayEmail)

cor.test(data$StatusSeeking, data$HoursDayEmail)

cor.test(data$HabitStrength, data$HoursDayEmail)

cor.test(data$DeficientSelfRegulation, data$HoursDayEmail)

cor.test(data$EmailUseEffective, data$HoursDayEmail)

data$WorkRelated <- data$UpToDateWork +
    data$MaintainRelationships +
    data$GetSupport +
    data$ProvideHelp +
    data$PressureToCheck +
    data$AppearProfessional +
    data$DevelopProfessional +
    data$ImportantToJob
cor.test(data$WorkRelated, data$HoursDayEmail)
```

```
### UgtCompareReportedvsActual.r
#### Compare the gratifications sought with the amount of actual email usage,
    as opposed to the reported

source("analysis/utility.r")
data = readData("analysis/data/Uses_and_Gratifications_just_prev_participants.
    csv")

data$Activity <- data$CheerUp +
```

```
    data$Entertained +
    data$UpToDateWork +
    data$UpToDateSocial +
    data$EnjoyFindingNew
data$Social <- data$GetSupport +
    data$MaintainRelationships +
    data$ProvideHelp
data$SelfReactive <- data$RelieveBoredom +
    data$RelieveStress +
    data$LessLonely +
    data$PassTime +
    data$ForgetProblems +
    data$FeelRelaxed
data$StatusSeeking <- data$PressureToCheck +
    data$AppearProfessional +
    data$DevelopProfessional +
    data$ImportantToJob
data$HabitStrength <- data$UseSameTimeDay +
    data$PartOfRoutine +
    data$WouldMissEmail
data$DeficientSelfRegulation <- data$HardTimeControl +
    data$KeepFromNervous +
    data$Irratable +
    data$UnsuccessfullyCutDown +
    data$ConcealEmailUse +
    data$OutOfWayToSatisfyUrge +
    data$EmailOutOfControl

cor.test(data$Activity, data$ActualEmailUsage)
cor.test(data$Social, data$ActualEmailUsage)
cor.test(data$SelfReactive, data$ActualEmailUsage)
cor.test(data$StatusSeeking, data$ActualEmailUsage)
cor.test(data$HabitStrength, data$ActualEmailUsage)
cor.test(data$DeficientSelfRegulation, data$ActualEmailUsage)
```

C.5 Lab Study

```
### LabStudyOverallRelevance.r
#### Calculate correlates for overall email relevance and various measures
responseRatings <- read.table("analysis/data/hip_data.txt", sep="\t", header=
    TRUE)

pdf('analysis/figures/5_SenderContact_Relevance.pdf')
scatter.smooth(responseRatings$SenderContact,
               responseRatings$Rating,
               ylab="Overall Email Relevance",
               xlab="Sender Contact")
dev.off()
```

```
11
12 cor.test(responseRatings$SenderRel,
13           responseRatings$Rating,
14           method="spearman",
15           exact = FALSE)
16
17 cor.test(responseRatings$TopicRel,
18           responseRatings$Rating,
19           method="spearman",
20           exact = FALSE)
21
22 cor.test(responseRatings$SenderContact,
23           responseRatings$Rating,
24           method="spearman",
25           exact = FALSE)
26
27 cor.test(responseRatings$SenderRel + responseRatings$TopicRel,
28           responseRatings$Rating,
29           method="spearman",
30           exact = FALSE)
```

```
1 ### LabStudyPlotsCorrelations.r
2 #### Generate the plots for correlations with response time
3
4 responseRatings <- read.table("analysis/data/hip_data.txt", sep="\t", header=
     TRUE)
5 attach(responseRatings)
6 names(responseRatings)
7 summary(responseRatings)
8
9 pdf('analysis/figures/5_SenderRel_ResponseTime.pdf')
10 scatter.smooth(responseRatings$SenderRel,
11                responseRatings$ResponseTime,
12                xlab = "Sender Relationship (1=Unimportant, 5=Very Important)",
13                ylab = "Response Time (seconds)")
14 dev.off()
15
16 pdf('analysis/figures/5_SenderContact_ResponseTime.pdf')
17 scatter.smooth(responseRatings$SenderContact,
18                responseRatings$ResponseTime,
19                xlab = "Sender Contact (1=Never, 5=At least once a day)",
20                ylab = "Response Time (seconds)")
21 dev.off()
22
23 pdf('analysis/figures/5_TopicRel_ResponseTime.pdf')
24 scatter.smooth(responseRatings$TopicRel,
25                responseRatings$ResponseTime,
26                xlab = "Topic Relevance (1=Unimportant, 5=Very Important)",
27                ylab = "Response Time (seconds)")
28 dev.off()
29
```

```
30 pdf('analysis/figures/5_OverallRel_ResponseTime.pdf')
31 scatter.smooth(responseRatings$Rating,
32                responseRatings$ResponseTime,
33                xlab = "Overall Relevance (1=Unimportant, 5=Very Important)",
34                ylab = "Response Time (seconds)")
35 dev.off()
```

Appendix D

Selected Source Code

These are the source files that are responsible for the bulk of the work during my study. I have not included unit tests, files that contain mostly boilerplate code, or any of the html/css.

```
### commands.py ###

#### This file is used to run the imap logger and ensure that it does not run
####  more than one logger for a user at a time.

import gc
import datetime

from django.core.cache import cache
from django.utils.hashcompat import md5_constructor as md5
from django.conf import settings

from huey.djhuey.decorators import queue_command, periodic_command, crontab

from boomerang.accounts.models import UserProfile
from boomerang.accounts.imaplogger import ImapLogger

LOCK_EXPIRE = 60 * 120  # Lock expires in 2 hours


@queue_command
def UpdateLogCommand(profile):
    print "starting update"
    try:
        hueylog = open(str(settings.HUEY_LOGFILE), "a")
        hueylog.write("Starting log for: %s\n" % profile.user.username)
        # get the lock name for this user
        user_hexdigest = md5(profile.user.username).hexdigest()
        lock_id = "%s-lock-%s" % ('UpdateLogCommand', user_hexdigest)
        hueylog.write("lock for user: %s is %s\n" % (profile.user.username,
            lock_id))
```

```
31
32          # cache.add fails if the key already exists
33          acquire_lock = lambda: cache.add(lock_id, "true", LOCK_EXPIRE)
34          release_lock = lambda: cache.delete(lock_id)
35
36          hueylog.write("Acquiring lock for user: %s\n" % profile.user.id)
37          if acquire_lock():
38              try:
39                  imap_logger = ImapLogger(profile.user, str(profile.user.email)
                        , str(profile.gmail_access_token), str(profile.
                        gmail_access_token_secret))
40                  imap_logger.refresh_logs()
41                  imap_logger.cleanup()
42                  hueylog.write("Finished log for: %s\n" % profile.user.username
                        )
43              finally:
44                  release_lock()
45          else:
46              hueylog.write("Log for %s was already being done by another worker
                    .\n" % profile.user.id)
47
48      except Exception, e:
49          hueylog.write('Exception: %s\n' % (e))
50      finally:
51          gc.collect()
52
53      return
54
55
56  @periodic_command(crontab(minute='*/3'))
57  def FireUpdateCommands():
58      hueylog = open(str(settings.HUEY_LOGFILE), "a")
59      hueylog.write("Starting to kick off all logs.\n")
60      profiles = UserProfile.objects.all()
61      for profile in profiles:
62          if (profile.user.is_active):
63              hueylog.write(profile.user.username + '\n')
64              UpdateLogCommand(profile)
65      hueylog.write("Finished kicking off all logs.\n")
66
67      return
```

```
1  ### accounts/models.py ###
2
3  #### This is where the models for accounts are setup, this handles any
       automatic
4  ####  actions, e.g. anonymizing the email senders
5
6  from django.db import models
7  from django.contrib.auth.models import User
8  from timezones.forms import zones
```

```
from django.db.models.signals import (
    pre_save,
    post_save,
)
import hashlib


class UserProfile(models.Model):
    user = models.ForeignKey(User, unique=True, related_name='profile')
    gmail_request_token = models.CharField(blank=True, max_length=255)
    gmail_request_token_secret = models.CharField(blank=True, max_length=255)
    gmail_access_token = models.CharField(blank=True, max_length=255)
    gmail_access_token_secret = models.CharField(blank=True, max_length=255)
    phone_number = models.CharField(max_length=12, blank=True, null=True)
    timezone = models.CharField(max_length=255, choices=zones.
        PRETTY_TIMEZONE_CHOICES, blank=True, null=True)

    def __unicode__(self):
        return self.user.username


class Corpus(models.Model):
    user = models.OneToOneField(User, related_name='corpus')
    is_active = models.BooleanField(default=False)
    last_transition_date = models.DateTimeField(auto_now_add=True, blank=True,
        null=True)
    new_message_since_active_count = models.IntegerField(default=0)
    inbox_new_message_since_active_count = models.IntegerField(default=0)


def create_corpus(sender, instance, created, **kwargs):
    if created and len(Corpus.objects.filter(user=instance)) == 0:
        Corpus.objects.create(user=instance)


post_save.connect(create_corpus, sender=User)


class Tag(models.Model):
    corpus = models.ForeignKey(Corpus)
    name = models.CharField(max_length=100, blank=True)


class EmailAddress(models.Model):
    user = models.ForeignKey(User)
    email_address = models.CharField(max_length=255, blank=True, db_index=True
        )

    def anon_email_address(self):
        m = hashlib.md5()
        m.update(self.email_address)
```

```
57          return m.hexdigest()
58
59
60  def anon_email(sender, instance, **kwargs):
61      if instance.pk is None:
62          instance.email_address = instance.anon_email_address()
63
64
65  pre_save.connect(anon_email, sender=EmailAddress)
66
67
68  class EmailMessage(models.Model):
69      tags = models.ManyToManyField(Tag)
70      senders = models.ManyToManyField(EmailAddress, related_name='sent')
71      receivers = models.ManyToManyField(EmailAddress, related_name='received')
72      copied = models.ManyToManyField(EmailAddress, related_name='copied')
73      user = models.ForeignKey(User)
74
75      num_messages_from_sender = models.IntegerField(default=0)
76      num_messages_to_sender = models.IntegerField(default=0)
77      num_receivers = models.IntegerField(default=0)
78      num_cced = models.IntegerField(default=0)
79      in_to_field = models.BooleanField(default=True)
80      sent_to_just_you = models.BooleanField(default=True)
81
82      uid = models.CharField(max_length=255, blank=True, db_index=True)
83      message_id = models.CharField(max_length=255, null=True, blank=True,
            db_index=True)
84      thread_id = models.CharField(max_length=255, blank=True, null=True)
85      in_reply_to = models.CharField(max_length=255, blank=True, null=True)
86
87      seen = models.BooleanField(default=False)
88      received = models.TextField(blank=True)
89      deleted = models.BooleanField(default=False)
90      from_whom = models.TextField(blank=True)
91      to = models.TextField(blank=True, null=True)
92      cc = models.TextField(blank=True, null=True)
93      date = models.CharField(max_length=255, blank=True, null=True)
94      has_attachment = models.BooleanField(default=False)
95
96      subject = models.TextField(blank=True, null=True)
97      thread_topic = models.CharField(max_length=255, blank=True, null=True)
98
99      def __unicode__(self):
100         return str(self.message_id)
```

```
1  ### accounts/views.py ###
2
3  #### This is where the views for accounts are setup, this handles any setup
       that
4  ####  is needed to render the web pages e.g. handling the oauth handshake or
```

```
5 ####  saving/retrieving things from the database.
6
7
8 from django.conf import settings
9 from django.http import HttpResponse
10 from django.http import HttpResponseRedirect
11 from django.contrib.auth.decorators import login_required
12 from django.contrib.auth import authenticate
13 from django.contrib.auth import login
14 from django.template import RequestContext
15 from django.shortcuts import render_to_response
16 from django.contrib.auth.models import User
17
18 import json
19 import xoauth
20
21 from accounts.forms import UserCreateForm
22 from accounts.imaplogger import ImapLogger
23
24
25 @login_required
26 def manage(request):
27     form = UserCreateForm()
28     choices = form.fields['timezone'].widget.choices
29     choices.sort()
30
31     return render_to_response('accounts/manage.html', {'choices': choices},
32                               context_instance=RequestContext(request))
33
34
35 def full(request):
36     return render_to_response('accounts/full.html',
37                               context_instance=RequestContext(request))
38
39
40 def google(request):
41     return render_to_response('google5246a23a6779fc9a.html',
42                               context_instance=RequestContext(request))
43
44
45 def register(request):
46     """ Register new users, this is what is called from the login page.
47         If POST then it creates, if not it renders the form.
48     """
49
50     # TODO: put in a check for whether or not there are 40 users
51
52     if request.method == 'GET':
53         if User.objects.all().count() >= 40:
54             return render_to_response('accounts/full.html',
```

```
55                                          context_instance=RequestContext(request)
                                                )
56
57      form = UserCreateForm()
58
59      if request.method == 'POST':
60          form = UserCreateForm(request.POST)
61          if form.is_valid():
62              form.save()
63              username = form.cleaned_data['username']
64              password = form.cleaned_data['password1']
65
66              # check if the user can authenticate
67              user = authenticate(username=username, password=password)
68
69              if (user is not None) and (user.is_active):
70                  # log them in
71                  login(request, user)
72
73                  return HttpResponseRedirect('/')
74
75      choices = form.fields['timezone'].widget.choices
76      choices.sort()
77
78      return render_to_response('accounts/register.html', {'form': form, '
            choices': choices},
79                                context_instance=RequestContext(request))
80
81
82  @login_required
83  def test_oauth(request):
84      current_user = request.user
85      current_user_profile = current_user.get_profile()
86      result = ImapLogger.test_imap_conn(current_user_profile)
87
88      return HttpResponse(json.dumps(result), 'application/json')
89
90
91  @login_required
92  def account(request):
93      if request.method == 'GET':
94          auth_url = None
95          current_user = request.user
96          current_user_profile = current_user.get_profile()
97
98          if current_user.email != '' and current_user.email is not None:
99              consumer = xoauth.OAuthEntity(settings.GOOGLE_CONSUMER_KEY,
                    settings.GOOGLE_CONSUMER_SECRET)
100             google_accounts_url_generator = xoauth.GoogleAccountsUrlGenerator(
                    current_user.email)
101
```

```
102             request_token = xoauth.GenerateRequestToken(consumer, 'https://
                    mail.google.com/', None, None, google_accounts_url_generator)
103             current_user_profile.gmail_request_token = request_token.key
104             current_user_profile.gmail_request_token_secret = request_token.
                    secret
105             current_user_profile.save()
106
107             auth_url = xoauth.GenerateAuthorizationUrl(
                    google_accounts_url_generator, request_token.key)
108
109         form = UserCreateForm()
110         timezone_choices = form.fields['timezone'].widget.choices
111         timezone_choices.sort()
112
113         account = {'gmail_address': current_user.email,
114                    'gmail_oauth_url': auth_url,
115                    'phone_number': current_user_profile.phone_number,
116                    'gmail_access_token': current_user_profile.
                           gmail_access_token,
117                    'time_zone': current_user_profile.timezone,
118                    'time_zone_choices': timezone_choices,
119                    }
120
121         return HttpResponse(json.dumps(account), 'application/json')
122     elif request.method == 'POST':
123         # initialize variables
124         data = request.POST
125         response_data = {}
126         response_data['token_error'] = False
127         response_data['phone_error'] = False
128         current_user = request.user
129         current_user_profile = current_user.get_profile()
130         # set the variables that have been passed
131         if data.__contains__('gmail_address'):
132             current_user.email = data['gmail_address']
133             current_user.save()
134         if data.__contains__('gmail_verification_token'):
135             try:
136                 consumer = xoauth.OAuthEntity(settings.GOOGLE_CONSUMER_KEY,
                        settings.GOOGLE_CONSUMER_SECRET)
137                 google_accounts_url_generator = xoauth.
                        GoogleAccountsUrlGenerator(current_user.email)
138                 oauth_verifier = data.get('gmail_verification_token')
139                 request_token = xoauth.OAuthEntity(current_user_profile.
                        gmail_request_token, current_user_profile.
                        gmail_request_token_secret)
140                 access_token = xoauth.GetAccessToken(consumer, request_token,
                        oauth_verifier,
141                                                      google_accounts_url_generator
                                                         )
142                 current_user_profile.gmail_access_token = access_token.key
```

```
143                 current_user_profile.gmail_access_token_secret = access_token.
                        secret
144             except Exception:
145                 response_data['token_error'] = True
146         if data.__contains__('phone_number'):
147             try:
148                 current_user_profile.phone_number = data['phone_number']
149             except Exception:
150                 response_data['phone_error'] = True
151         if data.__contains__('time_zone'):
152             current_user_profile.timezone = data['time_zone']
153         else:
154             current_user_profile.timezone = 'US/Eastern'
155         current_user_profile.save()
156         return HttpResponse(json.dumps(response_data), 'application/json',
                status=200)
```

```
1  ### diaries/models.py ###
2
3  #### This is where the models for diaries are setup, this handles any
       automatic
4  ####  actions, e.g. determining whether or not to send a diary after a session
5
6  from django.db import models
7  from django.contrib import admin
8  from django.contrib.auth.models import User
9  from django.db.models.signals import post_save
10 from django.conf import settings
11
12 import datetime
13 import pytz
14 from pytz import timezone
15 from googlevoice import Voice
16 import hashlib
17
18
19 class DiaryDetails(models.Model):
20     user = models.ForeignKey(User, related_name='diary_details')
21
22     # keep track of the types of entries
23     short_entries = models.IntegerField(default=0)
24     medium_entries = models.IntegerField(default=0)
25     long_entries = models.IntegerField(default=0)
26
27     def time_since_last_entry(self):
28         entries = self.user.entries.filter(create_date__gte=datetime.date.
               today()).order_by('-create_date')
29         if entries:
30             return datetime.datetime.now() - entries[0].create_date
31         else:
32             return datetime.timedelta(hours=100)
```

```
33
34      def number_of_entries_today(self):
35          entries = self.user.entries.filter(create_date__gte=datetime.date.
                today())
36          return entries.count()
37
38      def get_localized_now(self):
39          utc_dt = pytz.utc.localize(datetime.datetime.utcnow())
40          localized_now = None
41
42          try:
43              local_tz = timezone(self.user.profile.all()[0].timezone)
44              localized_now = utc_dt.astimezone(local_tz)
45          except Exception:
46              localized_now = utc_dt
47
48          return localized_now
49
50      def should_assign_diary(self, session_length):
51          # first check if they have done many entries
52          if self.time_since_last_entry() > datetime.timedelta(hours=4):
53              if self.number_of_entries_today() < 2:
54                  # check if this session is long enough
55                  if session_length > datetime.timedelta(minutes=8).seconds:
56                      # check if the user is within working hours and a weekday
57                      self.localized_now = self.get_localized_now()
58
59                      if self.localized_now.isoweekday() in range(1, 6):
60                          if self.localized_now.hour in range(6, 22):
61                              return True
62
63          return False
64
65
66  def create_diary_details(sender, instance, created, **kwargs):
67      if created:
68          if DiaryDetails.objects.filter(user=instance).count() < 1:
69              DiaryDetails.objects.create(user=instance)
70
71  post_save.connect(create_diary_details, sender=User)
72
73
74  def diary_hash():
75      m = hashlib.md5()
76      m.update(str(datetime.datetime.now()))
77      return m.hexdigest()[:8]
78
79
80  class DiaryEntry(models.Model):
81      user = models.ForeignKey(User, related_name='entries')
82
```

```
    # unique hash for the entry
    access_hash = models.CharField(max_length=8, blank=True, unique=True,
        default=diary_hash)

    # dates for entry
    create_date = models.DateTimeField(auto_now_add=True)
    completed_date = models.DateTimeField(null=True)

    # question results...if I ever reuse this make it so I can add questions
        via the database and use a fk relationship
    why_initiated_email = models.TextField(blank=True, null=True)
    task_interrupted = models.TextField(blank=True, null=True)
    email_session = models.TextField(blank=True, null=True)
    did_distract = models.BooleanField(default=False)


def send_notification(sender, instance, created, **kwargs):
    try:
        if created:
            voice = Voice()
            voice.login(email=settings.VOICE_EMAIL, passwd=settings.
                VOICE_PASSWORD)
            if (instance.user.profile.all()[0].phone_number):
                voice.send_sms(instance.user.profile.all()[0].phone_number,
                               'You had an email session in the last 5-8
                                   minutes, please complete the diary for it
                                   at: http://emailstudy.cs.vt.edu/diary/entry
                                   /%s' %
                               instance.access_hash)
    except Exception, e:
        print "error: %s" % e
        return

post_save.connect(send_notification, sender=DiaryEntry)
```

```
### imaplogger.py ###

#### This is where the majority of the work is, this file is responsible for
####  grabbing data from the imap server, parsing it, storing it, and making
####  sense of it.  It constructs two logs the activity and feature logs.
####  These logs were later used in my analysis.

from email.parser import HeaderParser
import imaplib
import re
import xoauth
from collections import defaultdict
import datetime
import pytz
from pytz import timezone
import hashlib
```

```
17 import traceback
18
19 from django.conf import settings
20 from django import db
21
22 from accounts.models import (
23     EmailMessage,
24     EmailAddress,
25 )
26 from diary.models import (
27     DiaryDetails,
28     DiaryEntry,
29 )
30
31
32 class ImapLogger:
33     def __init__(self, user, user_name, access_token, access_token_secret):
34         # this is here to clear the query cache that is usually cleared when a
                new request is done on the web...but not done if all you are
               doing is background jobs
35         db.reset_queries()
36
37         # assign variables
38         self.user = user
39         self.user_name = user_name
40         self.access_token = access_token
41         self.access_token_secret = access_token_secret
42         self.email_pattern = re.compile('([\w\-\.]+@(\w[\w\-]+\.)+[\w\-]+)',
               re.UNICODE)
43         utc_dt = pytz.utc.localize(datetime.datetime.utcnow())
44         self.localized_now = None
45         try:
46             self.local_tz = timezone(self.user.profile.all()[0].timezone)
47             self.localized_now = utc_dt.astimezone(self.local_tz)
48         except Exception:
49             self.localized_now = utc_dt
50
51         self._init_logs()
52
53         self._init_imap_conn()
54
55     ############ LOG HELPERS ###############
56     def _init_logs(self):
57         log_name = settings.EMAIL_LOG_LOCATION + str(self.user.id) + '.' + str
               (self.localized_now.year) + '.' + str(self.localized_now.month) +
               '.' + str(self.localized_now.day) + '.log'
58         self.activitylog = open(log_name, "a")
59
60         log_name = settings.EMAIL_LOG_LOCATION + str(self.user.id) + '.' + str
               (self.localized_now.year) + '.' + str(self.localized_now.month) +
               '.' + str(self.localized_now.day) + '.feature.log'
```

```
61          self.featurelog = open(log_name, "a")
62
63          log_name = settings.EMAIL_LOG_LOCATION + "error.log"
64          self.errorlog = open(log_name, "a")
65
66      def _write_to_log(self, log, message):
67          """
68          This function is just to make unit testing easier
69          """
70          if log:
71              log.write(message)
72
73      def _flush_log(self, log):
74          """
75          This function is just to make unit testing easier
76          """
77          if log:
78              log.flush()
79
80      ############ IMAP HELPERS #################
81      def _init_imap_conn(self):
82          self.activitylog.write('%s\tLogging in user %s\n' % (self.
                localized_now, self.user.id))
83          # setup the oauth stuff
84          consumer = xoauth.OAuthEntity(settings.GOOGLE_CONSUMER_KEY, settings.
                GOOGLE_CONSUMER_SECRET)
85          access_token_entity = xoauth.OAuthEntity(self.access_token, self.
                access_token_secret)
86          xoauth_string = xoauth.GenerateXOauthString(consumer,
87                                                      access_token_entity,
88                                                      self.user_name,
89                                                      'imap', None, None, None)
90
91          # get the imap connection
92          self._imap_conn = imaplib.IMAP4_SSL('imap.googlemail.com')
93          self._imap_conn.debug = 0
94          self._imap_conn.authenticate('XOAUTH', lambda x: xoauth_string)
95          self._imap_conn.select('"INBOX"')
96
97      @classmethod
98      def test_imap_conn(cls, profile):
99          try:
100             consumer = xoauth.OAuthEntity(settings.GOOGLE_CONSUMER_KEY,
                    settings.GOOGLE_CONSUMER_SECRET)
101             access_token_entity = xoauth.OAuthEntity(profile.
                    gmail_access_token, profile.gmail_access_token_secret)
102             xoauth_string = xoauth.GenerateXOauthString(consumer,
103                                                         access_token_entity,
104                                                         profile.user.email,
105                                                         'imap', None, None,
                                                            None)
```

```
106
107             # get the imap connection
108             imap_conn = imaplib.IMAP4_SSL('imap.googlemail.com')
109             imap_conn.debug = 0
110             imap_conn.authenticate('XOAUTH', lambda x: xoauth_string)
111             imap_conn.select('"INBOX"')
112
113             return True
114         except Exception:
115             pass
116
117         return False
118
119     def _get_tags(self):
120         result, tags = self._imap_conn.list()
121         return tags
122
123     def _get_server_message_ids_for_current_tag(self, current_tag, flag):
124         date = (datetime.date.today() - datetime.timedelta(days=183)).strftime
                ("%d-%b-%Y")
125         # select the tag
126         self._imap_conn.select(current_tag.name, readonly=True)
127         # get the list of messages by uid
128         result, data = self._imap_conn.uid('search', None, flag, '(SENTSINCE {
                date})'.format(date=date))
129         id_list = data[0].split()
130         # transform the id_list into a hash
131         id_dict = defaultdict(int)
132         for id in id_list:
133             id_dict[int(id)] = 1
134
135         self.tag_num_messages = len(id_list)
136         if (current_tag.name == '"INBOX"'):
137             self.inbox_num_messages = len(id_list)
138
139         return id_list, id_dict
140
141     def _get_header_and_flags_for_uid(self, uid):
142         # retrieve header data for the message
143         result, data = self._imap_conn.uid('fetch', uid, '(BODY.PEEK[HEADER]
                FLAGS)')
144         header_data = data[0][1]
145         parser = HeaderParser()
146         header = parser.parsestr(header_data)
147         flags = imaplib.ParseFlags(data[0][0])
148         return header, flags
149
150     ############ LOCAL DB HELPERS ###############
151     def _get_or_create_tag(self, tag):
152         tag_text = tag.split(' "/" ')[1]
153         # check if this tag is new and create accordingly
```

```
154         tag_set = self.user.corpus.tag_set.filter(name=tag_text)
155         current_tag = None
156         if not tag_set:
157             self._write_to_log(self.activitylog, '%s\tCreating new tag %s\n' %
                    (self.localized_now, tag_text))
158             current_tag = self.user.corpus.tag_set.create(name=tag_text)
159         else:
160             current_tag = tag_set[0]
161         return current_tag
162 
163     ############ GENERATING LOGS ##############
164     def refresh_logs(self):
165         # initialize feature variables
166         self.is_active = False
167         self.inbox_num_messages = 0
168         self.inbox_unread_messages = 0
169         self.inbox_new_messages = 0
170         self.num_messages_written = 0
171         self.num_messages_replied = 0
172         self.num_new_messages = 0
173         self.tag_count = 0
174 
175         # get the list of tags and loop through them
176         tags = self._get_tags()
177 
178         for tag in tags:
179             self.tag_count += 1
180             # get or create tag from db
181             current_tag = self._get_or_create_tag(tag)
182 
183             try:
184                 if not current_tag.name in settings.TAGS_TO_IGNORE:
185                     self._write_to_log(self.activitylog, '%s\tChecking
                            messages for tag %s\n' % (self.localized_now,
                            current_tag.name))
186 
187                     id_list, id_dict = self.
                            _get_server_message_ids_for_current_tag(current_tag, '
                            All')
188 
189                     # get all of the non-deleted messages for this tag
190                     emails = EmailMessage.objects.filter(user__id=self.user.id
                            , tags__name=current_tag.name, deleted=False).values()
191                     # also get a hash of all of the uids
192                     emails_dict = defaultdict(int)
193                     for email in emails:
194                         emails_dict[int(email['uid'])] = 1
195 
196                     # check if any messages have been removed from this tag
197                     self._check_deleted_emails(emails, id_dict, current_tag)
198 
```

```
199                     # check if there are any new messages for this tag
200                     self._check_new_emails(emails_dict, id_list, current_tag)
201
202                     # check for changes on the seen flag
203                     self._check_unread_emails(emails, current_tag)
204                     self._check_read_emails(emails, current_tag)
205
206                     self._flush_log(self.activitylog)
207                     self._write_to_log(self.activitylog, '%s\tTotal number of
                            messages for tag %s was %s\n' % (self.localized_now,
                            current_tag.name, self.tag_num_messages))
208             except Exception, e:
209                 self._write_to_log(self.errorlog, '%s\tException: %s\n' % (
                        self.localized_now, e))
210                 traceback.print_exc(file=self.errorlog)
211         finished_time = None
212         utc_dt = pytz.utc.localize(datetime.datetime.utcnow())
213         try:
214             finished_time = utc_dt.astimezone(self.local_tz)
215         except Exception:
216             finished_time = utc_dt
217         self._write_to_log(self.activitylog, '%s\tFinished activitylog\n' % (
                finished_time))
218         self._write_feature_log()
219
220         return
221
222     def cleanup(self):
223         self.activitylog.flush()
224         self.featurelog.flush()
225         self.errorlog.flush()
226
227         self.activitylog.close()
228         self.featurelog.close()
229         self.errorlog.close()
230
231         self._imap_conn.logout()
232
233     def _check_deleted_emails(self, emails, id_dict, current_tag):
234         self.num_deleted_mails = 0
235         deleted_emails = [email for email in emails if not id_dict[int(email['
                uid'])] == 1]
236         for email in deleted_emails:
237             self.is_active = True
238             self._write_to_log(self.activitylog, '%s\tDeleted mail %s from tag
                    %s\n' % (self.localized_now, email['message_id'], current_tag
                    .name))
239             EmailMessage.objects.filter(user__id=self.user.id, tags__name=
                    current_tag.name, deleted=False, uid=email['uid']).update(
                    deleted=True)
240             self.num_deleted_mails += 1
```

```
241
242     def _check_new_emails(self, emails_dict, id_list, current_tag):
243         new_email_uids = [uid for uid in id_list if not emails_dict[int(uid)]
                == 1]
244
245         for uid in new_email_uids:
246             try:
247                 email = EmailMessage.objects.create(user=self.user, uid=uid)
248                 email.tags.add(current_tag)
249
250                 if current_tag.name == '"[Gmail]/Sent Mail"' or current_tag.
                    name == '"Sent Messages"':
251                     self.is_active = True
252                     self.num_messages_written += 1
253                     self._write_to_log(self.activitylog, '%s\tMessage %s was
                        composed in tag %s\n' % (self.localized_now, email.
                        message_id, current_tag.name))
254
255                 header, flags = self._get_header_and_flags_for_uid(uid)
256
257                 email.user = self.user
258                 email.message_id = header['Message-ID']
259                 email.seen = flags.__contains__('\\Seen')
260                 email.thread_id = header['Thread-ID']
261                 email.in_reply_to = header['In-Reply-To']
262                 if header['Subject']:
263                     email.subject = header['Subject'].decode('utf-8')
264
265                 from_whom = ''
266                 # from field
267                 if header['From']:
268                     from_whom = header['From'].decode('utf-8')
269
270                 for match in self.email_pattern.findall(from_whom):
271                     email_address, created = EmailAddress.objects.
                        get_or_create(email_address=match[0], user=self.user)
272                     email.senders.add(email_address)
273                 if len(email.senders.all()) > 0:
274                     email.num_messages_from_sender = len(EmailMessage.objects.
                        filter(user__id=self.user.id, senders__email_address=
                        email.senders.all()[0].email_address).values('
                        message_id').distinct())
275                     email.num_messages_to_sender = len(EmailMessage.objects.
                        filter(user__id=self.user.id, senders__email_address=
                        self.user.email, receivers__email_address=email.
                        senders.all()[0]).values('message_id').distinct())
276
277                 # to field
278                 if (header['To']):
279                     email.to = unicode(header['To'].lower())
280                 if email.to:
```

```
281                     for match in self.email_pattern.findall(email.to):
282                         email_address, created = EmailAddress.objects.
                                get_or_create(email_address=match[0], user=self.
                                user)
283                         email.receivers.add(email_address)
284                         email.num_receivers += 1
285                 email.in_to_field = bool([True for receiver in email.receivers
                    .all() if receiver.email_address == self.user.email])
286                 email.sent_to_just_you = (email.in_to_field and email.
                    num_receivers == 1)
287 
288                 # cc field
289                 if header['cc']:
290                     email.cc = header['cc'].lower()
291                 if email.cc:
292                     for match in self.email_pattern.findall(email.cc):
293                         email_address, created = EmailAddress.objects.
                                get_or_create(email_address=match[0], user=self.
                                user)
294                         email.copied.add(email_address)
295                         email.num_cced += 1
296 
297                 email.date = header['date']
298                 email.thread_topic = header['thread_topic']
299                 if (header['X-MS-Has-Attach']):
300                     email.has_attachment = True
301 
302                 self._write_to_log(self.activitylog, '%s\tMessage %s was
                    created in tag %s\n' % (self.localized_now, email.
                    message_id, current_tag.name))
303                 self.num_new_messages += 1
304                 if current_tag.name == '"INBOX"':
305                     self.inbox_new_messages += 1
306 
307                 if email.seen:
308                     self.is_active = True
309                     self._write_to_log(self.activitylog, '%s\tMessage %s was
                        changed to seen in tag %s\n' % (self.localized_now,
                        email.message_id, current_tag.name))
310 
311                 if from_whom.__contains__(self.user.email.lower()):
312                     self._write_to_log(self.activitylog, '%s\tMessage %s was
                        composed in tag %s\n' % (self.localized_now, email.
                        message_id, current_tag.name))
313                     self.num_messages_written += 1
314                     self.is_active = True
315                     if email.in_reply_to:
316                         self._write_to_log(self.activitylog, '%s\tMessage %s
                            was replied to in tag %s\n' % (self.localized_now,
                             email.in_reply_to, current_tag.name))
317                         self.num_messages_replied += 1
```

```
318
319                 email.save()
320             except Exception, e:
321                 self._write_to_log(self.errorlog, '%s\tException: %s\n' % (
                        self.localized_now, e))
322                 traceback.print_exc(file=self.errorlog)
323
324     def _check_unread_emails(self, emails, current_tag):
325         id_list, id_dict = self._get_server_message_ids_for_current_tag(
                current_tag, 'Unseen')
326         unread_emails = [email for email in emails if id_dict[int(email['uid
                '])] == 1 and email['seen']]
327
328         for email in unread_emails:
329             if email['seen']:
330                 self._write_to_log(self.activitylog, '%s\tMessage %s was
                        marked as unseen in tag %s\n' % (self.localized_now, email
                        ['message_id'], current_tag.name))
331                 self.is_active = True
332                 EmailMessage.objects.filter(user__id=self.user.id, tags__name=
                        current_tag.name, deleted=False, id=email['id']).update(
                        seen=False)
333
334     def _check_read_emails(self, emails, current_tag):
335         id_list, id_dict = self._get_server_message_ids_for_current_tag(
                current_tag, 'Seen')
336         read_emails = [email for email in emails if id_dict[int(email['uid'])]
                == 1 and not email['seen']]
337
338         for email in read_emails:
339             if not email['seen']:
340                 self._write_to_log(self.activitylog, '%s\tMessage %s was
                        changed to seen in tag %s id %s\n' % (self.localized_now,
                        email['message_id'], current_tag.name, email['id']))
341                 self.is_active = True
342                 EmailMessage.objects.filter(user__id=self.user.id, tags__name=
                        current_tag.name, deleted=False, id=email['id']).update(
                        seen=True)
343
344     def _write_feature_log(self):
345         total_num_messages = EmailMessage.objects.filter(user__id=self.user.id
                , deleted=False).values('message_id').distinct().count()
346         total_unread_count = EmailMessage.objects.filter(user__id=self.user.id
                , deleted=False, seen=False).values('message_id').distinct().count
                ()
347         diary_details = DiaryDetails.objects.get(user=self.user)
348
349         self._imap_conn.select('"INBOX"')
350         result, data = self._imap_conn.uid('search', None, 'Unseen')
351         id_list = data[0].split()
352         self.inbox_unread_messages = len(id_list)
```

```
353         last_transition_date = self.local_tz.localize(self.user.corpus.
                last_transition_date)
354
355         # toggle the active flag
356         if self.is_active != self.user.corpus.is_active:
357             # spawn diary request
358             if not self.is_active:
359                 active_length = (self.localized_now - last_transition_date).
                        seconds
360                 if diary_details.should_assign_diary(active_length):
361                     DiaryEntry.objects.create(user=self.user)
362
363             self.user.corpus.is_active = self.is_active
364             self.user.corpus.last_transition_date = self.localized_now
365             last_transition_date = self.localized_now
366             self.user.corpus.save()
367
368         if not self.is_active:
369             self.user.corpus.new_message_since_active_count += self.
                    num_new_messages
370             self.user.corpus.inbox_new_message_since_active_count += self.
                    inbox_new_messages
371             self.user.corpus.save()
372
373         delta = (self.localized_now - last_transition_date).seconds
374
375         if delta < 0:
376                 delta = 0
377
378         self.activitylog.write('%s\tTotal number of messages was %s\n' % (self
                .localized_now, total_num_messages))
379
380         self.featurelog.write('%s\t' % self.localized_now)
381         self.featurelog.write('%s\t' % self.is_active)
382         # active and inactive time
383         if self.is_active:
384                 if self.user.corpus.last_transition_date is not None:
385                         self.featurelog.write('%s\t' % delta)
386                 else:
387                         self.featurelog.write('%s\t' % 0)
388                 self.featurelog.write('%s\t' % 0)
389         else:
390                 self.featurelog.write('%s\t' % 0)
391                 if self.user.corpus.last_transition_date is not None:
392                         self.featurelog.write('%s\t' % delta)
393                 else:
394                         self.featurelog.write('%s\t' % 0)
395         self.featurelog.write('%s\t' % total_num_messages)
396         self.featurelog.write('%s\t' % total_unread_count)
397         self.featurelog.write('%s\t' % self.user.corpus.
                new_message_since_active_count)
```

```
398         self.featurelog.write('%s\t' % self.tag_count)
399         self.featurelog.write('%s\t' % self.inbox_num_messages)
400         self.featurelog.write('%s\t' % self.inbox_unread_messages)
401         self.featurelog.write('%s\t' % self.user.corpus.
                inbox_new_message_since_active_count)
402         self.featurelog.write('%s\t' % self.num_messages_written)
403         self.featurelog.write('%s\t' % self.num_messages_replied)
404         # number of messages addressed to you in inbox unread
405         self.featurelog.write('%s\t' % len(EmailMessage.objects.filter(
                user__id=self.user.id, tags__name='"INBOX"', in_to_field=True,
                seen=False).values('message_id').distinct()))
406         # number of messages addressed only to you in inbox unread
407         self.featurelog.write('%s\t' % len(EmailMessage.objects.filter(
                user__id=self.user.id, tags__name='"INBOX"', sent_to_just_you=True
                , seen=False).values('message_id').distinct()))
408         # number of messages from senders in inbox unread
409         # number of messages sent to senders in inbox unread
410         senders = []
411         num_messages_from_senders = 0
412         num_messages_sent_to_senders = 0
413         for email in EmailMessage.objects.filter(user__id=self.user.id,
                tags__name='"INBOX"', seen=False):
414             for sender in email.senders.all():
415                 if not sender in senders:
416                     senders.append(sender)
417                     num_messages_from_senders += len(EmailMessage.objects.
                            filter(user__id=self.user.id, senders__email_address=
                            sender.email_address).values('message_id').distinct())
418                     num_messages_sent_to_senders += len(EmailMessage.objects.
                            filter(user__id=self.user.id, receivers__email_address
                            =sender.email_address, senders__email_address=self.
                            user.email.lower()).values('message_id').distinct())
419         self.featurelog.write('%s\t' % num_messages_from_senders)
420         self.featurelog.write('%s\t' % num_messages_sent_to_senders)
421         # number of messages to yourself
422         self.featurelog.write('%s\n' % len(EmailMessage.objects.filter(
                user__id=self.user.id, tags__name='"INBOX"', seen=False,
                senders__email_address=self.user.email.lower).values('message_id')
                .distinct()))
423
424         if self.is_active:
425             self.user.corpus.new_message_since_active_count = 0
426             self.user.corpus.inbox_new_message_since_active_count = 0
427             self.user.corpus.save()
```

Bibliography

Adamczyk, P. D. and Bailey, B. P. (2004). If not now, when?: the effects of interruption at different moments within task execution. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, CHI '04, pages 271–278, New York, NY, USA. ACM.

Allen, D. (2001). *Getting things done*. Viking.

Arminen, I. and Leinonen, M. (2006). Mobile phone call openings: tailoring answers to personalized summonses. *Discourse Studies*, 8(3):339–368.

Baddeley, A. D. (1995). Working memory. In et al., M. S. G., editor, *Attention: Selection, awareness and control. A tribute to Donald Broadent*, pages 755–784. Oxford University Press.

Ballas, J. A., Heitmeyer, C. L., and Pérez-Quiñones, M. A. (1992). Evaluating two aspects of direct manipulation in advanced cockpits. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, CHI '92, pages 127–134, New York, NY, USA. ACM.

Bälter, O. and Sidner, C. L. (2002). Bifrost inbox organizer: giving users control over the inbox. In *Proceedings of the second Nordic conference on Human-computer interaction*, NordiCHI '02, pages 111–118, New York, NY, USA. ACM.

Bandura, A. (1989). Human agency in social cognitive theory. *American Psychologist*, 44(9):1175–1184.

Bandura, A. (2001). Social cognitive theory: An agentic perspective. *Annual Review of Psychology*, 52(1):1–26. PMID: 11148297.

Bellotti, V., Ducheneaut, N., Howard, M., and Smith, I. (2003). Taking email to task: the design and evaluation of a task management centered email tool. In *CHI '03: Proceedings of the SIGCHI conference on Human factors in computing systems*, pages 345–352, New York, NY, USA. ACM.

Bellotti, V., Ducheneaut, N., Howard, M., Smith, I., and Grinter, R. E. (2005). Quality versus quantity: e-mail-centric task management and its relation with overload. *Hum.-Comput. Interact.*, 20(1):89–138.

Bellotti, V., Ducheneaut, N., Howard, M., Smith, I., and Neuwirth, C. (2002). Innovation in extremis: evolving an application for the critical work of email and information management. In *Proceedings of the 4th conference on Designing interactive systems: processes, practices, methods, and techniques*, DIS '02, pages 181–192, New York, NY, USA. ACM.

Bradley, A., Brumby, D. P., Cox, A. L., and Bird, J. (2013). How to manage your inbox: Is a once a day strategy best? In *Proceedings of the 27th International BCS Human Computer Interaction Conference*, BCS-HCI '13, pages 20:1–20:6, Swinton, UK, UK. British Computer Society.

Bush, V. (1945). As we May Think. Reprinted from the Atlantic Monthly, Vol. 176, No. 1 (1945).

Cecchinato, M., Cox, A. L., and Bird, J. (2014). "i check my email on the toilet": Email proactices and work-home boundary management. In *MobileHCI '14*, Toronto, Canada. ACM.

Chase, N. and Clegg, B. (2011). Effects of email utilization on higher education professionals. *International Journal of Technology and Human Interaction*, 7(4):31–45.

Chen, G. M. (2011). Tweet this: A uses and gratifications perspective on how active twitter use gratifies a need to connect with others. *Computers in Human Behavior*, 27(2):755 – 762. Web 2.0 in Travel and Tourism: Empowering and Changing the Role of Travelers.

Chewar, C. M., McCrickard, D. S., and Sutcliffe, A. G. (2004). Unpacking critical parameters for interface design: evaluating notification systems with the irc framework. In *Proceedings of the 5th conference on Designing interactive systems: processes, practices, methods, and techniques*, DIS '04, pages 279–288, New York, NY, USA. ACM.

Clark, H. and Schaefer, E. (1989). Contributing to discourse. *Cognitive Science*, 13:259–294.

Clark, H. H. (1996). *Using Language*. Cambridge University Press.

Clark, H. H. and Brennan, S. A. (1991). Grounding in communication. In Resnick, L., Levine, J., and Teasly, S., editors, *Perspectives on socially shared cognition*, pages 127–149. APA Books.

Cselle, G., Albrecht, K., and Wattenhofer, R. (2007). Buzztrack: topic detection and tracking in email. In *IUI '07: Proceedings of the 12th international conference on Intelligent user interfaces*, pages 190–197, New York, NY, USA. ACM.

Cutrell, E., Czerwinski, M., and Horvitz, E. (2001a). Notification, disruption, and memory: Effects of messaging interruptions on memory and performance. In *Proc. Interact 2001*, pages 263–269. IOS Press.

Cutrell, E., Czerwinski, M., and Horvitz, E. (2001b). Notification, disruption, and memory: Effects of messaging interruptions on memory and performance. pages 263–269. IOS Press.

Cutrell, E. B., Czerwinski, M., and Horvitz, E. (2000). Effects of instant messaging interruptions on computing tasks. In *CHI '00 extended abstracts on Human factors in computing systems*, CHI EA '00, pages 99–100, New York, NY, USA. ACM.

Czerwinski, M., Cutrell, E., and Horvitz, E. (2000a). Instant messaging and interruption: Influence of task type on performance. In *Proc. OZCHI 2000*, pages 356–361.

Czerwinski, M., Cutrell, E., and Horvitz, E. (2000b). Instant messaging and interruption: Influence of task type on performance. In *OZCHI 2000 Conference Proceedings*, pages 356–361.

Czerwinski, M., Gage, D. W., Gemmell, J., Marshall, C. C., Perez-Quinones, M. A., Skeels, M. M., and Catarci, T. (2006). Digital memories in an era of ubiquitous computing and abundant storage. *Commun. ACM*, 49(1):44–50.

Czerwinski, M. and Horvitz, E. (2002). An investigation of memory for daily computing events. In *Proceedings of HCI 2002*, pages 230–245.

Czerwinski, M., Horvitz, E., and Wilhite, S. (2004). A diary study of task switching and interruptions. In *Proceedings of the SIGCHI conference on Human factors in computing systems*, CHI '04, pages 175–182, New York, NY, USA. ACM.

Dabbish, L. A. and Kraut, R. E. (2006). Email overload at work: an analysis of factors associated with email strain. In *Proceedings of the 2006 20th anniversary conference on Computer supported cooperative work*, CSCW '06, pages 431–440, New York, NY, USA. ACM.

Dabbish, L. A., Kraut, R. E., Fussell, S., and Kiesler, S. (2005). Understanding email use: predicting action on a message. In *Proc. CHI 2005*, CHI '05, pages 691–700. ACM Press.

Ducheneaut, N. and Bellotti, V. (2001). E-mail as habitat: an exploration of embedded personal information management. *interactions*, 8(5):30–38.

Ducheneaut, N. and Watts, L. (2005). In Search of Coherence: A Review of E-Mail Research. *Human-Computer Interaction*, 20(1&2):11–48.

Englebart, D. (1962). Augmenting human intellect: A conceptual framework. Technical report, Stanford Research Institute, Menlo Park.

Fan, J., McCandliss, B., Sommer, T., Raz, A., and Posner, M. (2002). Testing the efficiency and independence of attentional networks. *Journal of cognitive neuroscience*, 14(3):340–347.

Faulring, A., Myers, B., Mohnkern, K., Schmerl, B., Steinfeld, A., Zimmerman, J., Smailagic, A., Hansen, J., and Siewiorek, D. (2010). Agent-assisted task management that reduces email overload. In *Proc IUI 2010*, pages 61–70. ACM Press.

Fisher, D., Brush, A. J., Gleave, E., and Smith, M. A. (2006a). Revisiting Whittaker & Sidner's "Email Overload" ten years later. In *CSCW '06: Proceedings of the 2006 20th anniversary conference on Computer supported cooperative work*, pages 309–312, New York, NY, USA. ACM.

Fisher, D. and Dourish, P. (2004). Social and temporal structures in everyday collaboration. In *CHI '04: Proceedings of the SIGCHI conference on Human factors in computing systems*, pages 551–558, New York, NY, USA. ACM.

Fisher, D., Hogan, B., Brush, A., Smith, M., and Jacobs, A. (2006b). Using social sorting to enhance email management. *HCIC '06*.

Flanagin, A. and Metzger, M. (2001). Internet use in the contemporary media environment. *Human Communication Research*, 27(1):153–181.

Franke, J. L., Daniels, J. J., and Mcfarlane, D. C. (2002a). Recovering context after interruption. In *Proc Cognitive Science Society 2002*, pages 310–315.

Franke, J. L., Daniels, J. J., and Mcfarlane, D. C. (2002b). Recovering context after interruption. In *In: 24 th Annual Meeting of the Cognitive Science Society*, pages 310–315.

Freed, M., Carbonell, J. G., Gordon, G. J., Hayes, J., Myers, B. A., Siewiorek, D. P., Smith, S. F., Steinfeld, A., and Tomasic, A. (2008). Radar: A personal assistant that learns to reduce email overload. In *AAAI*, pages 1287–1293.

Garfinkel, H. (1963). A conception of, and experiments with, "trust" as a condition of stable concerted actions. In Harvey, O., editor, *Motivation and social interaction: cognitive approaches*, pages 187–238. New York: Ronald Press.

Garfinkel, H. (1967). *Studies in ethnomethodology*. Prentice-Hall.

Goffman, E. (1967). *Interaction ritual: Essays in face-to-face behavior*. Aldine Transaction.

Grevet, C., Choi, D., Kumar, D., and Gilbert, E. (2014). Overload is overloaded: Email in the age of gmail. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, CHI '14, pages 793–802, New York, NY, USA. ACM.

Gwizdka, J. (2000). Timely reminders: A case study of temporal guidance in pim and email tools usage. In *CHI '00 Extended Abstracts on Human Factors in Computing Systems*, CHI EA '00, pages 163–164, New York, NY, USA. ACM.

Gwizdka, J. (2002). Reinventing the inbox: Supporting the management of pending tasks in email. In *CHI '02 Extended Abstracts on Human Factors in Computing Systems*, CHI EA '02, pages 550–551, New York, NY, USA. ACM.

Hanrahan, B. and Pérez-Quinones, M. (2012). Procrastinate: How i learned to stop worrying about email and love procrastinating. In *Personal Information Management Workshop 2012*.

Hanrahan, B. V. (2011). The effect of social proximity on email triage. Technical report, Human Information Processing Scholar Series for Virginia Polytechnic Institute and State University 2011.

Hemp, P. (2009). Death by information overload. *Harvard business review*, 87(9):82–89.

Herzog, H. (1940). Professor quiz: A gratification study. *Radio and the Printed Page*.

Herzog, H. (1944). What do we really know about daytime serial listeners? *Radio Research*, 1942(3):2–23.

Hofstadter, D. (1995). *Fluid concepts and creative analogies: Computer models of the fundamental mechanisms of thought*. Basic Books.

Iqbal, S. T. and Horvitz, E. (2007). Disruption and recovery of computing tasks: field study, analysis, and directions. In *Proceedings of the SIGCHI conference on Human factors in computing systems*, CHI '07, pages 677–686, New York, NY, USA. ACM.

Jerejian, A., Reid, C., and Rees, C. S. (2013). The contribution of email volume, email management strategies and propensity to worry in predicting email stress among academics. *Computers in Human Behavior*, 29(3):991–996.

Jones, W. (2007). *Keeping found things found: The study and practice of personal information management*. Morgan Kaufmann Pub.

Jones, W., Klasnja, P., Civan, A., and Adcock, M. L. (2008). The personal project planner: planning to organize personal information. In *CHI '08: Proceeding of the twenty-sixth annual SIGCHI conference on Human factors in computing systems*, pages 681–684, New York, NY, USA. ACM.

Jones, W. and Teevan, J. (2007). Introduction. In Jones, W. and Teevan, J., editors, *Personal Information Management*, pages 3–20. University of Washington Press.

Kelly, D. and Teevan, J. (2007). Understanding what works: Evaluating pim tools. In Jones, W. and Teevan, J., editors, *Personal Information Management*, pages 190–204. University of Washington Press.

Kokkalis, N., Köhn, T., Pfeiffer, C., Chornyi, D., Bernstein, M. S., and Klemmer, S. R. (2013). Emailvalet: Managing email overload through private, accountable crowdsourcing. In *Proceedings of the 2013 Conference on Computer Supported Cooperative Work*, CSCW '13, pages 1291–1300, New York, NY, USA. ACM.

Langstedt, E. (2013). An examination of the role of the communicator on gratifications attained on social network sites. *The Journal of Social Media in Society*, 2(1).

Lansdale, M. (1988). The psychology of personal information management. *Applied Ergonomics*, 19(1):55–66.

LaRose, R. and Eastin, M. S. (2004). A social cognitive theory of internet uses and gratifications: Toward a new model of media attendance. *Journal of Broadcasting & Electronic Media*, 48(3):358–377.

Leung, L. (2001). College student motives for chatting on icq. *New Media & Society*, 3:482–500.

Levinson, S. (1983). *Pragmatics*. Cambridge: Cambridge University Press.

Levy, D. M. (2005). To grow in wisdom: vannevar bush, information overload, and the life of leisure. In *Proceedings of the 5th ACM/IEEE-CS joint conference on Digital libraries*, JCDL '05, pages 281–286, New York, NY, USA. ACM.

Mackay, W. E. (1988). Diversity in the use of electronic mail: a preliminary inquiry. *ACM Trans. Inf. Syst.*, 6(4):380–397.

Malone, T. W. (1983). How do people organize their desks?: Implications for the design of office information systems. *ACM Trans. Inf. Syst.*, 1(1):99–112.

Mark, G., Gudith, D., and Klocke, U. (2008). The cost of interrupted work: more speed and stress. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, CHI '08, pages 107–110, New York, NY, USA. ACM.

McCrickard, D. S., Catrambone, R., Chewar, C. M., and Stasko, J. T. (2003a). Establishing tradeoffs that leverage attention for utility: empirically evaluating information display in notification systems. *Int. J. Hum.-Comput. Stud.*, 58(5):547–582.

McCrickard, D. S. and Chewar, C. M. (2003). Attuning notification design to user goals and attention costs. *Commun. ACM*, 46(3):67–72.

McCrickard, D. S., Chewar, C. M., Somervell, J. P., and Ndiwalana, A. (2003b). A model for notification systems evaluation–assessing user goals for multitasking activity. *ACM Trans. Comput.-Hum. Interact.*, 10(4):312–338.

McCullagh, P. and Nelder, J. A. (1990). *Generalized Linear Models*. New York: Chapman & Hall.

Mcfarlane, D. C. (1997a). Interruption of people in human-computer interaction: A general unifying definition of human interruption and taxonomy. Nrl formal report, US Naval Research Laboratory, Washington, DC.

Mcfarlane, D. C. (1997b). Interruption of people in human-computer interaction: A general unifying definition of human interruption and taxonomy. Nrl formal report nrl/fr/5510-97-9870, US Naval Research Laboratory, Washington, DC.

Mcfarlane, D. C. (1998). *Interruption of people in human-computer interaction*. PhD thesis. AAI9923559.

McFarlane, D. C. and Latorella, K. A. (2002). The scope and importance of human interruption in human-computer interaction design. *Hum.-Comput. Interact.*, 17(1):1–61.

McMurtry, K. (2014). Managing email overload in the workplace. *Performance Improvement*, 53(7):13–37.

McQuail, D., blumler, J. G., and Brown, J. R. (1972). The television audience: A revised perpective. *Sociology of Mass Communications*.

Muller, M., Millen, D. R., and Feinberg, J. (2010). Patterns of usage in an enterprise file-sharing service: publicizing, discovering, and telling the news. In *CHI '10: Proceedings of the 28th international conference on Human factors in computing systems*, pages 763–766, New York, NY, USA. ACM.

Nardi, B. A., Whittaker, S., Isaacs, E., Creech, M., Johnson, J., and Hainsworth, J. (2002). Integrating communication and information through contactmap. *Communications of the ACM*, 45(4):89 – 95.

Neustaedter, C., Brush, A. J., Smith, M. A., and Fisher, D. (2005). The social network and relationship finder: Social sorting for email triage. In *Proc. of the Conf. on Email and Anti-Spam (CEAS)*, Mountain View, CA. Proc. of the Conf. on Email and Anti-Spam (CEAS).

Norman, D. A. and Bobrow, D. G. (1975). On data-limited and resource-limited processes. *Cognitive Psychology*, 7(1):44 – 64.

O'Neill, J. and Martin, D. (2003). Text chat in action. In *Proceedings of the 2003 International ACM SIGGROUP Conference on Supporting Group Work*, GROUP '03, pages 40–49, New York, NY, USA. ACM.

Palmgreen, P. and II, J. R. (1979). Uses and gratifications and exposure to public television: A discrepancy method. *Communication Research*, 6:155–179.

Papacharissi, Z. and Rubin, A. M. (2000). Predictors of internet use. *Journal of Broadcasting & Electronic Media*, 44(2):175–196.

Park, N., Kee, K. F., and Valenzuela, S. (2009). Being immersed in social networking environment: Facebook groups, uses and gratifications, and social outcomes. *CyberPsychology & Behavior*, 12(6):729–733.

Posner, M. (1980). Orienting of attention. *Quarterly journal of experimental psychology*, 32(1):3–25.

Rector, K. and Hailpern, J. (2014). Minemail: Sms alert system for managing critical emails. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, CHI '14, pages 783–792, New York, NY, USA. ACM.

Reinke, K. and Chamorro-Premuzic, T. (2014). When email use gets out of control: Understanding the relationship between personality and email overload and their impact on burnout and work engagement. *Computers in Human Behavior*, 36:502–509.

Rennecker, J. and Derks, D. (2013). *The Psychology of Digital Media at Work*, chapter Email Overload, pages 14–31. Current issues in work and organizational psychology. Taylor & Francis.

Roda, C. (2011). Human attention in digital environments. In Roda, C., editor, *Human Attention in Digital Environments*, chapter Human attention and its implications for human-computer interaction, pages 11–62. Cambridge University Press.

Rubin, A. M. (1983). Television users and gratifications: The interactions of viewing patterns and motivations. *Journal of Broadcasting*, 27:37–52.

Sacks, H., Jefferson, G., and Schegloff, E. A. (1992). *Lectures on conversation*, volume 1. Blackwell Oxford.

Schegloff, E. A. (1968). Sequencing in conversational openings. *American anthropologist*, 70(6):1075–1095.

Schegloff, E. A. (1979). Identification and recognition in telephone conversation openings. *Everyday language: Studies in ethnomethodology*, pages 23–78.

Schegloff, E. A. (2004). Answering the phone. *Pragmatics & beyond. New series*, 125:63–107.

Schick, A., Gordon, L., and Haka, S. (1990). Information overload: A temporal approach. *Accounting Organizations and Society*, 15(3):199–220.

Shiffrin, D. (1987). *Discourse Markers*. Cambridge: Cambridge University Press.

Singh, N., Tomitsch, M., and Maher, M. L. (2013). Understanding the management and need for awareness of temporal information in email. In *Proceedings of the Fourteenth Australasian User Interface Conference - Volume 139*, AUIC '13, pages 43–51, Darlinghurst, Australia, Australia. Australian Computer Society, Inc.

Sumeckia, D., Chipulua, M., and Ojiakoa, U. (2011). Email overload: Exploring the moderating role of the perception of email as a business critical tool. *International Journal of Information Management*, 31:407–414.

Teevan, J., Capra, R., and Pérez-Quiñones, M. A. (2007). *Personal Information Management*, chapter How People Find Personal Informaiton, pages 22–34. University of Washington Press.

Tyler, J. R. and Tang, J. C. (2003). When can i expect an email response? a study of rhythms in email usage. In *ECSCW'03: Proceedings of the eighth conference on European Conference on Computer Supported Cooperative Work*, pages 239–258, Norwell, MA, USA. Kluwer Academic Publishers.

Vacek, M. (2014). How to survive email. In *9th IEEE International Symposium on Applied Computational Intelligence and Informatics*, pages 49–54. IEEE.

Venolia, G. D., Dabbish, L., Cadiz, J., and Gupta, A. (2001). Supporting email workflow. Technical report, MSR-TR-2001-88: Microsoft Research.

Venolia, G. D. and Neustaedter, C. (2003). Understanding sequence and reply relationships within email conversations: a mixed-model visualization. In *CHI '03: Proceedings of the SIGCHI conference on Human factors in computing systems*, pages 361–368, New York, NY, USA. ACM.

Wainer, J., Dabbish, L., and Kraut, R. (2011). Should i open this email?: inbox-level cues, curiosity and attention to email. In *PART 5 ——– Proceedings of the 2011 annual conference on Human factors in computing systems*, CHI '11, pages 3439–3448, New York, NY, USA. ACM.

Weilenmann, A. (2003). " i can't talk now, i'm in a fitting room": formulating availability and location in mobile-phone conversations. *Environment and Planning*, 35(9):1589–1605.

Whittaker, S., Bellotti, V., and Gwizdka, J. (2006). Email in personal information management. *Commun. ACM*, 49(1):68–73.

Whittaker, S., Bellotti, V., and Gwizdka, J. (2007). Everything through email. In Jones, W. and Teevan, J., editors, *Personal Information Management*. University of Washington Press.

Whittaker, S., Jones, Q., Nardi, B., Creech, M., Terveen, L., Isaacs, E., and Hainsworth, J. (2004). Contactmap: Organizing communication in a social desktop. *ACM Trans. Comput.-Hum. Interact.*, 11(4):445–471.

Whittaker, S., Matthews, T., Cerruti, J., Badenes, H., and Tang, J. (2011). Am i wasting my time organizing email?: a study of email refinding. In *Proceedings of the 2011 annual conference on Human factors in computing systems*, CHI '11, pages 3449–3458, New York, NY, USA. ACM.

Whittaker, S. and Sidner, C. (1996). Email overload: exploring personal information management of email. In *Proc. CHI 1996*, pages 276–283. ACM Press.

Wickens, C. and Hollands, J. (1999a). *Engineering psychology and human performance.*, chapter Attention, Time-Sharing and Workload. Prentice Hall New Jersey, third edition.

Wickens, C. and Hollands, J. (1999b). *Engineering psychology and human performance.* Prentice Hall New Jersey, third edition.

Wickens, C. and Hollands, J. (1999c). *Engineering psychology and human performance.*, chapter Memory and Training. Prentice Hall New Jersey, third edition.

Wickens, C. and Hollands, J. (1999d). *Engineering psychology and human performance.*, chapter Attention in Perception and Display Space. Prentice Hall New Jersey, third edition.

Wickens, C. and Hollands, J. (1999e). *Engineering psychology and human performance.*, chapter Signal Detection, Information Theory and Absolute Judgement. Prentice Hall New Jersey, third edition.

Winograd, T. (1983). *Language as a cognitive process*, volume 1. Addison-Wesley Reading, Mass.

Wolfe, J. (1994). Guided search 2.0 a revised model of visual search. *Psychonomic bulletin & review*, 1(2):202–238.