You Have E-Mail, What Happens Next? Tracking the Eyes for Genre

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Abstract

This paper reports on an approach to the analysis of form (layout and formatting) during genre recognition recorded using eye tracking. The researchers focused on eight different types of e-mail, such as calls for papers, newsletters and spam, which were chosen to represent different genres. The study involved the collection of oculographic behaviour data based on the scanpath duration and scanpath length based metric, to highlight the ways in which people view the features of genres. We found that genre analysis based on purpose and form (layout features, etc.) was an effective means of identifying the characteristics of these e-mails.

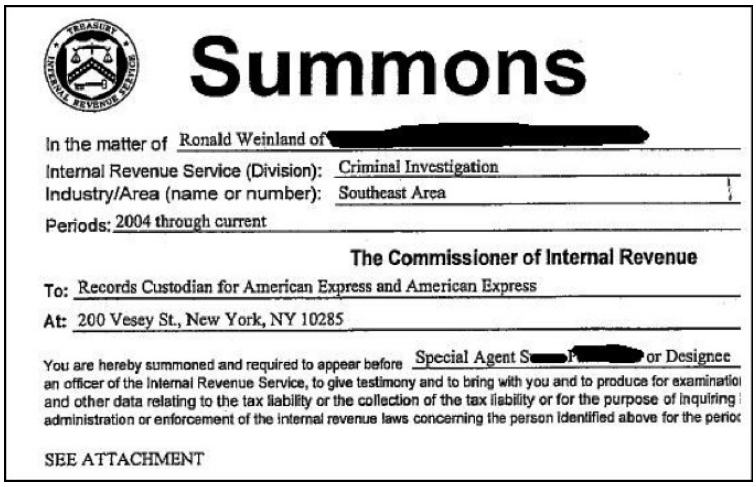
The research, carried out on a group of 24 participants, highlighted their interaction and interpretation of the e-mail texts and the visual cues or features perceived. In addition, the ocular strategies of scanning and skimming, they employed for the processing of the texts by block, genre and representation were evaluated.

Keywords: Genre, Eyetracking; E-mail, Scanpaths

1. Introduction

Documents or texts can be processed and differentiated from each other in many ways. Sometimes they are written in different dialects (forms of language), styles (Medieval, Shakespearean, etc.), levels (children's and adults'

books), topics (mathematics or creationism versus evolution), or different purpose, sometimes referred to as substance, (Ordinance survey, Atlas). In the context of this work, form (readily observable features, such as formatting and structure cf. Fig.2.) and purpose (communicative purpose) are considered during the identification of the e-mail genre but the focus is mainly on the structural characteristics. For example, in the summons shown in Fig.1., the information has been displayed using particular formatting devices, such as emboldened text, for attention-getting effects in a particular way e.g.**Summons**. It has been designed for the specific purpose of drawing the attention of an individual to the fact that his/her presence is required for a particular reason in a particular location on a particular date. This work will examine how this attention is achieved. This Information Retrieval & Seeking (IR & S) study employs eye-tracking technology to capture and record human ocular interactions with the layout features and formatting devices contained within documents.



Summons

In the matter of Ronald Weinland of [redacted]
Internal Revenue Service (Division): Criminal Investigation
Industry/Area (name or number): Southeast Area
Periods: 2004 through current

The Commissioner of Internal Revenue

To: Records Custodian for American Express and American Express
At: 200 Vesey St., New York, NY 10285

You are hereby summoned and required to appear before Special Agent S[redacted] or Designee an officer of the Internal Revenue Service, to give testimony and to bring with you and to produce for examinatio and other data relating to the tax liability or the collection of the tax liability or for the purpose of inquiring administration or enforcement of the internal revenue laws concerning the person identified above for the perio

SEE ATTACHMENT

Figure 1: The diagram shows a textual genre i.e., a summons, which has a specific purpose and form.

This was carried out by analysing the layout and structure of socially constructed texts of "organizational communication" (Yates and Orlikowski, 1992) amongst people in a particular workplace or in a "community of practice" (CoP) as described by Wenger (1999), where, genre, in a textual sense, is sometimes defined as a group of texts or documents that share a communicative purpose, as determined by the discourse community which produces

and/or reads them (Swales, 1990). As Yates and Orlikowski (1992) stated: "In structurational terms, genres are social institutions that are produced, reproduced, or modified when human agents draw on genre rules to engage in organizational communication". Collins et al. (2001) explained that what the community sees as important will be reflected in the implicit structures found in the objects they create and share and as Watt (2009) has observed: "convergence on a set of standardized document structures is both natural and helpful". These objects are genres that occur in the web; CoPs are utilised, but we need to look at the ways in which these digital communications in these communities are structured and the types of features of which they consist. For further discussion on Communities of Practice c.f. Wenger (1998, 1999); Wenger and Snyder (2000); Wenger (2000). Layout in organizational communities causes people to focus perceptually on key parts of the text (Schmid and Baccino, 2002) and our empirical research has previously demonstrated that people use layout and other related cues to focus on key parts of the text (Clark, 2008; Clark et al., 2008, 2010, 2012). The reader is able to perceive the meaning through interaction with the cues which exist on the outside and inside of the "frame" (Frow, 2006), - a term that Frow uses synonymously with genre. These structural cues in the document layout can take the form of lists, centred titles, emboldened texts etc. (Fig.2.) (Yates and Orlikowski, 1992).

Table 1: E-mail example in very basic and brief form.

(a) Formatting only – no lexical content	**(b) Formatting and content**
Xxxx: **Xxxx**: **Xx**: **Xxxxxxx**: Xxx, 99 Xxx 9999 99:99:99 <xx@xxxx.xxx.xx.xx> xxxx- xxxx@xxxxxx.xxxxxx.xxx Xx: xxxxxxxx xxxxxxx? Xx, x xxxxxx xxx xxxx xxxx xxx xxx xx xxxxxxx xx xxx xxxx, xxx xxx xxxxxx (xxx xxxxxxxx xxxxxxxx) xxx xxxxxxxxx?	**Date**: **From**: **To**: **Subject**: Wed, 27 Sep 2006 14:49:11 <mc@comp.rgu.ac.uk> java- user@lucene.apache.org Re: matching problem? Hi, I assume you mean that the set of matches is the same, but the scores (and possibly the order) are different?

The experimental work that follows includes an analysis that utilizes scanpaths to look at manually or human-developed types of digital e-mail genres. Table 1 shows the typical top-level genre structure of an e-mail: header (date,

from, to, subject) and the message body, but some e-mails have more explicit structures using formatting devices in just the message body and solely these were used in our experiment. Eye tracking enables us to collect data to ascertain whether there is evidence of particular types of perception, for example, Gestaltism (Wertheimer, Koffka and Köhler), Ecological (Gibson) or Constructivism (von Helmholtz and Gregory). The most prominent theories on perception are discussed in more detail in Section 3. In particular, we are looking for evidence of the Constructivist and Ecological processes, primarily when the user is asked to look at e-mail texts, some of which are without structure or semantic content. To examine genre and ways of perceiving, we used specific eye movement behaviour metrics or 'ocular metrics' Rayner (1998) which have been in fairly common use in contemporary eye tracking experiments i.e. Scanpath Duration and Scanpath Length, c.f. Goldberg and Kotval (1999, p. 638) . The experiment described in this paper has two objectives. Firstly, to examine the value of genres in e-mail categorization/filtering pertaining to genre and secondly, to collect clues to the perceptual processes that are predominant during the identification/decision-making processes of the recipients of each e-mail. For this purpose, the main research questions were formulated as follows:

1. What are the relative contributions of form in the scanpaths during the identification of genres of e-mail? Are there instances of mutually dependent elements? How do the form features of a genre aid in text interpretation and use?
2. Do the lengths of scanpaths significantly differ between each e-mail representation?
3. Do the lengths of scanpaths significantly differ between each e-mail genre?
4. Do the durations (gaze point samples) of scanpaths significantly differ between each e-mail representation?
5. Do the durations (gaze point samples) of scanpaths significantly differ between each e-mail genre?
6. Do participants 'fixate upon' shapes/features of the layout of e-mail texts in four different structures by predominantly using fixation ocular behaviour?
7. Is there any evidence of 'Frame' (Frow, 2006) theory (see Sections 2.1.1 and 2.1.2 in user activities involving internal and external cues, while they are identifying the e-mails?

8. Are there instances of skimming and scanning behaviour, particularly in shapes of features of the layout of e-mail texts in the four different structural representations (conditions 1-4 described in 5.7)?

In Section 2, the focus is on genre, including both historical and contemporary genre theory and texts; Section 3 looks at theories related to visual perception and strategies of skimming and scanning. Section 4 provides an introduction to the study, with scanpath definitions, theories and previous/background work on scanpaths. Section 5 describes the experimental setup in detail, and the results are presented in Section 6. Section 7 and Section 8 are spent setting out the directions of future research in this field and devoted to discussing the conclusions drawn from this experiment respectively.

2. Genre and Texts

2.1. Classical genre theory

Genre has been mused over for thousands of years. Aristotle (1954) considered that whatever was perceivable by the individual was reality. He believed that the entire 'visual array' was made up of substance and form; form was comprehensible when it specified the individual and could be abstracted from the objects in a process of perception. Outside objects imposed upon the senses, and due to the power of reason, the mind was able to extricate the form, which determined the nature of the perceived object (Breure, 2001). Any thorough book or literature review on genre, such as Freedman and Medway (1994) and Paltridge (1997) will divulge an overall lack of consensus on an appropriate definition of genre because so many questions remain unanswered with regard to how genres are created, evolve, function, overlap and interact with each other, which rules and patterns constitute a genre and how these characteristics are perceived. We contend that the specific contexts of researchers guide the way they delineate genre: as Kwaśnik and Crowston (2005) argue, the researcher chooses the definition applicable to the current context of the study. The textual features of genre play a vital role, as do the interaction and interplay of dynamic and static genres. The major challenge of this work is the collection of empirical data that can show how readers interpret genres.

2.1.1. Interpretation of genre

Frow (2006) based his semantic interpretation of an e-mail on two questions: "First, 'what is it that's going on here?'; second, what kind of thing is this?' The second question is about the genre of this e-mail, and when I have answered it I can then answer the first question: I know what's going on here." When we perceive and interrelate with any object, in this context a book or textual document, we view in an 'unconscious' (a misnomer in a real sense because in cognitive science it is described as attention and awareness) or conscious sense for the elements of background 'informations' that are evoked by texts and generically shaped and specific (Frow, 2006). When viewing the texts, the reader cannot help but pay attention to the "embedded assumptions" and "understandings". These attentive behaviours are structured by genre, specifically the "frames". Readers viewing text(s) are always involved or relate to the complete arrays of textual meaning. This is quite closely related to Semiotic 'intertextuality' a term that is said to have been coined by the post-structuralist semiotician, Kristeva (1980). Theorists working in the field of intertextuality have suggested that the meanings of texts are shaped by preceding texts. In other words, an author or artist refers to an earlier work and subsequently converts a previous creation with it then being referred to in the new text. As Chandler puts it: "The concept of intertextuality reminds us that each text exists in relation to others. In fact, texts owe more to other texts than to their own makers" (Chandler, 2011).

This gives rise to questions, such as, how the reader is involved with genre and what is the purpose of the textual meaning. Beebee (1994) states that genre is primarily the "precondition for the creation and the reading of texts" and literary learning or academic research is secondary. Extending Beebee's idea, Frow believes that interpretation is led by genre due to the constriction of the process of signs (semiotics) and the "production of meaning" (Frow, 2006). Lorch (1989) believes that the text provides signals (writing devices) which emphasize the text's content and structure. In this and many other contexts, genre postulates the kinds of meaning that are suitable and pertinent in a specific situation or context.

Hirsch jr (1967, p. 76), explains that genre is an interpretative process called into being by the fact that "all understanding of verbal meaning is necessarily genre bound." Basically, when we deduce the genre of a text or "what kind of thing this is" (Hirsch jr, 1967, p. 76) our guess stays the same

until the initial interpretation is reformed because of an event which allows the viewer to re-evaluate the understanding of the meaning. Hirsch's explanation could be appropriately linked to the work pertaining to "perceptual hypotheses" by Gregory (1980) or, indeed, as we like to refer to it, 'perpetual' perceptual hypotheses, where we are continuously trying to ascertain what an object or text is. The imputations or hypotheses that we make about the applicable and related conventions to apply in a specific instance, or context, will direct our reading, controlling the progression it will take, our expectancies of what it will lead to.

2.1.2. Genre as a 'frame'

The cues (or metacommunications) of the frame offer the reader/viewer specific options with regard to the following questions: how can I use the text?; What can I expect to occur at different stages?; what can I do if my expectations are not fulfilled? The cues encountered can either be internal to the text or external:"located at the margins of texts" (Frow, 2006, p. 104). Genette (1997, p. 1) has highlighted examples of external cues (or paratexts) that surround a literary text, for example, the name of the author, the title, the foreword, the figures or tables within the text. Lorch (1989) identifies textual signals, such as headings, previews, summaries, titles, numeric signals and so on. All texts are accompanied by these types of cues or signals which 'present' the texts to the reader or ensure the presence of the texts in the world.

2.1.3. Study definition of genre-structure

For the purpose of this study, genre was defined by its purpose (sometimes known as substance) but mainly by form (see Fig.2. for categories of form) as described in Dewdney et al. (2001) and Yates and Orlikowski (2002, p. 15). The form (and purpose) is the set of structures and layout that show the user the document's form through its structure, regardless of the topical nature of the writing. The purpose, communicative purpose, represents many attributes, such as arguments, discourse structure and so on. The form (the readily observable features) contains several attributes (Fig.2.); the structural features are text-formatting devices, such as lists and headings, and devices for structuring interactions at meetings, such as an agenda and chairpersons. More discussion of the definitions can be read in Clark et al. (2009a, pp. 3-6). The experimental analysis' described in this paper seeks to show how the textual features of documents reveal the meanings and the purposes for which

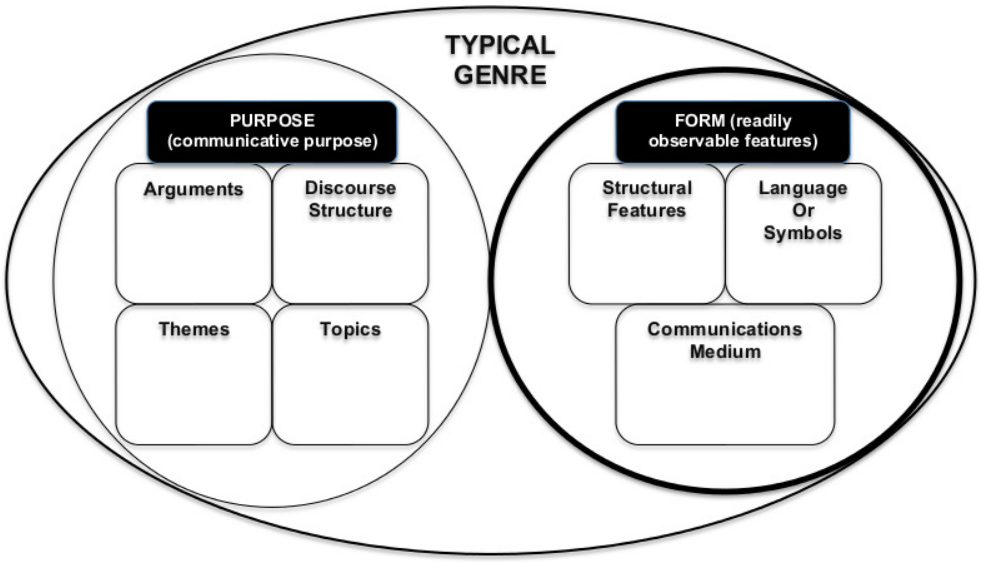


Figure 2: Diagram showing Yates and Orlikowski (1992, p. 15) definition of a genre's form and Purpose.

the text has been laid out and identify the form elements that are common to various e-mail genres. The methodology we used was intended to ascertain whether these categories of purpose and form were actually perceivable and measurable.

3. Theoretical Visual Perception

3.1. Prominent theories

There are two prominent theoretical visual perception processes, leading to different goals, through which human beings are thought to perceive: the Ecological goal, including the theory of Affordances, and the Constructivist goal processes. This is, of course, not to exclude the Gestalt movement (Koffka (1935), Köhler (1929), Wertheimer (1959)).

The constructivists defend a top-down approach, according to which perception leads to recognition, i.e., the perceiver uses sensory information, and builds or constructs this incomplete information to make sense of it (Braisby and Gellatly, 2005). Ecologists (Gibson and others) believe in an alternative and direct (bottom-up) framework for perception and Gibson, heavily influenced by Gestalt theories, not only challenged the stages but also intro-

duced the notion of 'affordance' (see Section 3.3 below) as a centrepiece for his theories and the Ambient Optical Array (Gibson, 1986).

To summarize, the ecological school believes that the goal of perception is perceiving in order to act, in this context, it could be the act of directing the attention of the reader to the salient properties of the text. The constructivists assert that the final goal in the perception process is recognition which would require intense cognitive processing, for example, Gregory (1980) and his theory of perceptual hypothesis. This involves the 'construction' in the brain of the meaning of an object (or text) or what it is.

3.2. Skimming and Scanning

"With such a large volume of material accessible from the World Wide Web, there is an urgent need to increase our knowledge of factors influencing reading from screen" (Dyson and Haselgrove, 2001).

The two kinds of reading techniques skimming and scanning are two techniques used for searching a stimuli, such as text or imagery at speed. Scanning is a technique that is used when a reader is looking for something, such as a keyword or key phrase: readers move their eyes over the text mostly horizontally and sometimes consciously fixate on the stimuli while looking for content; this process, in essence, demands the full attention of the reader so scanpath duration and length will be lengthier in duration and length. Scanning is usually employed by a reader who is looking at words, numbers or letters, for example, by a student who is looking for a definition in a dictionary, a phone number in a telephone book, or a bus-schedule on a timetable. Sometimes, the formatting of words (in italics or in bold) assists the reader to identify the object of the scanning.

Skimming is a technique which a reader uses to identify the main points or essence of a text without consciously taking in every word; this requires less attention (cognitive activity i.e. less fixations (counts and durations) and negligible saccadic regressions) and can be indicated by vertical movements rather than horizontal on the part of the reader looking at English texts from right to left (see section 5.2 for details of how the data was processed). A reader can also use this technique in order to decide whether a text is interesting and worth further reading. It is performed at a speed several times faster than conventional and is normally used when a reader has a large amount of text to read within a limited time and does not need to understand every word, for example, when a student has to perform a literature search,

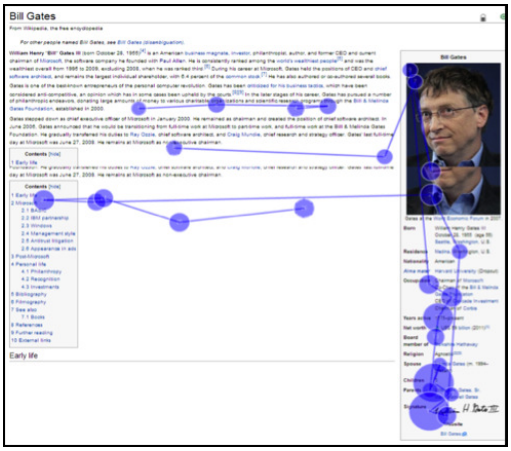


Figure 3: Snippet of Wikipedia article: Bill gates biographical article being scanned (gaze plots i.e. the bigger it is the longer duration in purple) from Clark et al. (2012).

an abstract could be skimmed to judge whether a particular article would be useful/relevant for the current research.

Many consider skimming and scanning to be techniques related to searching as opposed to strategies for reading, for example, Just and Carpenter (1987). In fact, they are both correct but reading and searching are two different contexts. In the context of this research we are examining visual search of text and not reading per se. Though scanning of course has some relevance to reading it is conducted at a faster speed than normal reading Rayner (1998). As Cole et al. (2010) found different tasks during reading comportment enabled the switching between skimming and reading behaviour and are inherent indicators of the present task. Scanning and skimming are two separate processes that substantially benefit such areas of research as reading and searching Scanning as described in Liversedge and Findlay (2000) helpfully is "a sequential attention scanning of elements. This scanning has often been assumed to be covert, using a 'mental spotlight'". The mental spotlight is quite a helpful analogy to describe a task, such as searching for a keyword etc. Masson (1983) describes skimming "for most of us, rapid reading involves some form of skimming in which we try to focus on information relevant to our goal and skip over irrelevant information". Masson also suggests that skimming in the task that was set for his participants involved ascertaining the "selective processing of the gist". Holmqvist et al. (2011) suggests that a "sequence of long saccades is likely to reflect skimming over the text". The

Figure 4: Snippet of Wikipedia article: 'List of deaths by death toll' being skimmed (gaze plots in light blue with long searching vertical saccades) from Clark et al. (2012)

reasons for deciding when, where and in which context to move the eyes are dependent on many different variables: e.g. the search task type; context, such as urgency of task, tiredness, age and interest in task. As Rayner (2009, pp. 1484) points out, equivalents between scene perception and visual search are greater than with reading because "visual saliency" plays a greater role in the directing fixations. By way of example, a search for a pack of nappies on a supermarket shelf amongst a huge amount of products or a search for a particular person in a large group picture (e.g. Where's Wally) or for a word in an email may well generate strategies that differ greatly from those used during the processes of skimming and scanning a text for a word. In each case, different ocular behaviour would be expected (Rayner, 2009, pp. 1484). Many methodologies and algorithms have been devised for the detection of reading, firstly for a baseline, then secondly, comparing those results to other data to detect skimming, scanning or both, for example Campbell and Maglio (2001), Buscher et al. (2008b) and Buscher et al. (2008a). However, the definitions of scanning and skimming may differ slightly amongst these authors and those cited, for example, in Campbell and Maglio (2001) skimming is defined as cognitively "medium interest" and scanning is "low interest". We argue that during skimming saccades are used mostly to take a holistic view of the stimuli, during which the Short Term Memory (STM) is low due to the suppression of cognitive activity i.e. saccades and vice versa. Many readers

look only at the abstract, the title, the first and last paragraphs, or even only the keywords. One main contention of this research is that an important aspect of the document structure, i.e., the layout or genre, is understated when considering the ocular behaviours in previous reading detection, skimming and scanning and comprehension experiments, for example, Just and Carpenter (1987), Just et al. (1982), Masson (1982) and Masson (1983).

3.3. Theoretical visual perception and genre–previous studies

Cognitively "Attention is guided by genre information" (Prof. Claire Michaels 2007, Personal Communication), and the abstract of an academic article allows a filtering decision to be made on whether the article is relevant or not; thus the filtering of the information load allows the reader to decide that he need not read a whole document because the genre provides the invariant cues to its relevance in its structure. In Watt (2009, p. 171) he opines, genres behave as "affordances" and in essence can be filtered and categorized by form.

Gibson's affordances are intended to describe how meaning and perception are inter-related: he argues in Gibson (1986, p. 127) that instead of perceiving objects (for example, texts) and then adding meaning later, there are visual combinations of invariant and distinctive characteristics of objects which provide cues on how to act and behave in relation to these objects (in this case textual e-mails). In the case of genre, these invariant properties or features are primarily layout cues, rather than linguistic cues (but admittedly sometimes can be both); they occur in two areas and are referred to in this project as shallow (or surface) features and deep features. There appears to be little consensus, however, on where these cues and features are located. Frow and Gibson seem to agree that the cues and features are located between the reader and the text in the 'visual array' (Frow) or the 'Ambient Optical Array' (Gibson).

In addition to the issue of investigating features (or invariants) there is also a case for exploring the possible actions which are afforded to the perceiver of documents; this is one of the main tenets of Gibsonian theory: 'perception for action' (Gibson, 1986). The affordances of genre, in our case, could be defined in terms of drawing the attention of the reader (the perceiver) to salient properties of the e-mail communication which could trigger a decision that a document is relevant to his/her search for a small item of information, such as, what is showing at the cinema that evening or even a large knowledge-seeking task, such as, a literature review.

Alternatively, Toms and Campbell (1999b), in their study, leaned towards the Constructivist (perception for recognition) process, since they aimed to contrast the content (function) and form in order to discover whether readers can perceive and process form on its own or need semantic content to identify it. They also aimed to question whether a participant referred to previous knowledge to identify a text, such as a web page, or used another technique.

Toms and Campbell (1999a) contended that the 'attributes' of a document's genre enable it to be specifically identified and showed that genre features play a significant role in recognizing documents. In Toms and Campbell (1999b) they performed experiments using form and function (content or purpose), exposing users, with backgrounds in IT and an academic environment, to digital and hard copies of web documents. They suggest that form is scanned and content is read so that possibly two processes are actually on going at the same time, and that function provides semantic hints which demonstrate the purpose of the genres. When the document structure was shown, however, Toms and Campbell (1999b, p. 2014) stated that:"participants had to match their sensory response with the corresponding representation stored in long-term memory". They also claimed that first of all, in order to identify a document using form, the user scanned and translated some or all of the visual cues present at the same time to locate the semantic clues. Secondly, the participants constructed or "loaded a set of expectations" which were founded on the available visual clues in the texts.

They argue that their results show that perception is a top-down process, in contrast to the Ecological bottom-up process, where the readers recognize the genres through the attributes of the layout which forms the basis of document recognition (or perception for recognition), and although Toms and Campbell, like Lakoff (1987), refer to the bottom-up process and suggest that genres may "act as a single gestalt" (Toms and Campbell, 1999a, p. 2015) they do not explore other possibilities, such as perception for action and how a genre is perceived when the document is displayed to a reader (in all fairness Watt (2009) also fails to explore the perception for recognition concept). In their conclusions, however, Toms and Campbell (1999a, p. 2015) query how the form of the document affects a user in the first few seconds of the interaction and this begs the question: how do the form features of a genre aid in text interpretation and use? This is one of the questions that forms a central part of our research.

In a later study, Toms (2001) claims that form is important but reinforces her perceptual claims by explaining: "because the unique shape triggers a

user's mental model of that class of genre. In interpreting the shape, a user develops a set of expectations about the document without first having to read the semantic content. Because the form takes on a distinctive visual appearance, document form essentially represents the shape of a document. Ultimately, the unique shape triggers a user's mental model of that class of genre. In interpreting the shape, a user develops a set of expectations about the document without first having to read the semantic content". Although the research carried out by Toms and Campbell (1999a), Toms and Campbell (1999b), Toms et al. (1999), Toms (2001), and then Watt (2009), seems to indicate a leaning towards one process or another (Watt Ecological and Toms Constructivist) the latter does explore Ecological in her thesis (Toms, 1997), it may emerge that they are both correct (or indeed wrong), but for different information searching tasks and in different contexts. It is possible that documents are identified and used in differing ways depending on the context of the task, the skill and expertise of the reader, reading and use. Here are several postulations as stated in Clark et al. (2012):

1. If the reading task is to be performed quickly, skimming is important, but if more time is available, more intensive scanning might take place.
2. If a participant is looking for a familiar text already seen, then the recognition process (scanning) is important but if the search is a fresh task looking for a particular genre then the ecological process could be vital, to save time.
3. It is possible that documents are identified and used according to differing methods depending on the context of the task, the skill and expertise of the reader, the reading and the use.

4. Eyetracking Study

4.1. Previous work

We conducted an analysis of the eyetracking data studying such basic metrics based on fixations, saccades and number of genres identified correctly along with length of time to identify, c.f. Clark et al. (2010). The measurements used in the experimental design were:

1. Mean fixation duration which is a metric normally used as an indication of information complexity, that is, the higher the duration the more complex the mental load/task

2. Mean fixation count for each genre
3. Mean gazing time
4. Saccadic rate per second which differs depending on task difficulty/mental load changes, that is, if task is difficult and cognitive processing increases then saccadic rate per second decreases and vice versa
5. Saccadic regressions indicate signs of less meaningful visual cues or features that lead the eye to 'regress' to the same locations looking for identification clues.

4.2. Scanpath definitions

A scanpath, also known as fixation sequences and scan patterns, is the path our eyes follow when presented with a stimulus, such as a photograph or webpage. Measurements of observed scanpaths are useful for analysing attention, the suppression of cognitive activity, interest, and salience. Each scanpath represents the spatial sequence of eye-movements for each participant during the eye tracking session. The scanpath mirrors clearly the unfolding of visual attention over time and indicates which features or contents in a visual context are attended (Coco, 2009). The movement represented by these scanpaths are not random, rather they reflect the viewer's frame of mind, expectations and purpose (Yarbus, 1967). A scanpath describes a sequential chain of saccade-fixation-saccade. A scanpath encompasses the entire series of the saccade-fixation-saccade, which can represent the patternation of ocular behaviour across the visual area of the stimuli. User scanpath behaviour can help to explain how a user navigates through the presented visual stimuli and during a search task.

4.3. Background/previous work on scanpaths - observed measurements

Measurements of observed scanpaths have been used in a multitude of different domains, such as, dyslexia research (Adler-Grinberg and Stark, 1978), cognitive computation (Humphrey and Underwood, 2011) and social phobias/anxiety disorders (Horley et al., 2003) and so on. Goldberg and Kotval (1999) conducted computer interface evaluations with twelve participants testing the interfaces whilst analysing their scanpath behaviour. The authors used scanpath duration (as we have done in this study), spatial density, transition matrix, scanpath regularity, spatial coverage calculated with convex hull area and the saccade/fixation ratio. From the analysis, they

determined that the better interface resulted in less, but similar duration fixations than the poor interface. Poorer interfaces led to less efficiency in search behaviour.

Goldberg et al. (2002) set out to evaluate specific design features for a prototype web portal application using scanpaths, etc. Lorigo et al. (2006), in an extension of the work in Pan et al. (2004), used scanpath fixations pattern-finding to compare the differences in gender and task type during a web search. They found differences in scanpaths according to gender, and the task comparison results although mixed, did not reveal any effects related to task type on scanpaths. Joachims et al. (2005) used scanpath measurements to examine the reliability of implicit feedback generated from click through data in Web searches. Brandt and Stark (1997) showed their participants visual imagery of irregularly-chequered diagrams. The analysis involved the string-edit methodology and they found that the arrangement of the fixations correlated with the spatial pattern of sub-features in the diagrammatic imagery; for an illusory picture, ocular behaviour was closely interconnected with the eye actions while viewing the same image.

After reviewing the very comprehensive and popular eyetracking scanpaths metrics in Goldberg and Kotval (1999), Goldberg et al. (2002), Salvucci and Goldberg (2000), Poole and Ball (2005) and comparing with the research questions and aims of the evaluation we decided on the two metrics: scanpath duration Fig.5. and scanpath length Fig.6. which also complemented our previous work. Unfortunately due to the limited nature of the data output in this particular software package we were very limited as to which scanpaths metrics we could use. The eye-tracking software package we used records raw gaze location data at the sampling rate of 60Hz which allows an eye movement to be recorded every 16.67 microseconds (ms).

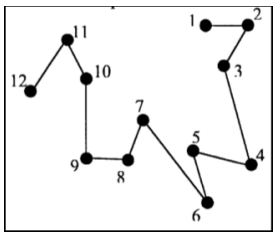


Figure 5: Example of scanpath duration from Goldberg and Kotval (1999, p. 638) 12 $(fixations)$ $\times$ 16.67 $(gazesample) = 200$ $microseconds$

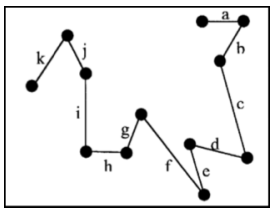


Figure 6: Scanpath length from Goldberg and Kotval (1999, p. 638) is computed by measuring (in pixels) the distances between each of the gaze point samples, for example, $= a + b + c + d \cdot \cdot \cdot + k$

5. Experimental Setup

This task-based study was observational/logged in design, based on questionnaires and end users' feedback in nature. Twenty-four participants took part in the experiment. Prior to beginning the identification task, each subject was given a three-minute introduction to the eye tracker as well as a guidance sheet as to what was to be expected. Each person was then asked to sign a consent sheet and then calibrated to the system before the eye tracking experiment was started; the Viewpoint PC-60 system calibrates the user's eyes. The experimental setup of the evaluation was based on commonly used standards c.f. Joachims et al. (2007) and Kelly (2009). Similar settings were also used in previous task-based evaluations, such as Harper and Kelly (2006), Huang et al. (2006), White et al. (2006). The experimental procedures, such as the time allowed for tasks and questionnaires, were based on methods and protocol used by previous interactive experiments (Dupont et al., 2010; Harper and Kelly, 2006; Huang et al., 2006; Kelly et al., 2007, 2008; White et al., 2002, 2006). The two questionnaires used 5-point Likert scales. The first (entry) questionnaire was used only to record demographic information, such as age, Web and e-mail experience, etc. The second (exit) questionnaire was used to compare and contrast the participants' familiarity with e-mails, and task evaluation.

5.1. Apparatus

The eye-tracker used in our experimental sessions was the Arrington PC-60 Viewpoint. The eyetracker is a desk-mounted device that allows the experimenter to detect the type of ocular behaviour each user makes when shown a stimuli. The Viewpoint software computes pupil height and width to better than 0.03 mm instantaneously and has blink detection and suppression. Temporal resolution is measured in Hertz (Hz), and records how

many times per second (p/s) the eye-tracker can sample the eye position. Temporal accuracy, in our case, was set at the maximum of 60Hz. The software logged eye data: X, Y position of gaze, pupil height and width, delta time, total time, and regions of interest (ROI) in which fixations, gaze times and saccades for each stimuli can be computed and recorded in an ASCII file. The monitor viewed by the participant was recorded by the Freeware application Wink which records using Flash. This allowed a playback of the session for each participant. The experiment was run using, at the time, a high specification dual core PC running Windows XP that had two monitors inter-connected to the same PC. The stimuli were shown randomly on a 15-inch monitor of 1024 x 760 pixel resolution. The recording was performed on another 15-inch monitor of the same type and resolution. The eyetracking interface is controlled by the experimenter(s) on one monitor whilst the other monitor shows the stimuli to the participants. To see what the participant sees, in regard to stimuli examples when making the judgements c.f. Fig's 6-11.

The smoothing algorithms used for the gaze data was the Simple Moving Average (SMA). The SMA method uniformly averages N pointsBack, i.e., all points having equal weight. The SMA rallies implementation during a fixation, but inclines to diminish the unexpected saccades from one fixation to the next. However, for this task it was suitable enough, as we didn't expect too much excessive ocular behaviour between users. The alternate is the Exponential Moving Average (EMA) is similar to the SMA but the EMA places more weight on the latest data. We also used IBM SPSS[1] and Microsoft Excel (version 2011 for the Mac) spreadsheet software.

5.2. Eye tracking data –data recording, capture, preparation and analysis

The eye tracking software records a large amount of types of data, such as:

1. logging –fixations
2. pupil dilations, queries
3. screenshots
4. timestamp
5. x/y location of the eye

[1]http://www-01.ibm.com/software/uk/analytics/spss/

The experimental eyetracking data was input into the SPSS software along with the data used in Clark et al. (2010) and then statistically evaluated. The raw data types, such as XY gaze points were used to determine the fixations and saccades data. Saccades, as stated in Holmqvist et al. (2011, pp. 23), are:"the rapid motion of the eye from one fixation to another (from word to word in reading, for instance) is called a*saccade*. Saccades are very fast - the fastest movement the body can produce- typically taking 30-80 ms to complete,...". Opposite to saccades, when the eyes are relatively still anywhere between tens of milliseconds and several seconds fixations occur: "...for example, when the eye temporarily stops at a word during reading." Firstly, to compute the Scanpath Lengths and Durations for each person we exported the raw data into Microsoft Excel. A formula (see Fig's 5 and 6, and originally by Goldberg and Kotval (1999, pp. 638)) for each metric was implemented to compute the means for the lengths and durations. Secondly, the experimental eyetracking scanpath data was then collated with the data used in Clark et al. (2010)[2] into the IBM SPSS software and then statistically evaluated. The data were used for cross-referencing to discover the, ocular strategies, attentional allocation (Scanpath Length) and cognitive processing complexity (Scanpath Duration).

In order to summarise the methodological stages of data processing to detect scanpath metrics and skimming and scanning occurrences:

1. **Data was exported from Arrington to Spreadsheet** Raw gaze data was exported from Arrington logs (Arrington use .WKS files[3]). After the tasks of detecting the scanpaths and the skimming and scanning techniques had been completed, the data was exported to SPSS for statistical analysis, as shown in sections 6.1 and 6.2.
2. **Scanpaths detected** The scanpaths were first detected and isolated from the gaze data for each stimulus, i.e. 64 images for each participant (n=24). A function was then implemented using the formulae shown in the Figures in Goldberg and Kotval (1999, p. 638) to calculate Length (Fig.5.) and Duration (Fig.6.)
3. **Skimming and scanning** The techniques were detected using the methodology employed in Campbell and Maglio (2001, p. 3) and Buscher et al. (2008a), with some modifications. These two papers

[2]mean fixation durations, mean fixation counts saccade lengths and saccadic regressions
[3]IBM Spreadsheet file extension primarily

reported on the detection of skimming and reading techniques, not skimming and scanning techniques. Our study, however, took the form of a visual search and categorisation task and, in this case, it was unlikely that a participant would have had time to 'read' a stimulus. If this had occurred, it would have shown up in the data obtained from Clark et al. (2010) i.e. the time taken to make an identification. Below is a summary of steps to detect skimming and scanning (most of the data processing was calculated using Microsoft Excel):

(a) We adopted the mode switch scoring system using "pooled evidence" described in Table 1 of Campbell and Maglio (2001, p. 3) to identify any changes of mode (scanning or skimming) within a "tokenized stream of eye-movement data" (Campbell and Maglio, 2001, p. 3).

(b) It should be noted that for the setting of the parameters, some research was necessary: first of all, we looked at the fixation duration descriptions found in Table 1 of Rayner (1998) who states that during the reading process, the fixation duration averages between 225 and 250ms. Our mean fixation durations within the scanpaths were on average 270ms, similar to that described by Rayner for Visual Search. To sum up: if a mean fixation duration in a sequence has more than two instances greater than 270 ms, this could be taken as an indication that scanning had played a part in the scanpath, whereas instances under 270 ms could be indicative of skimming. Secondly, the data which was not over the stimuli in the unformatted representation emails (U and UX described in section 5.7) was excluded from the analysis. This was simple to implement: the X/Y boundaries of the text were calculated and any data which was outside the email text co-ordinates was ignored (we did have to look for any instances of the scanpath 'drift', so we offset the cut-off parameters to allow a margin of error). Thirdly, like Campbell and Maglio (2001), the data was quantized by averaging the gaze points from 60Hz per second to 20Hz per second. Fourthly, we also used the scanpath length scores calculated by using the Fig.6 methodology to formulate heuristics for categorizing short, medium and long saccades in addition to that written below, for example, take average score for genre/representation from averages in section 6.2 then compute:

- below average score =short saccade

- equal to average length = medium saccade
- above average score = long saccade

(c) The use of skimming and scanning techniques was detected by referring to the 20 possible permutations found in Campbell and Maglio (2001, p. 3) and Buscher et al. (2008a) scoring was based on the short, medium or long movements, which were given a particular score whenever they occurred on the X or Y axes gaze point. In our analysis, we used the definitions of skimming and scanning shown in section 3.2. Medium and long saccades with low value fixation durations and multiple changes in directions were taken as indications of skimming; short and medium saccades, with at least one regression and mean fixation durations over 270ms, were taken as indications of scanning. Our scoring system differed from that shown in Table 1 in Campbell and Maglio (2001, p. 3): we used the term "skimming" to refer to the "long movement" mentioned by Campbell and scanning to refer to the 'short movement'. An example: $= 10(shortrightX(readforward)) + -5(shortupY(scanjump)) + -5shortupY(scanjump) + -10(shortleftX(regressionsaccade)) = -10$. According to Campbell and Maglio (2001, p. 3), a positive number is evidence that reading has taken place and a negative number is evidence of, skimming. Therefore, in our example shown above, the scanpath can be seen as pooled evidence of scanning, because the detection of a sequence of reading forward, small saccades and regressions is likely to reflect that behaviour because of the nature of the task.

5.3. Corpus

The e-mails collected for this task (Table 2) came from two sources. Firstly, e-mails sent from the university, such as information technology services (ITS notices), seminars and the library of the first named author above. Secondly, external e-mails, such as calls for papers, cinema, spam, newsletters and orders.

Although e-mails are genres in their own right, e-mails today contain subgenres with their own individual purpose and form. Our definition of these e-mail genres was decided in a prior investigation of the types of e-mails that commonly occurred in the e-mail accounts of several colleagues in our faculty, with the result, of course, that the participants in the experiment might not

Table 2: Types of E-mails for the eye-tracking experiment.

Type	E-mail Purpose	E-mail Form
Information Technology Services (ITS) Notices	Internal e-mail. Announces downtimes of servers and systems	Structural features: title uppercase, emboldened text items listing outage information.
Seminar (Sem).	Internal e-mail. Similar to calls for paper but internal announcement of invited talk.	Structural features: uppercase titles centred, block of text about speaker, abstract, and block of text about organizer (Fig 9. and Fig.10).
Library (Lib)	Internal e-mail. Message from library; reminder that a book is ready for collection/return.	Structural features: block of centred text, recipient details in uppercase. Opening salutation. Block of text (two paragraphs) terms and conditions, list of renewal item(s) referred to
Call for papers (Cfp)	Calls for submissions for conferences and workshops by announcing the requirements and important dates.	Structural features: large title, block of centred text (sometimes uppercased). Block of text explaining the event. Bullet points explaining scope of subjects for conference. Important dates / titles and dates in list format
Cinema (Cin)	Announces cinema listings, dates and times.	Structural features: uppercased cinema name/title rectangular block of text with name of film, rating, length, times per day of show.
Spam (Spm).	Scam letters with the motive of deceiving people to send money for a fraudulent cause.	Structural features: spam uses "letter" variation format. Top lines indicate type of spam i.e. Nigerian letter, lottery scam etc. (Fig.7. and Fig.8.)
Newsletter (NL)	Summarizes all the weekly news from an organization, i.e. Aberdeen Football club.	Structural features: lists of items emboldened. Opening salutation to the recipient. Emboldened title with small summary paragraph and URL below each for the e-mail. URL at end to unsubscribe.
Orders (Ord)	Confirmation from a business of an order for item(s) online i.e. Next, Tesco, etc.	Structural features: Order number and "thank you for the order details". Table created with format using lines consisting of symbols (-*/) with details of the order: quantity, item ordered unit cost and, at very bottom, total cost. Delivery address uppercased and the date of delivery of the order (Fig.11. and Fig.12)

have been familiar with the selected e-mail types. None of the participants in the experiment contributed any e-mails to the study. These eight types of e-mails used in the study are normally composed of several layers or sections, organized in a certain form using observable features and cues such as uppercasing of text, centring of sentences/paragraphs, blocks of text or numerical values and tables containing some of the features above. In the study design all the e-mails were ASCII format and normalized by length to prevent the possibility of the different results being due to the length of the e-mails rather than genre or representation. Occasionally the e-mails were artificially changed by length: in the Orders e-mails some of the items purchased were removed or Cinema movie lists normalized to make the e-mails the same length uniformly. However, in most cases only e-mails within a certain agreed length were chosen and picked by the authors. During the experimental analysis of ocular data and feedback from the participants via the questionnaires there was no indication of length of e-mail being a characteristic to identify specific e-mails either by genre or representation. Just like Watt (2009) - in his timed response design - we balanced for length and still found a very strong effect (an interaction - between layout representations) which indicated that genre speed was a factor independent of length, as in Clark et al. (2009b, 2010). We collected a pool of similarly sized images containing 6 examples of each genre giving a total of 48 e-mails. We were interested in the relative roles of purpose versus form in identifying e-mail genres. To test these, we followed the same data formatting approach previously used in Toms and Campbell (1999b), and later e-mail work by Watt (2009). Here, form refers to the structural formatting of the e-mails whereas purpose is seen as the content. Each e-mail was altered into four representations making 192 images in total. The four representations are listed in Section 5.7.

5.4. Research Questions

In this analysis, we are still asking the original questions from Clark (2008); Clark et al. (2008, 2009b, 2010), but we are also extending the scope of the questions shown in the Introduction.

5.5. Procedural Task

Each participant was shown a total of 64 e-mails, and asked to identify each genre by voice, while the eye-tracking system recorded the ocular behaviour of the participants when shown each stimulus. The eye-tracking

equipment was fixed to the desk; only a simple answer to identify the genre was possible, because detailed discussions (head/face movements) would have interfered with the eye tracking.

To reduce any possible order effects, the types of e-mail and their allocation were randomized by the eye tracker software for each participant using a 4-by-4 Latin Square. The order of activities was consent form and information sheet, short training session, calibration of eye tracking system, entry questionnaire, show each stimulus: 4 x blocks of 16 images and ask for an identification of type of genre whilst eye-tracker records viewing behaviour, exit questionnaire. There was a two-minute rest break after 32 images (2 blocks of 16 images) after which the calibration was repeated and the second set of 32 images was shown.

The reason that the procedure was split into blocks was two-fold:

1. The ability of the participants to remember all eight genres they were identifying was discussed during the design and once the pilot was complete it was found to be very difficult, so we split them into four blocks.
2. The equipment we were using was uncomfortable for the users to use if they sat in one position for too long. To expect them to sit without a break during the whole process would have been torturous so we split the images into four blocks to allow the participants to have a break in between each two blocks (if they required it). Additionally, it was also discovered that if we continued screen recording with the Screen Capture software Wink[4] for too long it would crash, leaving us with no visual data to examine due to running out of RAM and the software causing an out of memory exception.

5.6. Participants

Twenty-four unpaid volunteers took part in the experiments. The average age of the participants was 31.5; all were between 20-48 years old. The participants dealt with e-mail on a daily basis at work and could be expected to be familiar with the genres contained within the corpus: six faculty members, fourteen students and four administrative/technical staff. All participants were fluent in written and spoken English. Participants were asked about their prior familiarity with the eight types of genres used in this

[4]Available at: http://www.debugmode.com/wink/.

study and the results are shown in Table 3 below. The majority, i.e., at least 70% of the participants, were familiar with each genre (score of at least 3). The exceptions were cinema and seminar announcements, with which over one-third of the participants were largely unfamiliar.

Table 3: E-mail familiarity amongst participants recorded from the questionnaire. Familiarity (1=completely unfamiliar 5=completely familiar) N.B.percentages rounded down.

Type	Familiarity				
	1	2	3	4	5
Call for papers (Cfp)	5%	13%	8%	30%	44%
Cinema (Cin)	25%	16%	29%	16%	12%
Spam (Spm)	0%	0%	4%	29%	66%
Newsletter (NL)	8%	16%	16%	37%	20%
Orders (Ord)	4%	8%	12%	28%	45%
Information Technology Services (ITS) Notice	4%	4%	8%	32%	48%
Seminar (Sem)	12%	24%	12%	28%	20%
Library (Lib)	16%	12%	20%	32%	16%
Mean	9%	12%	15%	29%	33%

5.7. Independent variables

The variables tested were as follows:

1. Type of e-mail genre (Table 2)
2. Form - three comparisons:
    - **Blocks:** Blocks 1 & 2 (genre types: Call for Papers, Spam, Cinema and Newsletters. Blocks 3 and 4 (genre types: Information Technology Services (ITS) Notice, Seminar, Library and Orders genres.) A comparison is carried out between blocks 1 and 2 and between blocks 3 and 4 in order to ascertain whether there are any significant cognitive differences between the scanpaths from block to block.
    - **Genre types:** Call for Papers, Spam, Cinema and Newsletters, Information Technology Services (ITS) Notice, Seminar, Library and Orders genres. A comparison is carried out between blocks 1

and 2 and between blocks 3 and 4 in order to ascertain whether there are any significant cognitive differences between the scanpaths from genre to genre. This comparison can indicate the differences in cognitive processing as the experiment progressed, for example, is there is a pattern showing the scanpaths got shorter or longer from genre to genre?

- **Representations:** Four representations of the above eight genres were original e-mail (condition 1) with no formatting or content changes; the e-mail with the original formatting but with semantic content replaced with X or 9s (condition 2). This version retained possibly useful structural formatting clues but did not provide any content for the semantic identification of the e-mail. Successful identification of genre based on this version would indicate the role played by structural form in identifying genre; the e-mail with the original textual content but all structural formatting removed (condition 3). This version retains punctuation but presents the text as a stream of text; condition 4 was the e-mail with all content replaced by Xs or 9s (as in condition 2) and all structure removed (as in condition 3). This version gives no indication of content and acts as a baseline to measure participants' attempts to identify e-mail genre. A comparison is carried out between representations in order to ascertain whether there are any significant cognitive differences between the scanpaths from representation to representation.

6. Results

6.1. Scanpath duration

The scanpath duration measure is used to see how much time participants spend on processing information and "complexity" (Goldberg and Kotval, 1999, p. 638); a longer scanpath duration indicates participants are spending more time processing information and hence classifying information is far more 'intensive'. For each variable, a one-way ANOVA was conducted to assess the scanpath durations by blocks (Table 4), genre (Table 5 & Table 11) and representation (Table 6).

There were significant differences between blocks 1 & 2 (p=0.001) and blocks 3 & 4 (p=0.001). The scanpaths in this case, most notably, became

Table 4: Mean scanpath durations by block

Block 1	Block 2	Block 3	Block 4
1490 m/s	1164 m/s	570 m/s	470 m/s

shorter in duration (measured in microseconds) between the blocks 1-2 and blocks 3-4. This might be an indication that the participants found the e-mails easier to process cognitively and thus 'identify' as time went on. It might also show that cognitive processing diminished over time as the tasks became easier.

Block 2 indicated shorter durations of scanpaths compared with block 1. It may therefore be assumed that from the cognitive processing perspective; the first four types of e-mails became less complex when presented during the experimental session. The scanpath durations in blocks 3 and 4 followed the same trend, but all showed much shorter durations which indicates that the task became easier as the experiment progressed, and/or the four genres were less cognitively complex. Three of the four genres in blocks 3 and 4 were internal types of e-mail to The Robert Gordon University, which may also have been a relevant factor.

Table 5: One-way ANOVA mean scanpath durations by genre in microseconds

	Numerator (DF)	Denominator (DF)	F-Value	Sig
Genre	7	1535	29.222	p=0.000

As shown in Table 11 the block 1 and 2 e-mails (Calls for Papers, Spam, Newsletters and Cinema) the scanpath durations were much longer than blocks 3 and 4 (ITS, Library, Order and Seminar) and thus generally seemed more complex to decode overall. The ITS e-mails had the shortest durations in blocks 3 and 4, and the seminars, the longest. In blocks 1 and 2 (11), the Cinema e-mails were the least complex and the Newsletters, the most complex; the latter result was not surprising since the Newsletters had the least amount of formatting to aid in the decoding of its identification by the participant [5]

[5]The identification mentioned is self-reported by the participants and not always correct.

Table 6: One-way ANOVA mean scanpath durations by representations in microseconds

	Numerator (DF)	Denominator (DF)	F-Value	Sig
Representation	3	1535	12.922	p=0.000

Bonferroni post-hoc tests revealed that there were significant differences between the four representations specified in Table 6 Section 5.7. The normal (N) representation is significantly shorter than the formatting retained with contents removed (X) (p=<0.001). The X representations' duration was significantly longer than the normal (N), unformatted (U) and unformatted with no contents were (UX) all (p<0.001). The unformatted (U) e-mails were shorter in duration than X e-mails (p<=0.001). The UX e-mails were only significantly shorter than X (p=<0.001). With regard to the scanpath duration representations, the normal e-mails (considered as a baseline) were the shortest; unformatted with no content (UX) format were the next longest; unformatted with content (U), the third longest, formatted with no content (X) stimulated the longest scanpaths.

6.2. Scanpath Length

Scanpath length is computed by summing the distance in pixels (px) between the gazepoint samples. For information search tasks, the ideal scanpath is a straight line to the target, with relatively short fixation duration at the target (Goldberg and Kotval, 1999, p. 638). Shorter scanpaths are interpreted so that the information is well-organized and easier to locate e.g. in text or a user interface. Lengthy scanpaths indicate less efficient scanning behaviour but do not distinguish between search and information processing times unless compared with other metrics, such as fixation based measures. Since the scanpaths are formed by computing the fixations and saccades, this allowed us to make inferences about the allocation of the user's 'attention' i.e. cognitive processing to the stimuli (Goldberg and Kotval, 1999, p. 638). In other words, searching was far more 'intensive'.

For each variable, a one-way ANOVA was conducted to assess scanpath lengths by blocks (Table 7), genre (Table 8 and 10) and representation (Table 9).

There were significant differences between blocks 1 & 2 (p=.001) and blocks 3 & 4 (p=.040). The scanpath lengths in this case became spatially

Table 7: Mean scanpath lengths by block (px)

Block 1	Block 2	Block 3	Block 4
2960 px	1623 px	618 px	742 px

shorter between blocks 1 & 2 but the participants' scanpath lengths became longer from block 3 to 4. The differences of the scanpath lengths in blocks 1 & 2 were significantly large (Table 7). Block 1 (mean=2960px) was almost twice the size of block 2 (mean=1623px) from which it could be inferred that the image-searching processes became more efficient as the blocks progressed.

Table 8: One-way ANOVA mean scanpath lengths by genre in pixels (px).

	Numerator (DF)	Denominator (DF)	F-Value	Sig
Genre	7	1535	63.988	p=0.000

The scanpath lengths (Tables 8 and 10) followed roughly the same trend as the durations. The block 1 & 2 e-mails (Calls for Papers, Spam, Newsletters and Cinema) scanpath lengths were less efficient in scanning for features overall but the differences were statistically insignificant between them, with one exception, seminar e-mails. The scanpaths for this genre were statistically shorter (Tables 8 and 10) than all the block one e-mails. Blocks 3 & 4 (ITS, Library, Order and Seminar) e-mails were overall more efficient to search. The scanpath lengths/scanning behaviour of the Seminar e-mail was the least efficient, ITS was second least efficient, third was the Library e-mail and the least efficient was the Order. As the scanpaths were formed from computed fixations and saccades we can extrapolate the apportionment of attention to the particular e-mail genres, i.e. the longer the scanpaths, the more attention that is given to making the identification, and vice-versa.

Table 9: One-way ANOVA mean scanpath lengths by representation in pixels.

	Numerator (DF)	Denominator (DF)	F-Value	Sig
Representation	3	1535	6.909	p=0.000

Bonferroni post-hoc tests revealed that there were significant differences be-

tween the different representations of e-mails. The normal (1313 px) e-mails were statistically shorter (p=<0.001) than the X (1822 px). The normal (N) e-mails were significantly longer than all other types of e-mail representations. N (p=<0.001), U (p=0.002) and UX (p=0.008). The U (1380 px) e-mail scanpaths were significantly spatially shorter (p=0.002). The UX (1427 px) e-mails' scanpaths were significantly spatially shorter than the X (p=0.008). In the representations, the Normal (N) scanpath lengths were significantly shorter in length than the formatted with no content (X) e-mails; the formatted with no content (X) caused longer scanpath lengths than all the other representations. The unformatted and no content e-mails (UX) caused significantly shorter scanpath lengths than the formatted with no content (X). This reinforces our hypothesis on the potential effect of structure, while searching and scanning for information, on a stimulus such as an image or document.

6.3. Familiarity

After statistical testing in this experiment familiarity had no bearing on the scan path metrics and there is no evidence of a relation. The reason for this we cannot specify but can stipulate that this is not the reason for the difference in the data reported in the results section.

6.4. Post-experiment comments

On completion of the experiment, each of the 24 participants was given the exit questionnaire which asked them to name the features that they thought had been most significant in identifying the e-mails (Tables 12 and 13). After the participants had attempted to identify the genre, they indicated the most characteristic feature(s) of the image and later explained briefly how they reached that decision by means of post-experiment interview.

Overall, participants reached analogous conclusions about these features as summarized in (Tables 12 and 13), with little variation. However, there were dissimilarities between participants at the feature level, which as Toms and Campbell (1999b) found precludes the specification of an exclusive parsimonious set of attributes per genre. The features listed were the most characteristic features after we manually meticulously noted them after analysing the data. During the experiment each image was shown to each participant and then the on screen eye tracking scanpath activity was captured by screen recording. We then interpreted the fixation clusters/scanpath activity over

the areas of interest i.e. features, such as emboldened titles by examining each screen shot manually.

6.5. Summary of research question findings

1. **What are the relative contributions of form in the scanpaths during the identification of genres of e-mail? Are there instances of mutually dependent elements?** How do the form features of a genre aid in text interpretation and use? As can be seen in Tables 12 and 13, the participants themselves identified features of form, for example, main titles and sub-titles, emboldened text, blocks of content (text and numerical) typically justified. Numeric characters (especially in blocks) were also important, whether they were replaced or not. As regards interdependence, several genres were identified in form by the block shapes, in particular, seminars, calls for papers, and cinemas (which also contained blocks of numerics that were very helpful). The evidence in the data shown in Tables 6-8 in Clark et al. (2010) and collected here indicates a higher level of fixations and the longest scanpaths for the e-mails only represented by form with no content. This indicates the steep rise in ocular behaviour that is produced in the participants when they are shown the e-mail stimuli. The structure effect also lessens from one block to the next block, e.g., the scanpaths shortened in length distinctly from blocks 1 and 2. The form features which exhibit the genres were thus very important for the interpretation and categorization of the e-mails.
2. **Do the lengths of scanpaths significantly differ between each e-mail representation?** The scanpaths are statistically longer in the scanpaths of the e-mails with no content replaced by Xs and 9s (X) but with structure intact. Cross-comparison with Table 6 in Clark et al. (2010) revealed that the scanpaths for this representation were the longest overall (1822) dominated by fixations (mean count 8.09). The normal (N) e-mails had the lowest length scanpaths and the lowest number of mean fixations in the scanpaths which indicate a higher amount of saccadic behaviour. The unformatted e-mails with content (U) had a short scanpath length but the second highest mean count of 7.45 fixations. The unformatted with no content (UX) had the second longest scanpaths overall but the majority were saccades rather than fixations (6.64).

3. **Do the lengths of scanpaths significantly differ between each e-mail genre?** The scanpaths for the calls for papers, cinema, newsletters and spam were significantly longer than the ITS, Library, orders and seminars. Cross-comparison with the e-mail genres, (Table 6 in Clark et al. (2010)), revealed that the calls for papers, newsletters and spam had the highest level of fixations and longest scanpaths overall. This was not a surprise, since the participants were most familiar with these three genres, and we can therefore deduce that these e-mails were recognised because of previous experience. The ITS, orders and seminar e-mails had very short scanpaths but also a low number of fixations, so the scanpaths were mainly formed from saccades. On the opposite side were the library e-mails which had the second shortest scanpaths in all eight genres but a high number of fixations.
4. **Do the durations (gaze point samples) of scanpaths significantly differ between each e-mail representation?** The scanpath duration for the formatted but no contents (X) e-mails were the longest along with the highest count of fixations, this indicates a higher level of cognitive processing. The unformatted (UX) e-mails had the second longest scanpaths and second largest number of fixations which again indicate that the users spent more time fixating during the scanpaths. The smallest duration of scanpaths occurred during the normal e-mails with the lowest number of fixations. This is indicative of the scanpath containing more saccades than fixations, especially if cross-referenced with saccades per second, as shown in Table 8 in Clark et al. (2010).
5. **Do the durations (gaze point samples) of scanpaths significantly differ between each e-mail genre?** The scanpaths for the e-mails call for papers, cinema, newsletters and spam were significantly longer than the ITS, Library, orders and seminars. Cross-comparison with the e-mail genres, as shown in saccades per second Table 6 in Clark et al. (2010), calls for papers, cinema, newsletters and spam revealed that although the calls for papers, spam and newsletters had the highest level of fixations and the longest scanpaths overall, the cinema and newsletters had a low number of fixations which indicates a low level of cognitive processing and more saccades. The two genres, call for papers and spam, were the most familiar to the participants, but we cannot deduce that these e-mails were recognized as a result of previous experience. The ITS, orders and seminar e-mails had very short scanpaths but also a low number of fixations, so the scanpaths were

mainly formed from saccades. On the opposite side, were the library e-mails which had the second shortest scanpaths of all the eight genres but a high number of fixations.

6. **Do participants 'fixate upon' shapes/features of the layout of e-mail texts in four different structures by predominantly using fixation ocular behaviour?** As can be seen in Fig. 13 and Fig. 14, the participants' fixated on blocks of text (paragraphs), emboldened and centred titles (e.g.calls for papers) and blocks of numerics (e.g. cinema) and uppercase Xs on spam e-mails, of which there are many in the 'Nigerian letter' type.
7. **Is there any evidence of Frow (2006, pp. 103-109) 'Frame' theory (see 2.1.2) in user activities involving internal and external cues, while they are identifying the e-mails?** The types of cues used by our participants have reinforced the ideas put forward by Frow (2006) and also Genette (1997, p. 1). Particularly in the e-mails which consisted of structure with no content, the outer frame cues, i.e. paratextual information, were used because the participants perceived the shapes first, such as 'chunks' of texts like paragraphs. If the participants were then still uncertain they moved onto the internal cues, not the semantic content in this context, however, but structural cues, such as emboldened, and centralized titles, concentrations of numeric characters (replaced by 9s in orders and cinema e-mails) and many other instances of formatting and layout. In the unformatted e-mails, these behaviours were not recorded, but with one exception? The e-mails with a high concentration of numeric characters, such as orders and cinemas, were treated as internal cues for their genre identities.

8. **Are there instances of skimming and scanning behaviour, particularly in shapes of features of the layout of e-mail texts in four different structural representations?** By studying the data as described in Section 5.2 in the plotting of gaze data of e-mail representations, such as normal (N) and normal structure with no semantic content (X) there were many instances of genres and representations identified by our participants which contained instances of skimming - e.g. Fig .13, as detected using the methodology discussed in Section 5.2) - and scanning (Fig.14.) as also detected by the methodology discussed in Section 5.2).

7. Future Work

We intend to continue our research by looking at other genres on other web communities of practice, notably Wikipedia, to expand on previous work in Clark et al. (2009a, 2012) and using, in addition, two university intranets web data. This will give us a wide range of community discourse-based data to examine users' interactions to ascertain the value of form during real search tasks whilst they are being recorded using a more sophisticated eye tracker along with a software suite with a wider range of fixation-based metrics. It is also essential to continue with the thorough analysis of the data for each participant to ascertain the types of ocular behaviours predominant during the tasks.

8. Conclusions

This work is a continuation of the previous pilot studies conducted by Toms and Campbell (1999b) and the later study carried out by Watt (2009) on the findings of Toms and Campbell, to examine the importance of form and purpose (or function, which Toms and Campbell referred to as being synonymous with content) in communities of practice, but with the inclusion of more data. We provide additional empirical evidence two scanpath metrics testifying to the great significance of textual structure, in particular, genre, during search and identification. Not only was genre revealed as being important holistically but also our particular collection of texts showed the important structural features which form the whole. Our results have shown how, in most cases, the structural formatting and layout cues from the texts seemed to make our participants employ quite intensive scanning behaviour in which the participants matched what they were seeing with the information stored in their short term memories. As the experimental sessions continued, the scanpaths shortened, which seemed to indicate less cognitive processing and, at the same time, the 'affording' of the genre for identification. It should be noted that sometimes, in a few cases when there was a small amount of cognitive processing due to lack of fixations, there were also long saccades that may be seen as indicating the skimming of the structural aspects of the e-mails by the participants. Interestingly enough, however, by cross-referencing of the data in Clark et al. (2010), such as mean fixation durations and the scanpath data in SPSS did not reveal any particular patterns between the scanpath metrics and familiarity. Finally, the

results of the experiment also provided support for the theory that structural information, such as format and layout, plays an important role in human text categorization and that the messages can even be categorized correctly with all words omitted.

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References

D. Adler-Grinberg and L. Stark. Eye movements, scanpaths, and dyslexia. *American Journal of Optometry and Physiological Optics*, 55(8):557–570, 1978.

Aristotle. *The rhetoric and the poetics of Aristotle*. Modern library college editions series. McGraw-Hill Higher Education, New York, NY, USA, 1st edition, 1954.

T.O. Beebee. *The ideology of genre: A comparative study of generic instability*. The Pennsylvania State University Press, University Park, PA, USA, 1994.

N. Braisby and A. Gellatly, editors. *Cognitive psychology*. Oxford University Press, Oxford, 1st edition, 2005.

S. A. Brandt and L. W. Stark. Spontaneous eye movements during visual imagery reflect the content of the visual scene. *Journal of Cognitive Neuroscience*, 9(1):27–38, 1997.

L. Breure. Development of the genre concept, August 2001. URL `http://people.cs.uu.nl/leen/GenreDev/GenreDevelopment.htm`.

Georg Buscher, Andreas Dengel, and Ludger van Elst. Eye movements as implicit relevance feedback. In *CHI '08 Extended Abstracts on Human Factors in Computing Systems*, pages 2991–2996, New York, NY, USA, 2008a. CHI EA '08, ACM.

Georg Buscher, Andreas Dengel, Ludger van Elst, and Florian Mittag. Generating and using gaze-based document annotations. In *CHI '08 Extended Abstracts on Human Factors in Computing Systems*, pages 3045–3050, New York, NY, USA, 2008b. CHI EA '08, ACM.

Christopher S Campbell and Paul P Maglio. A robust algorithm for reading detection. In *Proceedings of the 2001 workshop on Perceptive user interfaces*, pages 1–7. ACM, 2001.

D. Chandler. Intertextuality, 2011. URL `http://users.aber.ac.uk/dgc/Documents/S4B/sem09.html`.

M. Clark. Doctoral forum. In *Proceedings of the 2nd symposium on information interaction in context (IIiX) 2008*, London, UK, 14 October 2008 2008. BCS, ACM.

M. Clark, I. Ruthven, and P. O' B. Holt. Genre analysis of structured e-mails for corpus profiling. In *Proceedings of the Workshop on Corpus Profiling for Information Retrieval and Natural Language Processing*. British Computer Society HQ, London, EWICS, 2008.

M. Clark, I. Ruthven, and P. O' B. Holt. The evolution of genre in wikipedia. *Journal for Language Technology and Computational Linguistics*, 25(1):1–22, 2009a.

M. Clark, I. Ruthven, and P. O' B. Holt. How do people interact with structured e-mails in terms of genre and perception? In *Proceedings of the Conference on Information: Interaction and Impact (I3)*, Aberdeen, Scotland, 2009b. I3.

M Clark, I Ruthven, and P. O' B. Holt. Perceiving and using genre by form - an eye-tracking study. *Libri: International Journal of Libraries and Information Services*, 60(3):268–280, 2010.

M. Clark, I. Ruthven, P. O' B. Holt, and D. Song. Looking for genre: the use of structural features during search tasks with wikipedia. In *Proceedings*

of the 4th Information Interaction in Context Symposium, pages 145–154, New York, NY, USA, 2012. IIiX 2012, ACM.

M. I. Coco. The statistical challenge of scan-path analysis. In *Proceedings of the 2nd Conference on Human System Interactions*, pages 372–375, Catania, Italy, 21-23 May 2009 2009. HSI 2009, IEEE Press.

M. J. Cole, J. Gwizdka, R. Bierig, N. J. Belkin, J. Liu, C. Liu, and X. Zhang. Linking search tasks with low-level eye movement patterns. In *Proceedings of the 28th Annual European Conference on Cognitive Ergonomics (ECCE 2010)*, pages 109–116, Delft, Netherlands, August 25 - 27, 2010 2010. ECCE 2010, ACM New York.

T. Collins, P. Mulholland, and S. Watt. Using genre to support active participation in learning communities. In *Proceedings of the European Conference on Computer Supported Collaborative Learning*. Euro CSCL 2001, KMI, 21-24 Mar 2001 2001.

N. Dewdney, C. VanEss-Dykema, and R. MacMillan. The form is the substance: classification of genres in text. In *Proceedings of the Workshop on Human Language Technology and Knowledge Management*, volume 2001, pages 1–8. HLTKM 2001, Association for Computational Linguistics, Stroudsburg, PA, USA, 2001.

G. Dupont, S.A. Requier, S. Adam, Y. Lecourtier, B. Grilheres, and S. Brunessaux. A step toward an adaptive composition of query suggestion approaches. In *Proceedings of the 3rd Symposium on Information Interaction in Context*, pages 271–276. IIiX 2010, ACM, 2010.

Mary C. Dyson and Mark Haselgrove. The influence of reading speed and line length on the effectiveness of reading from screen. *International Journal of Human-Computer Studies*, 54(4):585–612, 2001.

A. Freedman and P. Medway, editors. *Genre and the new rhetoric*. Critical Perspectives on Literacy and Education. Taylor & Francis Group, London, 1994.

J Frow. *Genre and Interpretation*, chapter 5, pages 101–123. The New Critical Idiom. Routledge Taylor & Francis Group, Oxon, UK, 1 edition, 2006.

G. Genette. *Paratexts: thresholds of interpretation*. Literary Criticism. Cambridge University Press, Cambridge, 1997.

J. J. Gibson. *The ecological approach to visual perception*. LEA, New Jersey, 2nd edition, 1986.

J. H. Goldberg and X. P. Kotval. Computer interface evaluation using eye movements: methods and constructs. *International Journal of Industrial Ergonomics*, 24(6):631–645, 1999.

J. H. Goldberg, M. J. Stimson, M. Lewenstein, N. Scott, and A. M. Wichansky. Eye tracking in web search tasks: design implications. In *Proceedings of the 2002 Symposium on Eye tracking research & applications*, pages 51–58. ETRA 2002, ACM, 2002.

R.L. Gregory. Perceptions as hypotheses. *Philosophical Transactions of the Royal Society of London. Series B Biological Sciences*, 290(1038):181–197, 1980.

DJ. Harper and D. Kelly. Contextual relevance feedback. In *Proceedings of the 1st Symposium on Information Interaction in Context*, pages 129–137. IIiX 2006, ACM, 2006.

E.D. Hirsch jr. *Validity in interpretation*. Yale University Press, New Haven, 1967.

Kenneth Holmqvist, Marcus Nyström, Richard Andersson, Richard Dewhurst, Halszka Jarodzka, and Joost van de Weijer. *Eye Tracking:A comprehensive guide to methods and measures*. Oxford University Press, Croydon, UK, 2011.

K Horley, L. M. Williams, C. Gonsalvez, and E. Gordon. Social phobics do not see eye to eye: a visual scanpath study of emotional expression processing. *Journal of Anxiety Disorders*, 17(1):33–44, 2003.

F. Huang, S.N.K Watt, D. J. Harper, and M. Clark. *Robert Gordon University at INEX 2006: Adhoc track*, volume 4518/2007 of *Lecture Notes in Computer Science*, pages 64–72. Springer-Verlag, Berlin, 2006.

K. Humphrey and G. Underwood. See what i'm saying? expertise and verbalisation in perception and imagery of complex scenes. *Cognitive Computation*, 3(1):64–78, 2011.

T. Joachims, L. Granka, B. Pan, H. Hembrooke, and G. Gay. Accurately interpreting clickthrough data as implicit feedback. In *Proceedings of the 28th Annual International ACM SIGIR Conference on Research and Development in Information Retrieval*, pages 154–161. SIGIR, ACM, 2005.

T. Joachims, L. Granka, B. Pan, H. Hembrooke, F. Radlinski, and G. Gay. Evaluating the accuracy of implicit feedback from clicks and query reformulations in web search. *ACM Transactions on Information Systems (TOIS)*, 25(2):7, 2007.

M.A. Just and P.A. Carpenter. *The psychology of reading and language comprehension*. Allyn & Bacon, Old Tappan, NJ, USA, 1987.

Marcel A Just, Patricia A Carpenter, and Jacqueline D Woolley. Paradigms and processes in reading comprehension. *Journal of Experimental Psychology: General*, 111(2):228–238, 1982.

D. Kelly. Methods for evaluating interactive information retrieval systems with users. *Foundations and Trends in Information Retrieval*, 3(1-2):1–224, 2009.

D. Kelly, N. Wacholder, R. Rittman, Y. Sun, P. Kantor, S. Small, and T Strzalkowski. Using interview data to identify evaluation criteria for interactive, analytical question-answering systems. *Journal of the American Society for Information Science and Technology*, 58(7):1032–1043, 2007.

D. Kelly, DJ. Harper, and B. Landau. Questionnaire mode effects in interactive information retrieval experiments. *Information Processing and Management*, 44(1):122–141, 2008.

K. Koffka. *Principles of Gestalt psychology*. Harcourt Brace, Oxford, England, 1935.

W. Köhler. An old pseudoproblem. *Naturwissenschaften*, 17:395–401, 1929.

J. Kristeva. *Desire in language: a semiotic approach to literature and art*. European Perspectives Series. Columbia University Press, New York, 1980.

B. H. Kwaśnik and K. Crowston. Introduction to the special issue: genres of digital documents. *Information Technology & People*, 18(2):76–87, 2005.

G. Lakoff. *Women, fire, and dangerous things: what categories reveal about the mind*. University of Chicago Press, Chicago, US, 1987.

S. P. Liversedge and J. M. Findlay. Saccadic eye movements and cognition. *Trends in Cognitive Sciences*, 4(1):6–14, 2000.

R. F. Lorch. Text-signaling devices and their effects on reading and memory processes. *Educational Psychology Review*, 1(3):209–234, 1989.

L. Lorigo, B. Pan, H. Hembrooke, T. Joachims, L. Granka, and G. Gay. The influence of task and gender on search and evaluation behavior using google. *Information Processing & Management*, 42(4):1123–1131, 2006.

M.E.J. Masson. Cognitive processes in skimming stories. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 8(5):400–417, 1982.

M.E.J. Masson. Conceptual processing of text during skimming and rapid sequential reading. *Memory & Cognition*, 11(3):262–274, 1983.

B. Paltridge. *Approaches to genre*, chapter 2, pages 2–46. Pragmatics & Beyond New Series. John Benjamins Publishing Company, Amsterdam, 1997.

B. Pan, H. A. Hembrooke, G. K. Gay, L. A. Granka, M. K. Feusner, and J. K. Newman. The determinants of web page viewing behavior: an eye-tracking study. In *Proceedings of the 2004 Symposium on Eye Tracking Research & Applications*, pages 147–154, San Antonio, Texas, 2004. ETRA 2004, ACM Press.

A. Poole and L. J Ball. Eye tracking in human-computer interaction and usability research: current status and future. In C. Ghaoui, editor, *Prospects, Chapter of Encyclopedia of Human-Computer Interaction*, PA, USA, 2005. The Interaction Design Foundation, Idea Group, Inc.

K. Rayner. Eye movements in reading and information processing: 20 years of research. *Psychological Bulletin*, 124(3):372–422, 1998.

K. Rayner. Eye movements and attention in reading, scene perception and visual search. *Quarterly Journal of Experimental Psychology*, 62(8):1457–1506, 2009.

D. D. Salvucci and J. H. Goldberg. Identifying fixations and saccades in eye-tracking protocols. In *Proceedings of the 2000 Symposium on Eye Tracking Research & Applications*, pages 71–78, Palm Beach Gardens, Florida, US, 2000. ETRA 2000, ACM.

S. Schmid and T. Baccino. Perspective shift and text format: an eye-tracking study. *Current Psychology Letters Behaviour Brain & Cognition*, 3(9):73–87, 2002.

J.M. Swales. *Genre analysis: English in academic and research settings*. Cambridge Applied Linguistics. Cambridge University Press, Cambridge, UK., 1990.

E. G. Toms. Recognizing digital genre. *Bulletin of the American Society for Information Science and Technology*, 27(2):20–22, 2001.

E. G. Toms and D. G. Campbell. Utilizing information "shape" as an interface metaphor based on genre. In *Proceedings of the 27th Annual Conference of the Canadian Association for Information Science*, pages 370–386. CAIS 1999, QB: The CAIS, 1999a.

E. G. Toms and D. G. Campbell. Genre as interface metaphor: exploiting form and function in digital environments. In *32nd Annual Hawaii International Conference on System Sciences*, pages 2008–2024. HICSS 1999, IEEE Computer Society, 1999b.

E. G. Toms, D. G. Campbell, and R. Blades. Does genre define the shape of information? the role of form and function in user interaction with digital documents. In *Proceedings of the ASIS Annual Meeting*, volume 36 of *Knowledge Creation, Organization and Use*, pages 693–704, Washington DC, US, 1999. ASIS 1999, Information Today.

E.G. Toms. *Browsing digital information examining the affordances in the interaction of user and text*. PhD thesis, Graduate School of Library and Information Science, University of Western Ontario Ottowa Canada, 1997.

S. N. K. Watt. *Text categorisation and genre in information retrieval*, chapter 8, pages 159–176. John Wiley & Sons, Chichester, U.K., 2009.

E. Wenger. Communities of practice: Learning as a social system. *Systems Thinker*, 9(5), 1998.

E. Wenger. *Communities of practice: learning, meaning, and identity*. Learning in Doing: Social, Cognitive and Computational Perspectives. Cambridge University Press, Cambridge, UK., 1999.

E. Wenger. Communities of practice and social learning systems. *Organization*, 7(2):225–246, 2000.

E. Wenger and W.M. Snyder. Communities of practice: the organisational frontier. *Harvard Business Review*, 78(1):139–146, 2000.

M. Wertheimer. *Productive thinking*. Harper & Brothers, New York, US, 1959.

R. White, I. Ruthven, and JM. Jose. The use of implicit evidence for relevance feedback in web retrieval. In F. Crestani, M. Girolami, and C. J.Van. Rijsbergen, editors, *Proceedings of the 24th BCS-IRSG European Colloquium on IR Research: Advances in Information Retrieval*, volume 2291, pages 449–479. British Computer Society - Information Retrieval Specialist Group, Springer-Verlag, 2002.

R. White, J. Jose, and I. Ruthven. An implicit feedback approach for interactive information retrieval. *Information Processing & Management*, 42 (1):166–190, 2006.

A.L. Yarbus. *Eye movements and vision*. Plenum Press, New York, US, 1967.

J. A. Yates and W. J. Orlikowski. Genre systems: structuring interaction through communicative norms. *Journal of Business Communication*, 39 (1):13–35, 2002.

J.A. Yates and W.J. Orlikowski. Genres of organizational communication: a structurational approach to studying communication and media. *Academy of Management Review*, 17(2):299–326, 1992.

Table 10: Bonferroni post-hoc comparison tests of Genres (described in Section 5.3) mean scanpath lengths

Genre	Length	Longer	Sig	Shorter	Sig
Call for papers (Cfp)	2121	Information Technology Services (ITS) Notice, Library, Orders & Seminars	p=<0.001		
Cinema (Cin)	2114	Information Technology Services (ITS) Notice, Library, Orders & Seminars	p=<0.001		
Spam (Spm)	2424	Information Technology Services (ITS) Notice, Library, Orders & Seminars	p=<0.001		
Newsletter (NL)	2506	Information Technology Services (ITS) Notice, Library, Orders & Seminars	p=<0.001		
Orders (Ord)	575			Calls for papers, Cinema, Newsletters & Spam	p=<0.001
Information Technology Services (ITS) Notice	698			Call for papers, Cinema, Spam & Newsletter	p=<0.001
Seminar (Sem)	802	Calls for Papers, Newsletters, Spam & Cinema	p=<0.001		
Library (Lib)	646			Calls for Papers, Cinema, Newsletters & Spam	p=<0.001

Table 11: Bonferroni post-hoc comparison tests of Genres (described in Table 2) mean scanpath durations

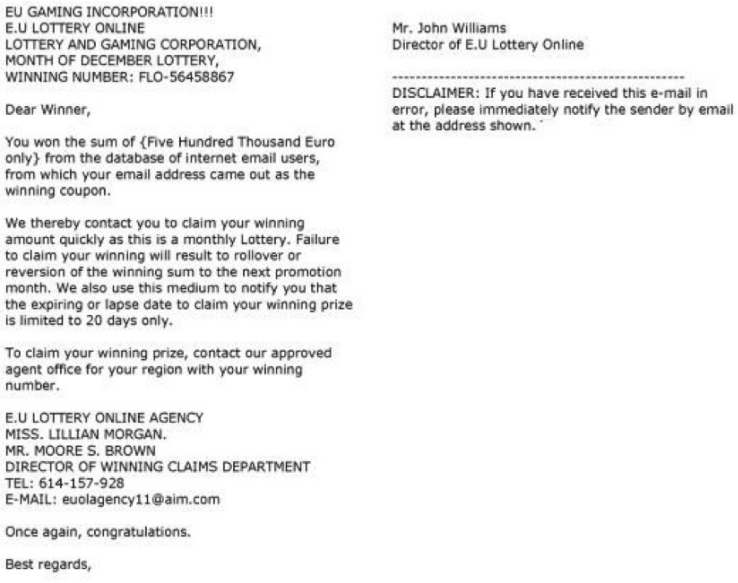
Genre	Duration	Longer	Significance	Shorter	Sig
Call for papers (Cfp)	1372	Information Technology Services (ITS) Notice, Library, Orders & Seminars	p=<0.001		
Cinema (Cin)	1193	Information Technology Services (ITS) Notice, Library & Orders	p=<0.001		
Spam (Spm)	1338	Information Technology Services (ITS) Notice, Library, Orders & Seminars	p=<0.001		
Newsletter (NL)	1405	Information Technology Services (ITS) Notice, Library, Orders & Seminars	p=<0.001		
Orders (Ord)	518			Calls for papers, Cinema, Newsletters & Spam	p=<0.001
Information Technology Services (ITS) Notice	385	Seminar	p=0.011	Call for papers, Cinema, Spam & Newsletter	p=<0.001
Seminar (Sem)	776	Information Technology Services (ITS) Notice	p=0.025	Calls for Papers, Newsletters & Cinema	p=<0.001 (except Cinema p=0.011)
Library (Lib)	414			Calls for Papers, Cinema, Newsletters & Spam	p=<0.001

Table 12: Important features concluded from the participants from post-task interview.

Genre	Feature(s) deemed important by the Participants in Questionnaire
Call for papers (Cfp)	A conference title followed by a blurb and an item list of dates. Key dates, title of conference or journal, lots of capitals, information separated [sic] out. Title of journal/conference, e-mail addresses, themes, article/paper specifications. Structured title and brief, followed by denser passage of text, and contact details. Conference name, location/date etc., deadline, links to conference website. Big heading with organization and venue, return e-mail address, date
Cinema (Cin)	Movie titles, blocks of times, places. Rows of text followed by numbers noting times. Film names, times and days.What's on, list of films/times/dates. Cost of any Tickets. Special offers. Table of films. Lots of blocks/lists times, dates. Times, i.e., 99:99 (colon)
Spam (Spm)	Keywords (e.g. Viagra) possibly miss-spelt, short messages, poor grammar, uppercase titles.Lengthy wordings, mostly uncoordinated text. Capitals, mangled English, laid out like a letter. Poor layout, product names, large font Currency symbols, certain unfamiliar names. Lists of costs, totals, store name/address, buyer. Capitals, exclamation marks, letter style ("Dear sir", etc.) Usually a "you have won" message
Newsletter (NL)	A list of headlines, followed by multiple blocks. A list of headlines, followed by multiple blocks of text with links. Common/identical or linear structure split into sections. Columns of small text, like a newspaper, bold headings. Quite long, name of company/organization etc., at top, date/month of newsletter, a number of short paragraphs on various topics, possibly a number of links to get more information on the various topics listed. Newsletter title, different sections. These tend to vary but generally columns or linear paragraphs

Table 13: Important features concluded from the participants from post-task interview.

Genre	Feature(s) deemed important by the Participants in Questionnaire
Orders (Ord)	List of decimalised numbers. Lists Table(s) emboldened top row text (with columns and rows). Currency() symbology Address block (Uppercased)for delivery. Keywords "subtotal" & "total"
Information Technology Services (ITS) Notice	Dates, problem summary, solution in a table. Spread out, a list of dates/times and a block of text attempting to describe the problem. Headings, blocks of text, perhaps titled in bold, contact details of ITS at bottom. Fault, users affected, time, usually in box/table. ITS notice heading at top, short message usually in the format of a table indicating the time/date/reason of outage.
Seminar (Sem)	Name of speaker, abstract of research, time and place.A big block of text (abstract), with a clear title. Date, time, subject, speaker, more fluid in structure depending on who was writing it. Invitation. Date, speaker, title, abstract, name/address. Of Seminar organizer. Speaker's name, title of seminar, date/time/place of seminar, maybe abstract, contact details of seminar organizer. Big and bold text for the headlines; pictures and lengthy, well articulated and coordinated words thereafter. Name of organization inviting me for the seminar, salutations and secretary signature at the end.
Library (Lib)	Expiry dates of book due back, list of book titles, links to online library. Dates, list of items. Book names, name, address details. Library address at start, date, list of books.


EU GAMING INCORPORATION!!!
E.U LOTTERY ONLINE
LOTTERY AND GAMING CORPORATION,
MONTH OF DECEMBER LOTTERY,
WINNING NUMBER: FLO-56458867

Dear Winner,

You won the sum of {Five Hundred Thousand Euro only} from the database of internet email users, from which your email address came out as the winning coupon.

We thereby contact you to claim your winning amount quickly as this is a monthly Lottery. Failure to claim your winning will result to rollover or reversion of the winning sum to the next promotion month. We also use this medium to notify you that the expiring or lapse date to claim your winning prize is limited to 20 days only.

To claim your winning prize, contact our approved agent office for your region with your winning number.

E.U LOTTERY ONLINE AGENCY
MISS. LILLIAN MORGAN.
MR. MOORE S. BROWN
DIRECTOR OF WINNING CLAIMS DEPARTMENT
TEL: 614-157-928
E-MAIL: euolagency11@aim.com

Once again, congratulations.

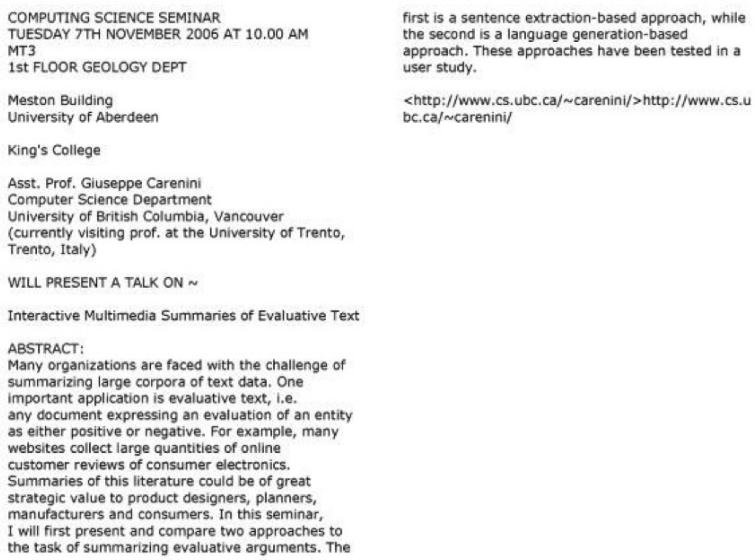
Best regards,

Mr. John Williams
Director of E.U Lottery Online

DISCLAIMER: If you have received this e-mail in error, please immediately notify the sender by email at the address shown.

Figure 7: Screenshot shows Spam e-mail original but transformed into a BMP image for the eyetracker.

Figure 8: Screenshot shows Spam e-mail original (same as Fig.7.) but semantic content removed (x's and 9's), with structure maintained.



COMPUTING SCIENCE SEMINAR
TUESDAY 7TH NOVEMBER 2006 AT 10.00 AM
MT3
1st FLOOR GEOLOGY DEPT

Meston Building
University of Aberdeen

King's College

Asst. Prof. Giuseppe Carenini
Computer Science Department
University of British Columbia, Vancouver
(currently visiting prof. at the University of Trento,
Trento, Italy)

WILL PRESENT A TALK ON ~

Interactive Multimedia Summaries of Evaluative Text

ABSTRACT:
Many organizations are faced with the challenge of
summarizing large corpora of text data. One
important application is evaluative text, i.e.
any document expressing an evaluation of an entity
as either positive or negative. For example, many
websites collect large quantities of online
customer reviews of consumer electronics.
Summaries of this literature could be of great
strategic value to product designers, planners,
manufacturers and consumers. In this seminar,
I will first present and compare two approaches to
the task of summarizing evaluative arguments. The
first is a sentence extraction-based approach, while
the second is a language generation-based
approach. These approaches have been tested in a
user study.

<http://www.cs.ubc.ca/~carenini/>http://www.cs.u
bc.ca/~carenini/

Figure 9: Screenshot shows RGU Internal Seminar e-mail original but transformed into a BMP image for the eyetracker.

Figure 10: Screenshot shows RGU Internal Seminar e-mail (same as Fig.9.) but semantic content removed (x's and 9's), with structure maintained.

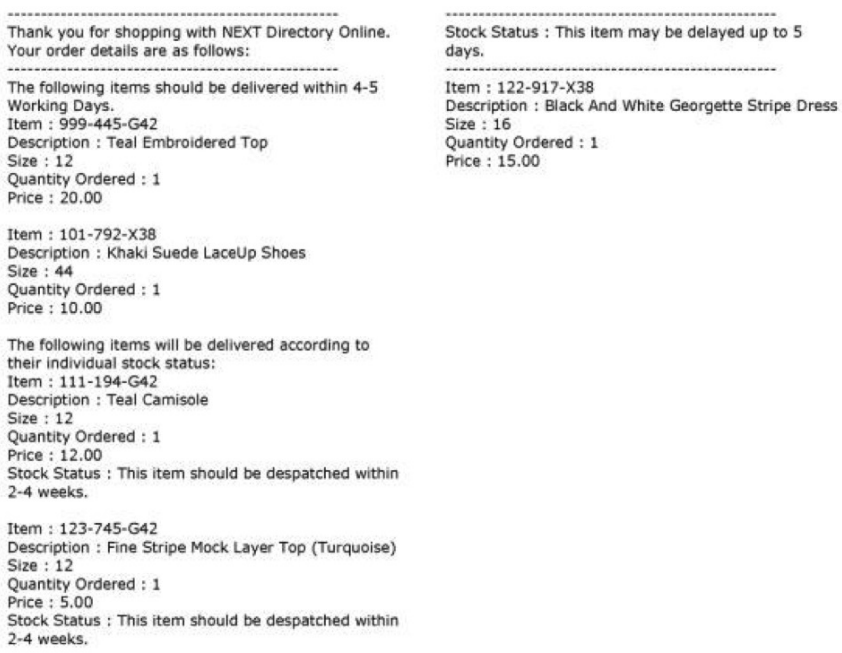


Figure 11: Screenshot shows an Order e-mail (NEXT) original but transformed into a BMP image for the eyetracker. Other Orders' e-mails were used such as online orders for a well known global Supermarket chain.

Figure 12: Screenshot shows an Order e-mail (NEXT) (same as Fig.11.) but semantic content removed (x's and 9's), with structure maintained.

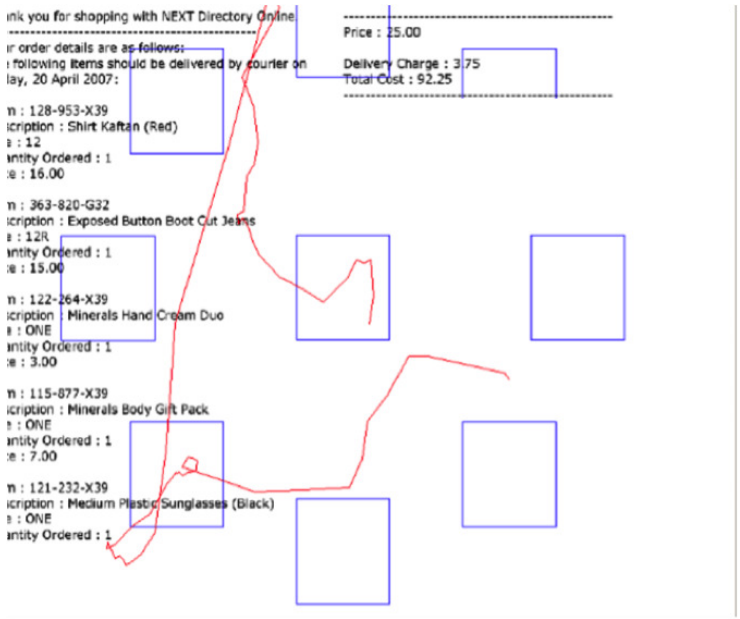


Figure 13: Shows participant 4 skimming some of the text on an original Orders e-mail until some information got his/her attention.

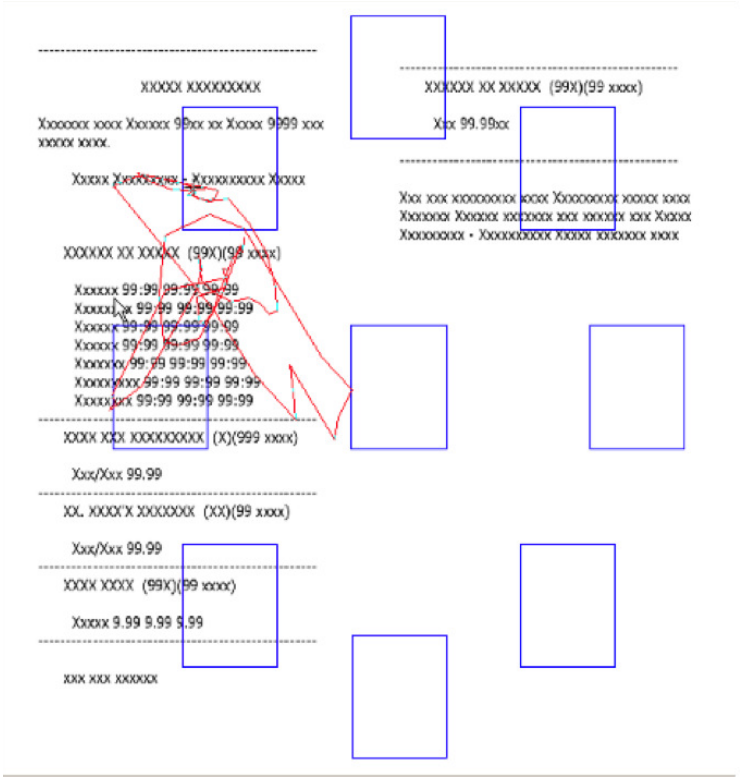


Figure 14: Shows participant 7 viewing a Cinema e-mail -original structure with semantic information removed- in which the shape is skimmed vertically and the numeric information block is scanned in a 'circular' motion.