Encouraging serendipity in research: Designing technologies to support connection-making ☆

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ABSTRACT

Mobile applications have the ability to present information to users that is influenced by their surroundings, activities and interests. Such applications have the potential to influence the likelihood of individuals experiencing 'serendipity', through a combination of information, context, insight and activity. This study reports the deployment of a system that sends push text suggestions to users throughout the day, where the content of those messages is informed by users' experience and interests. We investigated the responses to and interactions with messages that varied in format and relevance, and which were received at different times throughout the day. Sixteen participants were asked to use a mobile diary application to record their experiences and thoughts regarding information that was received over a period of five consecutive days. Results suggest that participants' perception of the received suggestions was influenced by the relevance of the suggestion to their interests, but that there were also positive attitudes towards seemingly irrelevant information. Qualitative data indicates that participants, if in an appropriate time and place, are willing to accept and act upon push suggestions as long as the number of suggestions that they receive is not overwhelming. This study contributes towards an understanding of how mobile users make connections with new information, furthering our understanding of how serendipitous connections and insightful thinking could be accommodated using technology.

1. Introduction

Understanding the way that people think and make associations among their own interests, resources and other people is important not only for encouraging communication and collaboration but also for identifying key elements that contribute to making unexpected connections – something that can be termed 'serendipity'. Notions of serendipity have been widely documented as being '*a happy accident*', something' *unexpected*' or a '*pleasant surprise*' (Bawden, 1986). Furthermore, sagacity – that is the ability to make *valuable connections* among 'unconnected' information – has been documented as being an important element of serendipity (Kop, 2012). However, other researchers argue that

something needs to be *interesting* as well as *surprising* in order to be considered serendipitous (Ge et al., 2010) and that serendipity can facilitate information browsing (Marchionini and Shneiderman, 1988). Recent research has identified that the conceptualization and realisation of 'serendipity' involves insightful thinking, promoting the idea that 'serendipity' is not just a 'happy accident' (Friedel, 2001; Makri and Blandford, 2012) but requires some proactive input from the individual. Serendipity has been researched in numerous contexts including counselling psychology (Krumboltz, 1998), information seeking (Foster and Ford, 2003), ubiquitous computing (Newman et al., 2002), entrepreneurship (Dew, 2009) and medicine (Klein, 2008; Ban, 2006). In Human Computer Interaction (HCI), serendipity has been explored especially under the context of recommender systems because they provide an excellent test-bed to tackle the so-called 'serendipity problem' (Iaquinta et al., 2008) and the overspecialisation of recommended information, which can impair serendipity (Gup, 1997), while aiming to provide richer experiences in suggestions. Our own work (Sun et al., 2011) has shown that the concept of

serendipity is also relevant to the work of those who are conducting research, in both an academic and non-academic setting.

While other researchers acknowledge that 'inaccuracy' can be critical for developing recommender systems (McNee et al., 2006), the majority of the recommender systems incorporate commonalities, relevancies and previous data patterns and choices (i.e. bookmark lists) as their operative core (Adomavicius and Tuzhilin, 2005; Resnick and Varian, 1997). However, new methods of data recommendations have emerged in recent years such as prediction techniques, content-based methods, collaborative methods and hybrid methods (Adomavicius and Tuzhilin, 2005). In an attempt to enrich the experience and data pool of modern recommender systems new approaches have been suggested such as ambient recommender systems, which utilise users' emotional responses, machine learning and intelligent agents to provide focused and more personalised suggestions to the users (Gonzalez et al., 2006).

However, a critical question here is whether absolute personalisation and content fit is the optimal answer to efficient and successful recommender systems. In a serendipity context, one could say that inaccuracy and 'open-mindedness' in systems is of fundamental importance in order to design and implement a system that can accommodate serendipitous encounters because such a framework allows wider reflection and surprise, open information augmentation and acceptance – qualities that can support serendipity (Gaver et al., 2003). While serendipity is a slippery concept (Makri and Blandford, 2012), attempts have been made to introduce serendipity into systems through serendipity heuristics (Iaquinta et al., 2008), shuffling algorithms (Leong et al., 2005), through design for reflection (Maxwell et al., 2012), through ambient intelligence and interactive data mining (Beale, 2007) and in music recommendations (Zhang et al., 2012).

A system that can accommodate serendipitous encounters may not strictly be a 'recommender system' – according to past recommender systems' definitions (Felfernig et al., 2007; Ricci et al., 2011) – however, there is value in developing a framework that provides the basis for new technologies, beyond traditional recommender approaches, to support elements of serendipitous encounters and encourages free connection-making between resources and people.

Making *new, loose associations* that can lead to *valuable, concrete connections* in a mobile-dominated world is challenging due to the amount of information that is shared and forgotten. While there are models of serendipity that may incorporate the notions of connection-making (e.g. Sun et al., 2011; Makri and Blandford, 2012), the stage of connection-making, what influences it, and how technology can support it, is yet to be specifically examined.

Despite the fact that we live in a world that values information and information sharing, there is a need to identify the role of technology and system design in supporting connection-making (Palmer, 1999). At the same time, information browsing and information encountering reaches new levels and offers new opportunities due to technology ubiquity demonstrating that environmental context plays an important role in information seeking and information understanding (Erdelez, 1999, 2004). We argue that there is value in exploring the value technology that is used every day, such as phone-based text messaging, as a medium to facilitate insightful thinking and connections-making, whilst also allowing time for reflection (e.g. through the use of a mobile diary application). By understanding the qualitative elements of connection-making we will be able to inform the design of systems that support serendipitous encounters and connection-making.

According to empirically-driven models of serendipity (see Fig. 1), unexpected associations may be influenced by the environment in which new information is encountered (location), the timing of receipt of new information (time), the circumstances of information presentation (context) and the individual's preparedness for new thoughts and ideas (Makri and Blandford, 2012; Sun et al., 2011). Furthermore, 'noticing' and 'examining' presuppose the 'capture of attention' and 'engagement' of the user (Sun et al., 2011).

Other researchers note factors that can influence unexpected connection-making including memory (Auble et al., 1979), creativity (Sternberg and Davidson, 1995) and engaging in activities that allow reflection (Mann et al., 2009). McCay-Peet and Toms (2011) have previously discussed specific elements that they have found that may induce serendipity encounters. Such elements include facilitating *connection-making and exploration* between information, exposing people to *unexpected and varied information*, accommodating *browsing of information*, promoting *divergence and triggering curiosity*. McCay-Peet and Toms (2011) have particularly looked at the importance of environment in inducing serendipity and unexpected connection-making by designing information environments that offer similarity-based recommendations based on (1) what users report as their likes/dislikes, (2) their tracked browsing history and (3) their previous search keywords.

More recent research has particularly looked at design for positive experiences with special focus on the role of delight in serendipitous encounters (Kefalidou et al., 2012). While the concept of 'delight' is found to be associated to e.g. customer engagement and satisfaction (Chitturi et al., 2008) and positive user experience (Fleck, 2003), it is also found to be linked to the notion of 'surprise' when designing for ambiguity (Gaver et al.,
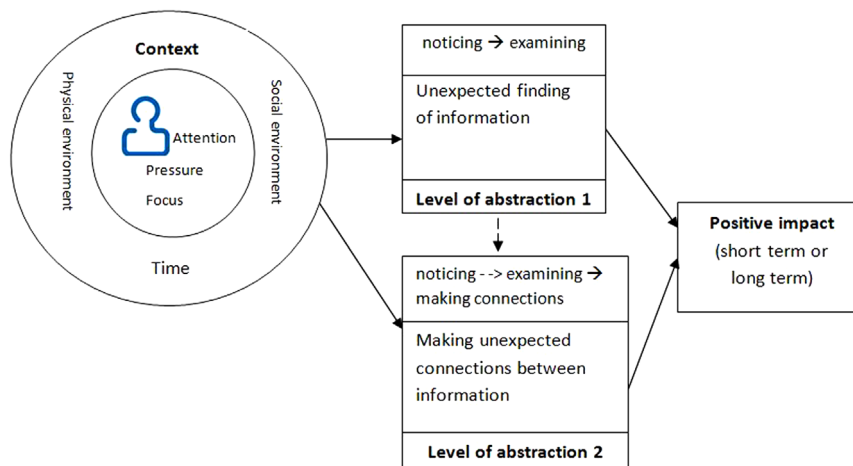

Fig. 1. A model of serendipity (as presented in Sun et al. (2011)).

2003). Surprise appears to be, indeed, a critical factor interplaying in experiencing serendipity and 'delight' therefore could be argued to offer potential triggers for serendipitous encounters (André et al., 2009; Leong, 2009).

Connection-making pervades our everyday lives and manifests both in our face-to-face communications and technology-mediated communications (Siemens, 2005; Barzilai and Zohar, 2006). Indeed, the act of *sharing* appears to play a pivotal role in creating meaning and trigger new connections with ideas and perceptions (Short, 1993). Social media and microblogging have presented new opportunities for information sharing within business and personal communications (Java et al., 2007) while the utilisation of short, semi-structured messages can offer advantages in computer-supported collaborations by reducing complexity and making information processing more manageable (Malone et al., 1987). In this study we explore the value and design of short text messages, delivered to individuals throughout the day, in stimulating new thoughts and ideas, and potentially increasing the likelihood of serendipitous thoughts. We employed a 'text-messaging' framework to test the concept of instant text messaging and rapid information flow, both of which have been associated with serendipity in the past either in the form of serendipitous mobile file exchange mechanisms (Ahn and Pierce, 2005) or theories in mobile learning (Sharples et al., 2005). The text message suggestions tested within this study represent a small element of an anticipated mobile serendipity assistant that would support users in making inspiring and insightful connections with new people and information.

When introducing new technologies it is important to understand their impact and the way in which they are perceived in a naturalistic manner wherever possible. In this study we use a mobile diary to record participant attitudes towards the receipt of messages 'on the go'. The main advantage of mobile diary studies is that they can capture experiences, thoughts and events as they are lived (Bolger et al., 2003; Cranwell et al., 2015) while experience sampling methods can be used to prompt users to provide structured feedback on specific tasks (Consolvo and Walker, 2003). In this research we use text messages as the stimuli, and adopt a combination of mobile diary study and 2-stage interview methodology to capture participant responses and attitudes both immediately after receipt of messages, and before and after participating in the study for a five day period. While research using mobile diary studies and interviews has previously been conducted to explore the theoretical concept of 'serendipity' (Sun et al., 2011), based on participants' past experiences and encounters, this new study explicitly examines responses to stimuli that were constructed based on knowledge about participants' experiences and interests, mimicking the proposed behaviour of a 'serendipity system'.

2. Rationale and contribution

This paper investigates how people can make connections among other people and among resources using a text messaging and mobile diary study framework 'in the wild'. This is the first study that investigates the responsiveness of people using a combination of such frameworks in a contextual, experiential and suggestions-based perspective with the aim to explore how people perceive and determine the value of the suggestions through the use of a mobile diary and SMS text messaging. Past research has shown that, when browsing, seeking and evaluating information, users either: perform search-oriented browsing, then review-browse the information that they found; or scan-browse without necessarily reviewing but with an aim to just identifying *interesting* information (Carmel et al., 1992; Chen and Rada, 1996; Erdelez, 1999, 2004) leading researchers to identify different strategies in text browsing (e.g. verbalisers vs. imagers – Graff,

2005). Consequently, for the purpose of our study we examine serendipitous encounters through the lens of how surprising, interesting and valuable text suggestions are.

As the use of smart phones and text messages communication increases, it is important to understand how mobile users perceive and respond to textual information 'pushed' to them by a device or system. If information is to be 'pushed' in such a manner it is also important to understand how the subtleties of presentation affect perception of that information. Pennebaker et al. (2003) provided reviews regarding the importance of intonation in spoken and written language and how this affects human perceptions, attitudes and their psychological status and insight into the perception of emotional polarity in words (Wilson et al., 2005). This past research suggests that particular syntactic frameworks of messages (i.e. question-like sentence framework vs. statement-like sentence framework) may influence the attitude that someone has towards a received message and the connections that they make. Pennebaker et al. (2003) report findings on linguistic styling and content, the changes of which apparently indicate personality, emotional and individualistic traits of the people that employ them. For example, utilising particular syntactic (as defined above) and grammatical structures within a single sentence (e.g. using imperative instead of employing a polite request) may not only provide information about the person that generates and expresses this sentence but also may influence the subsequent interactions of that person with the surrounding people and other peoples' reactions to this sentence. Through a number of different analytical methods such as judge-based content thematic analyses, thematic content analyses, word pattern analyses, latent semantic analyses, word count and sentiment analyses (which is quite popular in social media research), it is concluded that words, their selection and usage manifest psychometric properties that retain their properties throughout different environments and social contexts. For example, in Mehl and Pennebaker's longitudinal studies (e.g. Mehl and Pennebaker, 2003) students' everyday conversations over a period of time and with an intermediate break appear to be utilising the same words, tones and syntax in their communications independently of whether they are at work or school, at home or anywhere else outdoors during their leisure time (public and private places).

Nevertheless, despite the consistency observed in peoples speech and communications, the choice of words chosen to construct these communications appear to constitute markers for individual differences with strong indications that age contributes to changes in word selection and usage. In a cross-sectional analysis of multiple written and text spoken samples from disclosure studies and from a longitudinal project that analysed works of 10 novelists, playwrights and poets that lived in the past 500 years, it was found that as people grew older they tended to utilise more positive emotion words in their speech and text and fewer first person singular self-references (Pennebaker and Stone, 2003). Similar differences have been found in peoples' converses depending on their gender.

Following prior research's indication that style and content of language may influence individual's interactions, we compare two types of syntactic presentation (i.e. question-like sentence framework vs. statement-like sentence framework) of messages in our study.

The influence of the apparent 'relevance' of information on enthusiasm for and attitudes towards that information is also of interest. Research in the fields of marketing and advertising has examined consumer attitudes in mobile advertising (Tsang et al., 2004; Conti et al., 2012) and in the use of language in advertising (Piller, 2003). Through a field survey that aimed to investigate people's attitudes, intentions and behaviours towards Internet and mobile advertisement it has been found that peoples' attitudes towards mobile advertising for the promotion of products through

text messaging are mostly negative (Tsang et al., 2004). Tsang et al. (2004), found that entertainment, informativeness, and credibility related positively to the overall attitude of people responded to mobile advertisement while irritation is negatively correlated. A stepwise regression analyses indicated that entertainment is the foremost factor that affects overall attitude with credibility, irritation and informativeness following up. This suggests that peoples' attitudes to mobile advertisement can be positive if only permission is asked prior to adverts distribution on their mobile devices. Conti et al. (2012) sent out 400 tailored mobile adverts to 20 professionals over 5 consecutive days and conducted follow-up interviews with them. It was found that busy workload and localised context influenced the decisions and opinions of the individuals towards the mobile advertising received. While participants appeared to appreciate the context-relevant adverts, it was found, overall, that they negatively rated the majority of the received adverts. Privacy, control of data and effective tailoring of the distributed adverts were found to be critical for determining the perception and attitude of people towards the adverts.

Other research in this field has found that content irrelevance of an advert and the frequency of adverts is correlated with negative experience (Haghirian et al., 2005; Merisavo et al., 2007). For example, Haghirian et al. (2005), interviewed 815 mobile phone users over a 6-week period using a 5-point Likert-type scale questionnaire and found that both informativeness and entertainment relate strongly to advertising value confirming previous studies. They also found out that irritation correlates negatively with advertising value, although on a weaker extent compared to informativeness and entertainment observed correlations. High credibility of the advert correlates positively with advertising value suggesting that people's opinion about an advert is determined by the trust they assign to the marketer. Finally, and most importantly it was found that if people are exposed frequently to the same advertisements, they have a higher chance of perceiving the advert negatively as their informativeness is reduced (i.e. as exposed to the same advert repeatedly). Merisavo et al. (2007) applied structural equation modelling to test five metrics (utility, context, control, sacrifice and trust) of SMS-based mobile advertisement acceptance from data they obtained from 4062 Finnish mobile phone users. Context and sacrifice were found to be particularly strong indicators for acceptance and non-acceptance of the mobile adverts. This suggests that mobile adverts' content and relevance to the individual needs need to be emphasised if it is to be accepted and be positively perceived by the individual. Contrary to previous studies, Merisavo et al. (2007) found that trust and privacy do not correlate strongly (negatively or positively) to advertisement value but utility and context are positive drivers for mobile advertisement acceptance.

Although previous research on mobile text messaging has focused on the interestingness and relevance of content on peoples' perceptions and acceptance, limited attention has been shown in investigating the impact of unexpectedness of content on peoples' perceptions and attitude. Research into serendipity shows that the 'unexpected' nature or content of a source can be key in forming new ideas and insight (Sun et al., 2011). No research as of yet has taken place into attitudes towards messages that vary in their relevance in the context of serendipity and idea generation. We present users with two classes of messages, 'relevant' and 'irrelevant' and examine the different responses to and perceptions of these messages.

In this paper we target users of smart phones to whom we send text suggestions either tailored towards their interests or apparently unconnected to their interests. We used this approach for two main reasons: first of all, in order to explore for the first time a widely-used technological message setting (as SMS text messaging is widely adopted with minimal learning curve) within serendipity and connection-making research; secondly, to investigate how connection-making 'on-the-go' can be facilitated through the exchange of specific text messages targeted to an individual and not necessarily to the whole world (e.g. compared to the more 'public' approach of tweets for example) and thirdly to construct and investigate a messages construction protocol for tailoring the suggestions sent to the individual participants. We deployed a mobile diary application and interviews before and after the use of the mobile diary application to understand users' responses to and perceptions of these suggestions. We also captured the time at which the participants responded to the suggestions through acknowledging or exploring the message, notes-taking, photos-taking and audio-taking using the mobile diary application. This allowed an examination of the role of message relevance (relevant vs. irrelevant), framing (suggestions formed as a question or sentence) and temporal context on user attitude and response.

2.1. Theoretical background and research questions

RQ1: Does time of day influence peoples' responses?
It is well known that positive affect and mood behaviour is influenced by the time of day and the day of the week (Clark et al., 1989; Egloff et al., 1995). Furthermore, it has been found that human performance exhibits differences depending on the time of day (Fröberg, 1977) while the latter can determine the cognitive and evaluative efficiency of individuals (Natale et al., 2003). Consequently, considering that mood can influence human performance and evaluation activities, we wanted to investigate whether the time that a suggestion as a text message is being received by an individual, qualitatively affected the individual's response to the suggestion. In the study presented here, as we are using an 'in the wild' approach, we are unable to isolate time from other contextual factors, including physical location and the presence or absence of other distractors, therefore we refer to this factor as 'temporal context'.
RQ2: Does text content influence peoples' responses?
The manipulation of advertising message contents in response to customers' involvement and engagement has been considered in the past (Andrews and Durvasula, 1991). Furthermore, recent research by Conti et al. (2012) has employed the action of sending advertisements to mobile phones in the form of text messages revealing a positive response towards context relevant texts. Therefore, we explored whether the relevance of the texts suggestions' content influenced how positive or negative the participants would be towards the suggestions received.
RQ3: Do text characteristics influence peoples' responses?
Linguistics framing and rhetoric patterns have long been considered that have an effect on audiences reactions and responses (Hallahan, 1999). In addition, reader-response theory emphasises the advertisement texts' importance in message decoding and understanding (Scott, 1994). Consequently, we wanted to find out whether the way that texts were phrased and constructed had some impact on the way that people responded to the suggestions.
RQ4: How do people perceive text suggestions 'on-the-go'?
Previous research (e.g. Westlund, 2008), suggested that approximately only one third of mobile users' were positive in using mobile devices for reading news (i.e. information 'pulling'), and that would happen only when they did not have any other means to get informed. However, more recently, as mobile technological innovations have risen, accessing news while 'on-the-go' has gained popularity. Furthermore, mobile devices have moved from being devices that support provision of news to being devices that support communication services. According to Lenhart et al. (2010), text messaging constitutes the major

teenagers' means for daily communication for contacting friends and family. A reason for this rise has been attributed to the widespread usage of social media (all of which are available through their mobile phone editions) and facilitate a 'push and pull' model of information exchange. More recently, the development of mobile recommendation systems has opened up more opportunities for enhancing 'pushing' and 'pulling' information for supporting decision-making 'on-the-go' (Van der Heijden et al., 2005). A number of mobile recommendation systems have been developed utilising different recommendation strategies that either based on collaborative, time-based, content-based or location-based filtering (Ricci et al., 2011). However, the major challenge that they possess includes the inability to employ (or acquire) the '*right*' level of users' information for the recommendation system to provide *appropriate* suggestions to each one of the users (Pazzani and Billsus, 2007). As such, our research here focused on identifying how people perceive suggestions 'on-the-go' generated by a human agent rather than by an automated system (i.e. a traditional mobile recommender system) that delivers recommendations based on an algorithmic approach.

RQ5: Do people make new connections when they receive text suggestions 'on-the-go' and under what kind of circumstances? The widespread use of mobile devices across the world has created new ways to share and receive information (including information for educational purposes). Recent research has demonstrated that peoples' learning can be substantially assisted via modern mobile devices while at the same time has the potential to change the way people learn and digest new information (Sharples et al., 2005). While mobile learning may take place within different contexts and via different ways (e.g. blogging, microblogging, social media, podcasts etc.), we wanted to investigate whether and how people generate new ideas, make new associations and act upon them based on information that they received via a familiar personal medium such as text messages on their mobile phone device.

RQ6: How can we design new technologies that support connection-making 'on-the-go?

Acknowledging the modern necessity and challenge for having available the right information at the right place and time while 'on-the-go' (Church and Smyth, 2009), we wanted to explore how we can design new and novel technological approaches to facilitate and promote connection-making 'on-the-go' that is relevant to each user via appropriate content personalisation and tailoring of user suggestions. As Sun et al. (2011) suggest, context plays a critical role in connection-making and experiencing serendipitous encounters. Furthermore, according to Consolvo et al. (2009), behavioural change can take place via persuasive technologies that facilitate the following: abstraction and reflection, unobtrusiveness, publicity, aesthetic values, positivity, controllability, trending, historicity and comprehensiveness. Considering the challenges that current recommendation systems incorporate and the great potential mobile devices and services offer on acquiring and synthesising new information, we wanted to identify the factors that interplay in supporting connection-making while mobile and generate a framework to design technologies that support and inform this process.

We explored the above research questions mainly through our qualitative data collected in our study.

2.1.1. A 'Wizard of Oz approach'

We employed a 'Wizard of Oz' approach in our system to investigate further aspects of messages tailoring. The concept of 'Wizard of Oz' is not new in research studies. In a 'Wizard of Oz' setting, a human acts as the information processor (in our case, the constructor of the messages sent to people) completing and simulating one or more of the intended system's operations and functions, without people being aware of that. Indeed, participants of such a study are usually informed about this setting after the end of the study and during their debriefing (Lazar et al., 2010). The value that 'Wizard of Oz' approaches for data collection offer is that they provide opportunities to test-bed and investigate particular frameworks and settings for dialogue and messages interactions between people and between people and machines (Dahlbäck et al., 1993). Natural language processing research has utilised 'Wizard of Oz' as a data collection method previously (e.g. Kelley, 1984; Dahlbäck et al., 1993) while more recently augmented reality studies have adapted it in a different mobile setting (i.e. that of simulating wearable mobile devices functionalities – e.g. Alce et al., 2015). In our context, adopting a 'Wizard of Oz' approach to investigate mobile-based connection-making provides us with opportunities to unpack aspects of messages tailoring (the level of which is found to be critical for peoples' acceptance and perception of these messages as mentioned before) to fit individual's needs yet allow for new discoveries and ideas generation.

The contributions of our paper are

- Deployment of a 'Wizard of Oz' serendipity system that presents messages to participants as they go about their everyday lives through which we have unpacked aspects of how connection-making 'on-the-go' takes place.
- Structured examination of different content type (pre-defined as 'relevant' or 'irrelevant') on participant responses to and perceptions of messages – this has helped us understand better how content relevance and irrelevance interplay in determining not only peoples' acceptance and overall perception of the messages received but also their attitude towards generating new connections Structured examination of impact of message syntax (messages formed as 'statements' or 'questions') on participant responses to and perceptions of messages – this has provided us with insights as to whether tone of phrasing and stylistic message construction influences the acceptability of messages and provide impetus in making new associations with information received and with existing knowledge.
- Varied time of day at which messages are presented, to qualitatively explore the impact of different times and contexts on participant attitudes and behaviours after receiving messages – this has revealed to us new understandings as to what effect frequencies of messages and personal and environment context of when messages were received interplays with connection-making and perception of messages utility. The production of two frameworks which are empirically generated from our data. Firstly, a renewed insight into serendipity is gained, through our new knowledge regarding the specific activity of 'connection making' within the serendipity process; secondly we propose initial categorisation of the different elements of design of technologies to support serendipity.

3. Method

3.1. Participants

We recruited 16 university students and staff from the University of Nottingham (5 males and 11 females), aged between 18 and 44 years (mean=29.94, sd=6.79). From those, 5 participants were University staff and 11 were university students (including PhD students). From the University staff participants, 2 were working in administration roles and 4 in research roles. The rest of the participants were University students. For detailed demographics including

Table 1
Participants demographics.

Participants' demographics	N (%)
Age range	
18–24	5 (31.25%)
25–49	11 (68.75%)
Gender	
Male	4 (25%)
Female	12 (75%)
General educational background	
Medical and Health Sciences	1 (6.25%)
Engineering	4 (25%)
Science	6 (37.50%)
Social Sciences	3 (18.75%)
Arts	2 (12.50%)
Work experience	
10+ years	2 (12.50%)
6–9 years	0
5 years	1 (6.25%)
1–4 years	13 (81.25%)

their background please see Table 1. Table 1 shows also the general educational background of the participants (e.g. subject of study), their current job role and the experience they have in this job role measured in number of years being on that professional post. All participants were compensated with £30 in high-street vouchers upon completion of all three stages of the study.

3.2. Materials and procedure

A diary study was conducted over five consecutive days. The study took part in 3 stages. Stage 1 was preliminary interviews with each participant to identify their background, routine, likes and dislikes. Based on data collected from these interviews, tailored text suggestions were constructed. Stage 2 the tailored text suggestions were sent to each participant over the period of 5 consecutive days during which time participants created diary entries based on the text suggestions they received. Stage 3 took place after the diary study period ended and consisted of interview sessions with each participant to unpack their experiences, identify their responses and evaluations and walkthrough their diary entries. More information about each of the stages is provided below.

The preliminary interview was conducted one week before the diary study to elicit each participant's background, research interests, hobbies, routine and aspirations. This interview was used to mimic the 'data mining' process that might be used by a functioning serendipity system that would describe an individual's interests and experiences, and be used as a basis for determining future suggestions. The interview lasted for approximately 1 h and had 3 phases: (1) demographics data collection (e.g. asking about the age, occupation and background), (2) investigating daily routine and weekend routine (e.g. asking about what they usually do in their everyday activities, prompt them to walkthrough a routine day/weekend), (3) investigate hobbies, work activities, likes and dislikes (e.g. by prompting them to recall a day/activity that they enjoyed/not enjoyed, asking them whether they have something that they would like to do but for some reason they currently do not do, what are their expectations/envisage for their research activities). During the week-long mobile diary study, tailored suggestions, based on the information gathered in the pre-study interview, were sent to the participants' smart phones in a text format by the first author. The purpose of the Stage 3 interview

was to give the participants opportunity to reflect upon the suggestions received and provide some more information regarding the rationalisation of their reflections. Both Stage 1 and Stage 3 interviews were intended to replicate the type of information that might be inferred from analysis of data that could be within an individual's digital footprint-derived from sources such as 'liked' articles on the web, or stated interests in user profiles.

3.2.1. Process of inferring interests and constructing suggestions

The suggestions were developed by the first author to be either relevant or irrelevant to the participants' interests and activities, and were phrased as either a question (e.g. "Did you know that phantom hand was mapped for first time?") or a sentence (e.g. "Smart cars on smart roads").

3.2.2. The construction of suggestions

Once the participant information at Stage 1 interview was gathered, topics of interest and relevance to each participant were identified. The topics identification included the search for keywords in the interview transcripts (i.e. travelling, stressed, foreign friends, family-concerned, psychology etc.). The latter had information about: research interests, hobbies, routine activities, non-routing activities and personality traits (i.e. introvert, extrovert). An example of the information provided during Stage 1 interview for the Case X in order to provide an understanding of what type of information was available, what kind of inferences were being made to enable us to proceed to the 'search-for-suggestions' phase, can be seen below. The parentheses below include some inferences made but also some further information that was gathered from the interview in an indirect manner (i.e. not by asking the participant (Case X) a direct question).

After identifying 'keywords'/topics from the transcripts, a Google and Google Scholar search was conducted on the topics identified. The search occurred on a two-layer base: firstly, a direct search with direct/exact keywords and secondly a search with 'coupled' keywords that consisted of three words. The first word would be the exact keyword identified in the first stage of search. The second and third words would be words that represent two topics identified for each participant. Preliminary tests with the use of two words only for the 'coupled' keywords generated limited varied results, therefore, the addition of a third word in the 'coupled' keywords search was decided. If an exact keyword is 'London', then a 'coupled' set of keywords would be something like 'foreign news', 'cooking. A 'coupled' keyword can also be a synonym or antonym of the exact keywords identified in the interview transcript. Inclusion of antonyms enabled expansion of search space and avoided solely pairing 'like with like'.

Google/Google Scholar searches with 'exact' and 'coupled' keywords were performed. Furthermore, searching books, periodicals, magazines using both 'exact' and 'coupled' keywords complemented the search.

Examples for Case X: The first step was to find a suggestion that is relevant to Case X's interests. In order to do so, the first author had to identify what were the general topics of interest for Case X. These topics were retrieved from Stage 1 interview with Case X. In their case, the identified topics of interests were the following: travelling, foreign cultures, psychology, working in engineering and human factors. Regarding their personality traits as were mentioned by the participant were: open-minded, perfectionist, stressed, used to be professional swimmer. Acknowledging these identified topics, the next step was to search – through brainstorming – for resources potentially relevant to the participant, which they would use to construct a suggestion for them. For example, as Case X is fond of psychology, the first author found a research article from psychology about 'Cultural Differences in the Self' via Google search following the aforementioned steps. The

participant (Case X) reported that this suggestion was useful for them to think about cultural differences effects in vehicle design and drivers' behaviour – acknowledging that is a potential direction for further research.

Each message included a link to a website that could be clicked on if the participant wished. Participants were instructed to make diary entries (either by text, audio, photo or any combination of these) for each suggestion they received independently of whether they followed the link or not. For example, if participants did not follow a link, they were still expected to make a diary entry explaining the reasons for not following the link. Relevance of suggestions was informed by the identification of topics, and individual information about: research interests, hobbies, and routine/non-routine activities.

Fig. 2 illustrates an example of the process alongside with the questions that prompted participants responses (i.e. middle green call-outs).

Participants were asked to use the mobile diary to record their thoughts and experiences in response to each text suggestion. After the five day study period, an interview was conducted to acquire further insight into the evaluation of the suggestions by the participants and their overall experience. On the basis of the interview and participant records in the diary, responses to each suggestion were classified as *positive*, *negative* or *neutral*. During the latter stages of the interview, participants were explicitly asked to comment on each of the suggestions by whether they found them positive, negative or neutral.

The mobile diary application employed for the study was the same with the one used in previous research (e.g. Sun et al., 2011)

and was compatible with Android devices. The mobile diary application supported the following functions:

(1) 'Write diary' function: participants were able to make as many diary entries as they wished using either of the following modes: text, audio, photos/videos.
(2) 'View diary' function: participants were able to re-view at any point entries made alongside with their timestamp.
(3) 'Reminder diary' function: participants were able to schedule reminders (if they wished) to prompt them make their entries.

Fig. 3 shows the Android mobile application used in our study.

Each participant was sent six text suggestions per day for five consecutive days. They received two messages in the *morning* (8 am – noon), two messages in the *afternoon* (noon – 6 pm) and two in the *evening* (6 pm–11 pm). A text suggestion comprised text (either in a form of a sentence or question) and a web link with the content of the suggestion. The order of all suggestions (relevant vs. irrelevant; sentence vs. question) were counterbalanced. Based on the research questions (RQs) presented above, the text messages were constructed and varied by content type (relevant/irrelevant) and message style (sentence/question). This lead to the following combinations:

(1) Question – irrelevant
(2) Sentence – irrelevant
(3) Question – relevant
(4) Sentence – relevant

These combinations were randomly assigned to all the participants across the different times of day (morning, afternoon,
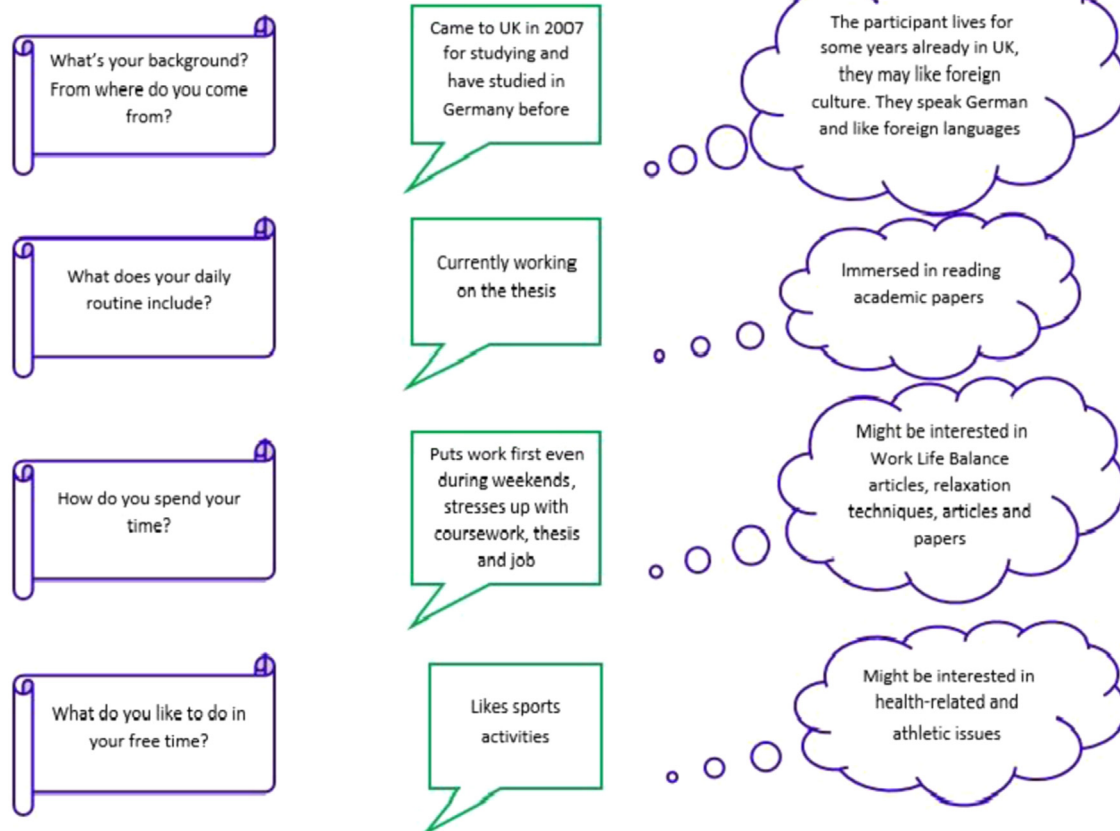

Fig. 2. Inference process – scrolls are interviewer's questions that triggered participants' responses (i.e. green text boxes) while cloud callouts are the interviewer's inferences. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Fig. 3. The mobile diary app.

Fig. 4. An example of a suggestion sent to a participant's mobile phone.

evening) for the whole duration of the study. All participants were sent the same amount of text messages (i.e. 2) per different times of day (i.e. morning, afternoon, evening).

Participants were supplied with an Android phone (i.e. HTC Nexus One) if they did not have their own. Seven participants were provided with HTC Nexus One phones to conduct the study. All the participants were briefed on the application and its functionality during Stage 1 interviews. Any participants who did not have experience with smart phones were given the phone one week prior to the commencement of the study in order to familiarise themselves with both the phone and the diary application. Participants were instructed that they should make a mobile diary entry for each text message they receive to record their impressions and reactions to the messages. There was no time constraint placed on when the mobile diary entries should be made or how long the entries should be.

Stage 3 interviews took place after the end of the 5-days period of using the mobile diary app for responding and reflecting on the suggestions that participants received. Similarly to Stage 1 interviews, each session lasted for approximately 1 h and consisted of four stages that are the following: (1) what their favourite/worse suggestions were and what did they do with them, (2) how were they responding to the suggestions overall and what they were doing when receiving the suggestions, (3) a 'deepening' stage where we asked participants to co-walkthrough with us each of their suggestions and the diary entries they made to retrospectively reflect on their reflections about the suggestions they received (we can call that stage a meta-reflection) and (4) how they perceived the useage of the mobile diary app under the context of receiving suggestions on-the-go (e.g. this included usability-oriented questions such as how they found the display and other features of the app).

As our research questions involved the investigation of how people perceive suggestions over a period of time (e.g. throughout each day), temporal context (the time the text suggestions were sent and received-morning vs. afternoon vs. evening) was of a particular interest to us. As such, and as part of what data we collected from our participants, was also tracking the time it took them to respond to the text suggestions (time elapsed between receipt of the text suggestion and making a mobile diary entry about this text suggestion – measured in minutes). We also collected data in terms of our participants' perception of text suggestions (positive vs. neutral vs. negative) inferred from data in
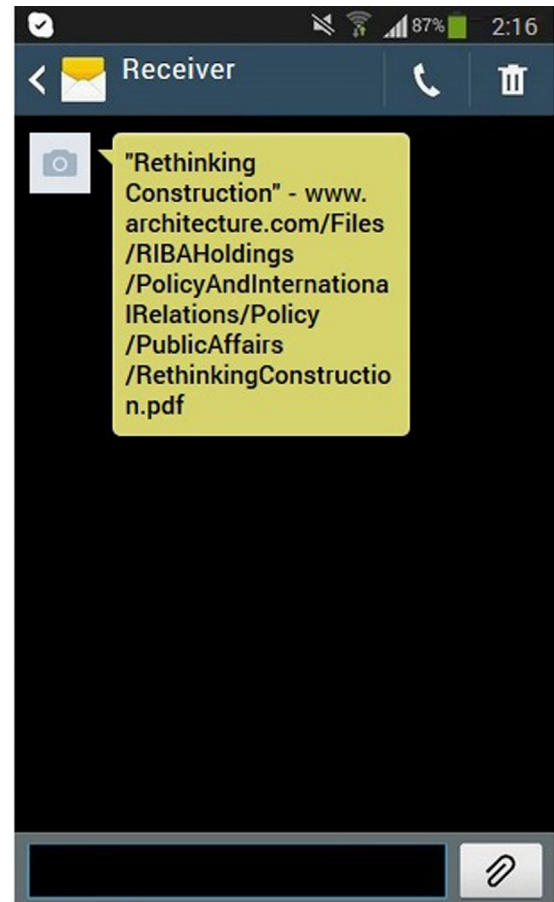
diary as well as the qualitative data obtained from the post-study interviews.

3.3. Suggestions examples

A hundred and fifty suggestions were generated for each participant (example provided in Fig. 4). Suggestion examples for Case X can be seen below:

- For the 'question' and 'relevant' condition – 'Did you know that Yorkshire has its own Science and Adventure Centre?' – www. visitmagna.co.uk:
- For the 'sentence' and 'relevant' condition – 'Evaluating driver distraction countermeasures' – http://www.projectsparadise. com/evaluating-driver-distraction-countermeasures/
- For the 'question' and 'irrelevant' condition – Did you know that music influences the interpretation of film and video?' – www. upei.ca/~musicog/research/docs/How_music_in-fluences_film_and_video_AJC.pdf.
- For the 'sentence' and 'irrelevant' condition – Kent Art Space – www.kentartspace.co.uk/.

All the suggestions were presented to all the users in the standardized SMS text format that Android mobile phones (Nexus One series) had. For each of the suggestions the 'sentence' and/or 'question' statement was followed by the corresponding URL link of the suggestion. Suggestions were viewed by participants as seen in Fig. 4.

4. Results

4.1. Quantitative data (descriptive statistics) – coding of participants' diary entries

Each participant received 30 text suggestions in total over the five consecutive days, giving a total of 480 text messages sent. All participants made one diary entry (either text, photo, audio or combinations) for each suggestion they received (i.e. 30 diary entriesx16 participants=480 diary entries). The response to each message was classified as positive, negative or neutral by analysing the written comments in the diary and verbal comments in post-study interviews. During the last stage of the post-study interviews participants were prompted to comment on each of their suggestions based on whether they found them positive, neutral or negative. Of the responses, there were 109 (23%) negative responses, 293 (61%) positive responses and 78 (16%) neutral responses.

The majority of the participants responded positively to both relevant (68%) and irrelevant (53%) suggestions. Type of phrasing and relevance or irrelevance of the suggestions did not appear to influence participants' perceptions of the suggestions. Irrespective of time of day, participants' responses to suggestions seemed to be perceived as positive when they were relevant rather than either negative or neutral.

Table 2 provides a summary of the frequencies of evaluation and perception of the two different types of text suggestions and time of day that the message was sent.

Participants' diary entries varied by type (i.e. text, audio, photo). Not all participants made text diary entries but all completed at least one diary entry for each of the suggestions they received. Out of the 494 entries that were made (i.e. 480 single entries for each suggestion received and 14 double entries per suggestion), 153 were audio, 57 were photos and 284 text entries. The aforementioned 14 double entries refer to those people that made two different diary entries for one suggestion received – for example, they made a text diary entry and a photo entry for a single suggestion. Twelve participants made mixed entries, 2 participants made audio entries only and 2 participants made text entries only. For the text entries, the average length of participants' responses (i.e. number of words per entry) was 29.47 words (in effect, 30 words). The minimum words of text entries were 1 word and the maximum was 142 words.

4.2. Thematic analysis of qualitative data

For our qualitative data we conducted thematic analysis (Kitzinger and Willmott, 2002) on our semi-structured interviews and the comments and thoughts that participants reported using the mobile diary application. In the interviews we asked participants about their interaction with the text messages sent and their opinion of the mobile diary application to record their thoughts on the suggestions sent to them. We also asked them about their opinion of the content of the suggestions, whether the time they received each of them mattered in their evaluations of their suggestions and we went through the suggestions they were sent alongside with their entries on the mobile diary application. We selected thematic analysis as our analytical methodology of our data over other methods (e.g. content analysis, grounded theory and narrative analysis) because it provides flexibility and does not require tying and formulating the data towards a particular theoretical framework. Furthermore, thematic analysis allows for maintaining a realist and constructionist approach that allows for reflecting both reality and its context (Braun and Clarke, 2006). The analysis of the qualitative data involved organising the data into themes (Campbell and Schram, 1995) allowing the data itself to dictate the themes identified (Kissling, 1996). We particularly followed Braun and Clarke's (2006) stages of conducting thematic analysis that included (1) familiarising ourselves with the whole data, (2) generating initial codes, (3) searching for themes, (4) reviewing themes, (5) defining and naming themes and (6) producing an initial report. To demonstrate our data themes, we provide direct quotes from our participants' interviews and mobile diary application entries. We conducted an inter-rater reliability for our qualitative data. Two different researchers thematised three sets of our collected data. Cohen's Kappa co-efficient's statistic was calculated: for QD1 was 0.73; for QD2 was 0.72 and for QD3 was 0.77. What we present below are how participants' perceived the suggestions and the themes we identified within our qualitative data. While the results presented below are not overly dependent on individual participants, the extracts presented have been selected as they are the most representative of the overall pattern of results. Participants' identity is fully anonymized and coded for the purpose of this paper – participants' identity codes are presented next to the quotes in parentheses.

4.2.1. Overall value of receiving messages

This theme is about how people overall perceived the process of receiving text suggestions on a daily basis. This includes perceptions of the kind of value the suggestions offered to them in term of knowledge, research, ability to share with others and general interest. This theme relates to RQ4 (i.e. **How do people perceive text suggestions 'on-the-go'?**). Some of the participants reported that their response to and perceived value of the suggestions was dependent on the task with which they were currently engaged:

"Some of them were interesting…some not…guess depended on the day…?…actually…it might have been depending on what tasks I was engaged with…"(P1),

Delivering the suggestions via smartphone messages seemed to be effective.
Participants enjoyed receiving the messages e.g.

"really enjoyed it…probably would pay for such a service…(…)…I quite [often] use the phone for internet…checking facts and things"(P12).

And commented that they provided focus e.g.

"…useful idea of having a tool like that…too much information on the Internet…texts help to focus…"(P10),
"really useful as a concept to receive text messages as suggestions….(…)…really liked the hobby-like suggestions…it definitely works!" (P7), "having the site from the link and the mobile diary application at the same time works well!"(P1), "do you call it serendipity…? Don't know…managed to stimulate thoughts… remind me of stuff…make connections…"(P13)

Table 2
Users' response by suggestion relevance, type and time.

Suggestion type/time	User response		
	Positive	**Neutral**	**Negative**
Relevant	172 (68%)	42 (17%)	39 (15%)
Irrelevant	121 (53%)	36 (16%)	70 (31%)
Question	162 (64%)	40 (16%)	51 (20%)
Sentence	131 (58%)	38 (17%)	58 (26%)
Morning	100 (63%)	25 (16%)	30 (19%)
Afternoon	95 (59%)	27 (17%)	38 (24%)
Evening	98 (61%)	26 (16%)	36 (22%)

4.2.2. Simplicity, frequency and timing

This theme clusters all perceptions of participants in terms of particular design decisions of the study such as frequency of text suggestions sent to them, volume of content for each suggestion and perceptions about the different times they received the suggestions within each day. This theme addresses RQ1 (i.e. **Does Time of Day influence peoples' responses?) and RQ2 (i.e. Does Text Content influence peoples' responses?).**

The vast majority of participants (15 out of 16) commented that the time at which they received the suggestion informed the way and speed with which they would either follow up the suggested link or use the mobile diary application to record their thoughts about the suggestion. Many participants (15 out of 16) clicked on the URL links within the messages as soon as they received the text message – this occurred for each message they received. Others clicked on the URL once it was convenient for them to read the URL content. Whenthey opened and read the text message, they then followed the URL link and made at least one diary entry for each of the suggestions they received. However, one participant did not click on all URL links; in Stage 3 interviews they reported that this was influenced by their judgment of their interest in the URL on the basis of the link alone. It was clear however that timing alone was a crude manipulation, and in fact an interaction of time and activity affected the likelihood of checking and following up messages, as well as potentially influencing the perceived value of the message:

> "…mixed feelings…interesting info that didn't expect it…sometimes inconvenient due to other activities…tried to respond immediately but depending on the timing…context…".(P12)
> "…timing was important…I think…depended on what I was doing at the time…"(P4)
> "I was mostly at work…always checking them…apart from meetings…not on Friday though…I was too busy (…) I was mostly checking them in the morning…at work…not in meetings…less in the afternoon…"(P2)
> "received txt during meeting and so didn't check phone until later…I looked at the link and it looks pretty cool…I love seeing how people have made cool stuff. I will check out the site on my laptop this evening and probably show it to my boyfriend"(P4)

Other participants thought to some extent timing alone would influence likelihood of following up suggestions – they thought that during the evening they would be more open to looking and reading suggestions, particularly those that were initially perceived as less relevant to their primary activities.

> "if I was receiving the texts in evening, when free, I would also read irrelevant stuff…"(P14)

When exposed to less pressure at work and/or at home they would feel more open-minded, affording more allowances to suggestions that are 'off topic', suggesting that a contextual and time-framed state of mind and/or mood could potentially influence the openness of attitude towards suggestions. Issues of time and contextual elements have been depicted within Sun et al.'s (2011) model of serendipity as factors that influence potential serendipity encounters. However, that model represents time as a separate entity from the context and does not attempt to unpack the levels of contexts involved within potential serendipitous encounters (e.g. mood, health, workload, company etc.) or even connection-making. Our new data further suggests that workload and random incidentals influence not only our routine everyday tasks but also our attitude towards stimuli and information around us:

> "…if in the morning receiving them…then would respond later in the day otherwise I responded straight away!…oh! also I had a major toothache…had to visit the doctor…this affected my response I think…"(P11)
> "I would be more inclined to read 'irrelevant' stuff when I have free time or during the weekend…"(P6)

Indeed, in some occasions, even when participants were away from work, they were not 'in the mood' to follow up on suggestions. One participant even felt stressed which was exacerbated when they received a particular suggestion while off sick

> "the [suggestion related to] project management stressed me… made me think of how to manage my projects…doesn't help that I am not feeling well…"(P15)

Some participants explicitly expressed that the combination of the overall context in which they were when receiving the suggestions along with the people that they were with at that time, influenced greatly their perception of the suggestions and their attitude towards the action of receiving suggestions. It is as if they become more demanding from the 'service' when they feel that they get 'interrupted' by it.

> "…today I am in the seaside town XXX with my little sister in the photo. So receiving a link to an academic paper was not so good for three main reasons. First it felt rude to read things on my phone with my family…second, the abstract sounded interesting but too long to read on holiday away from work! Thirdly, my phone reception is very bad down here, not sure I will revisit this link…does not appear to have any value for me…". (P12)

This example highlights the interaction between timing, location and context. Firstly, the participant is with their family so feel that it is rude to act upon the suggestions at that time; Secondly, they are on holidays and off work so they do not want to look at long research articles (they inferred the URL linked to a long article from the wording within the message); And thirdly, technical issues, associated with their location, were interruptive and irritating.

However, in other situations, the interplay between context and content can be unexpected food for thought. The same participant later comments about another suggestion that received at another context as follows: "…I read this on bus…(…)…seeing my family…I'm in a quite poor rundown area now with lots of young women looking harassed with kids…(…)….I agree with nearly everything the article says and loved reading it, even if it was very long for the average blog! I even shared it with friends! Poignant reading considering a woman was being berated by her aggressive boyfriend on the bus as I read how to make feminism more real for real women? Hmm…". (P12)

On other occasions, participants felt that they missed out on opportunities due to timing constraints and realized the importance of linking information and place.

> "…such a shame we have left Place XX because this might have … have been really useful! My boyfriend would have been impressed too by my local knowledge!", "could be useful but again too busy and serious for today…nice to see it exists though…"(P12)

The absolute number of messages was also commented upon, and interacts with simplicity. Participants reported that if the suggestions were long, they would not look at them, implying that text suggestions on-the-go need to be simply, straightforward and not overwhelming in number:

> " …too busy with work…think might have affected my response… greater than 3 or 4 messages per day is like spam!…would prefer more fewer ideas…but again it might be me…think it is overload…" (P5), "if the texts were longer, I may not have looked at them…the shortness of texts was good!"(P4)

"6 messages per day were too much…I got annoyed after a time… maybe something could be done in relation to a website…hmm… maybe having 2 to 4 messages receives per day…hmm…"(P8)
"…sometimes the links in the text were too long…sometimes off-putting…don't know why…"(P9)
"…it has to be precise…concise…the content of suggestions…not too detailed…cognitive overload needs to be avoided…that's why I don't like twitter…"(P4)

The format of the text suggestions was straightforward and simple, something that participants appreciated in terms of efficiency and provision of focus: *"…love the idea of suggestions on-the-go…like the small posts, blog articles…they are to the point…"(P12)* suggesting that simplicity in the presentation of the suggestions is pleasant and effective.

Finally, as discussed later in further consideration of relevance, there were some comments that suggested that actually receiving messages that were inspired by non-work related interests or were 'irrelevant' were actually valued during time when the primary focus was on work tasks.

"…it was good to slightly sidetrack myself from my heavily-focused schedule…"(P1) and *"…you see…there is not time for leisure googling…it was good to be reminded of things that I like…"(P13)*

4.2.3. Note-taking and reflection

This theme presents participants' opinions and impressions in regards to the process of reflecting upon the suggestions they received using the mobile diary tool they have been provided with. The notion of utilising reflection to make new associations and connections among people and ideas is also incorporated within this theme. This theme addresses RQ5 (i.e. **Do people make new connections when they receive text suggestions 'on-the-go' and under what kind of circumstances?**).

Reflection can be both immediate and longer term. Participants reported that suggestions could 'become' interesting over time, suggesting that any system should allow opportunities for reflection and incubation in identifying potential connections

"…some were interesting…some were not…some after a time became interesting…" (P10)

Participants also valued the use of the diary to reflect on the messages

"…I felt the app to be useful to record thoughts…would be using the voice if I knew that nobody would be listening to it…usually I write notes on the phone but you lose the context…while with the app I can be reminded of stuff…"(P5)
"…was waiting for the next break to write the diary…",(P2)

Making connections does not need to be instantaneous, and it can take some time to recognise opportunities and reflect upon ideas. Indeed, it may be in appropriate to check in detail on a message received if not relevant to the current activity; other examples demonstrated that sometimes wi-fi or phone coverage limited access to more detailed information at the time, so the opportunity to delay the point of reviewing and reflecting on the information was valuable from a technical perspective as well.

"received this whilst at work…and briefly checked site…has too much to check on my phone…at the time as I only have 3g at work…later I will check it out at home…but I am not sure how useful it is to me. I will keep it in mind though!"(P4)
"I also received this text in meeting…after the meeting I looked at the webpage and briefly scanned it…the list of tips…etc…as I am writing my thesis at the moment it is very important to keep things like these in my mind. I will print the page out later and

keep it by my desk at home to remind me when I am next writing"(P4)

Reflection occurred not only in regards to the participants' selves but also in regards to other issues in their lives. Sometimes the action of reflection was enhanced by the use of the mobile diary application suggesting that it was the **combination** of the suggestions received and the act of recording thoughts about them using the mobile diary application that synergized into connection-making.

"…the title tells it all! Went for a study last month which involved measuring brain response to EEG. I was listening to a series of different ambient soundtracks and watching a movie without sound. It feels totally different, thinking about it, from what we usually do…without music/sound…the image seems very life-less…I find it hard to concentrate even in the most exciting part of harry Potter…article mentioned that music interprets and adds meaning as well as aids memory – this is SO true – sometimes not remembering the story of the movie and feel blurred with some of the scenes – I guess sound and music play a part in enhancing our memory on something…made a lot of sense…remembered how my teacher taught me to memorise history facts by using soundtracks…"(P10)

Re-evaluating suggestions sometimes took place twice; increased viewing of suggestions seemed to either lead to or reflect a more positive view of the suggestion,

"timing was important..I checked the link twice at different times and the second time that I saw the same link I found it interesting…bizarre…"(P14)

Many of the connections made linked the information suggested in the message with other thoughts or ideas in participants' long term memories:

"the self-belief and problem solving link reminded me of the 'make it or break it' – it is a very helpful link…it was a lesson for me… made me think about judgment and balance and how this can be applied indeed…"(P11), "reminded me of when I was little and imagining if I had a 6th finger what she would be doing if she indeed had it…also reminded me of the theory of dreams in blind people…maybe something to look at later…"(P10)

However, one participant just did not like the concept of making notes as they viewed the action of note-taking as a waste of time and a distraction rather than a way to focus on concepts and ideas.

"I like completing tasks…keeping notes does not make me feel that I complete something…I wouldn't have kept diary notes if it was not the study…I would not really use a service like this in my day-to-day life…I want to stay focused…not using facebook…twitter…I like seeing my progress…with such a service I am not sure I produce…"(P8)

4.2.4. Message phrasing

This theme entails participants' perceptions of message phrasing (e.g. whether they feel they have been influenced by the way the suggestion was phrased to them) and it addresses RQ3 (i.e. **Do Text Characteristics influence peoples' responses?**)

As described earlier, the format of the text suggestions sent to the participants varied in way that the suggestion was phrased (i.e. question vs. sentence framing). This variation did not appear to influence participants' responses to the suggestions (i.e. being more interested or positive to question-framed or prompt-like suggestions). The majority of the participants reported they even had not realized the different message phrasing configurations:

"…not really remember…think that…the suggestions type made any difference…don't think so…" (P7), "…it is not the phrasing important but the content of the text suggestions…the communication of the suggestions…"(P14)

This could be partly because they did not really remember whether the phrasing indeed made any difference to their perception of the suggestions by the time the post-interview took place. Indeed, some of them did not even notice the phrasing of the suggestion

"oh…didn't realise…I can't remember the phrasing…were they different…?"(P16)

A minority reported that the suggestions phrased as questions (instead of a sentence) helped them having more focus on the content

"…the question suggestions helped focusing targeting the content…"(P14)

The 'question' framing intrigued some of the participants and encouraged them to follow the link straight away

"…sometimes were questions weren't they?…those were intriguing…used…if I remember well…to follow the link straight away…they were increasing my curiosity!"(P3)

4.2.5. Creativity, irrelevance and obscurity

This theme incorporates findings related to how our participants perceived the content and qualities of the suggestions received, unpacking further notions of how and under what circumstances people make new meaningful connections. For example, we found that even 'irrelevant' suggestions were found to be facilitating the making of new associations between information and people. This theme addresses RQs 2 (i.e. **Does Text Content influence peoples' responses?**), RQ4 (i.e. **RQ4: How do people perceive text suggestions 'on-the-go'?**) and RQ5 (i.e. **RQ5: Do people make new connections when they receive text suggestions 'on-the-go' and under what kind of circumstances?).**

Having a tool that will allow people to come up with ideas, broaden their horizons and accommodate multidisciplinary connection-making is acknowledged to be important not only for work purposes but also for creative leisure time suggesting that information provided to support serendipity in work or research activities does not need to be solely work-oriented:

"the suggestions received helped me to broaden my horizons….to discover multidisciplinary links….how for example, the same concepts are approached from different disciplines…even the news blogs helped me to search further for the terms…I enjoyed really reading them all!"(P13)
"…found this interesting and I will go back to it for my PhD. Public sector initiatives can offer new ways for business to tackle inequality…not something I would necessarily read on my phone though, need a button that resends links to my email to read at work!"(P11)

Suggestions' value varied in terms of how interesting, unexpected, intriguing they were and whether they were worthy to follow-up and be acted upon. Our data suggests that the more obscure and slightly off-topic the suggestions were, the more interesting and unexpected they were perceived, identifying the need to move from a pure recommendation system platform to a more sophisticated and less 'specific' suggestions tool. Surprise appears to be a positive element for further connection-making. This finding is also supported by our quantitative analysis as well (e.g. the frequencies data).

"…some were completely bizarre…some interesting…weird… random… (…) … I would definitely say that the interesting and little obscure were the best ones…"(P7)
"oh my god! This is awesome! Busy looking for a place to go during next weekend and here I have got the map…so excited! And planned to do some travelling…I live to travel and this is really helpful and informative!"(P10)

Having a tool that can provide creative and useful 'distraction' appears to be needed as it can offer pathways to move forward or get unstuck from a block in ideas

"the texts sent helped me to move forward…how to say…hmm… helped to gather new ideas…to remember and reflect on old ideas…"(P1)
"this is such a good find!!! Will definitely get access to this through the library and use it in my research. I've read the writer's other stuff but never found a methodology paper!!! THANK YOU! This kind of thing feels so good when it is useful!! It is quite late at night but now I am excited and think about my PhD again…uh… oh!!") (P12)

While the value of the suggestions took different forms in terms of how interesting something was or how immediately valuable it was to them, some participants defined the value of the suggestions by how useful they were not necessarily only to them but also to their family

"…at times some links were useful…for me and the kids as well!." (P6), "….not interesting to me but interesting to the mother of my boyfriend who has just(!) expressed an interest in learning music…the photo attached is from her notes from researching on youtube!…"(P12)

In some occasions, where participants were exposed to 'irrelevant' information, the verdict of whether the suggestion is interesting or not was developed gradually (i.e. as the participant was reading the suggestion) and escalated (i.e. as the participants were proceeding with the reading of the suggestion, they became more and more interested in it):

"OK, so I liked this link. Whilst it didn't have any bearing on my PhD research, it gave me something to think about in respect of the open data stuff that I work on at work. It was an interesting article and I'm sure that some of the ideas will pop up in conversation. Also, as an additional note, tonight I found myself talking about the bilingualism article and discussing what language we thought in, which wouldn't have happened otherwise." (P13)

Others made connections across different fields of interest and had unexpected outcomes through a conversational process (i.e. while discussing suggestions with friends) indicating the influence of context not only at the time of suggestion making but also during any point of reflection.

"…so, first I have to say that I keep having conversations with people about the stuff that I've been sent during this trial. Yesterday it started with me talking about the 'perfectionists' being tired article, and ended with me agreeing to write an article for a non-academic journal. This is both exciting and weird. I mean, totally unpredictable."(P13)

This participant started writing an article about something that received as a suggestion. As they say *"this happened…as a result being exposed to lots of information…"(P13)*
Many participants approached a directly 'irrelevant' suggestion with an open mind, able to identify links with their field and indeed, appreciate the perceived value of the suggestion.

Furthermore, as noted earlier, the timing did not influence negatively their impressions of the suggestion providing support to the idea that delivery time of a text suggestion does not influence the participant's perception of the suggestion but it influences their response time to it.

> "…received when I was at my desk and I'd just arrived at work and had a meeting to attend…looked at it later though…the topic itself is not of so much direct interest to me but I saw links with my field and the importance of understanding the domain of the user…"(P4)

Our analysis suggests that the concept of 'surprise' is perceived on a multi-dimensional level. For example, a suggestion could be surprising because they never heard it before, or because they did not notice before while they should have done, or because it brought up memories and past associations, or because it made them make connections, to name a few reasons. This multi-dimensionality of 'surprise' is being similarly reflected on the way that participants evaluated the suggestions as well.

Surprise though was not necessarily a feature of 'relevant' suggestions. Indeed, some participants reported that the 'relevant' information had been considered as 'boring' emphasising however, that the time they received this suggestion may had influenced the way that they perceived it. Furthermore, another reason for considering a 'relevant' suggestion could be the screen limitations that the mobile phone offers.

While from the quantitative analysis it was apparent that the majority of people found interesting the information 'relevant' to them e.g.

> "the ones (suggestions) directly related to my PhD were very useful…I already cited them in my paper!!"(P11),

for other participants, suggestions that they received coincided with their current interests:

> "I read this on a bus ride seeing off my family…(…)…the blog subject on the elitism really hit home…it is something I had thought about…worried about…(…)…I agree with nearly everything the article says and loved reading it even if it was very long…poignant reading considering a woman was being berated by her aggressive boyfriend on the bus…"(P12)

Other times participants reported the opposite: that the suggestions 'relevant' to them were boring, e.g.

> "the qualitative research paper even though related to what I am doing…it was boring…well…if I were at another stage I would find it more interesting but not any more…"(P1), "Received on Friday evening. Couldn't open the paper on my phone though. Having worked at Airbus it is of interest but not directly related to my research. I am not sure I will open the full paper. The abstract was enough info."(P4).
> "…saw the title and yawned…studying and teaching CSR means I am bored of the normative arguments that go back and forth about business and whether they can or can't, should or shouldn't do charity. I read the first page, was put off because of the law focus and couldn't work out how to read the rest of it. Articles relying to work are impossible to read on a small screen with dodgy internet connections….still on the coast enjoying a break from the uni…".(P12)

Overall, our analysis seems to suggest that people have a tolerance for irrelevance, and that the potential 'cost' of sending messages that may or may not be seen as interesting or unexpected is outweighed by the potentially high value of an 'irrelevant' suggestion being acted upon and followed up.

4.2.6. The path to serendipity

Acknowledging that previous literature on serendipity suggests that 'connection-making' is a process stage of a serendipitous encounter (see Makri and Blandford (2012)), this theme incorporates participants' experiences as reported by them in terms of uncanny coincidences, lucky encounters and fruitful actions that took place as a result of receiving a particular text suggestion over the period of our study. Whilst we did not intend in this study to directly influence serendipitous outcomes, there were some indications that participants found messages unexpected, interesting and followed them up – three elements that our on-going work has suggested are indicative of increased likelihood of a serendipitous outcome. This theme addresses RQ 4 (i.e. **RQ4: How do people perceive text suggestions 'on-the-go'?) and RQ5 (i.e. Do people make new connections when they receive text suggestions 'on-the-go' and under what kind of circumstances?).**

In our research presented here, we found that, sometimes suggestions led to particular actions that were of value to the participants whether this was a collective or an individual value

> "the science centre in Yorkshire…we visited that…the whole family…after receiving the text…it was very intriguing!"(P6)

Bringing back memories, surprise and suggestions that were not mentioned during the pre-study interviews managed to 'capture' participants' interests leading them to be surprised

> "oh my!…I used to do stuff with origami…it is very beautiful… actually it was rather surprising to get a suggestion like this…I had completely forgotten about it…I even got one back in the years and I had put it away…I shall search for it and give it to my daughter…"(P6).

Playfulness of the suggestions was also addressed within the perceived value. For example, while the majority of the participants mentioned that the suggestions they liked the most were the ones associated with their hobbies and interests, there are few participants that reported that receiving suggestions that had a 'fun' element in them acted as an opportunity to further socialise with their colleagues and friends and gain some quality time with them. Playfulness, concepts of 'delight' and mingling with others socially are researched in the current literature and indeed, as part of our previous work (Kefalidou et al., 2012), we have identified that they can be associated to experiences of serendipity, promoting open-mindedness and new connection-making.

> "hmm…most boring were the ones related to my job…the ones related to my interests …for example the scuba diving one…the heart rate…were the best ones…I really preferred the links that were quite funny…(..)…telling others about those suggestions led to intriguing discussions…also quite diverse…for example… hmm…the one with the knitting abilities…well! It led to talk about fish and chips in the end! It was quite fun!…the funny ones I tell you provoked small talk…" (P5).

The playfulness of the suggestions offered the opportunity to socialise more, to come up with new discussions and engage more with friends and family, providing further support on the notion that a mobile suggestions system could support a framework that accommodates connections-making, reflection and potentially serendipity.

Enjoyment of suggestions did not presuppose instantaneous value, instead participants would still enjoy suggestions that could have a potential value later in time thus proposing a long-term evaluation process for the suggestions received.

> "the bilingual stuff enjoyed reading it and not really thinking about applicability of knowledge at this point…" while for other

suggestions they would respond "this could be potentially used in the future…for my MSc…"(P10)

In other occasions, participants reported that suggestions received were not new to them, however, the suggestions themselves acted as a 'reminder' to them with an opportunity to reflect upon them and conduct further research

"…read that in the past…I read about that…forgot how music could affect…I googled further on that…"(P11)

However, in all occasions, enjoyment of suggestions and connection-making required the actions of noticing and examining further supporting the serendipity model as proposed by Sun et al. (2011).

The role of social context was demonstrated by the vast majority of the participants (14 out of 16) sharing some of their suggestions with others (i.e. family, friends and colleagues). The choice of sharing the suggestions or not was dependent on the content and the nature of the suggestion. So for example, suggestions that were 'relevant' to their job activities would be shared with work colleagues while more hobby-related suggestions or "socially viable and interesting" suggestions could be shared with friends and family.

Communicated suggestions triggered discussions and further reflections for the participants showing that connection-making is a multi-level process that can be mediated by both the technological, physical and social environment.

"…there was one with jokes…I think…yes…I told the jokes to the others…and friends liked that…"(P3)

"I have been communicating the suggestions to children…husband…friends…and colleagues! Especially the ones with related research" (P6).

4.2.7. Usability and design

This theme includes participants' opinions in relation to how usable the connection-making framework we present here was, design implications for improving the framework and additional features they would wish to have available when using such a framework. This theme addresses RQ6 (i.e. **How can we design new technologies that support connection-making 'on-the-go'?).**

The most prevalent issue associated with the design of the system related to connectivity and access to wifi/phone signal coverage.

"I love the idea of suggestions on-the-go…(…)…but not long articles for example, pdfs…research papers…"(P12), "…like sharing and interactive stuff…couldn't bother though reading the research papers…sometimes off campus and couldn't download! How frustrating…!"(P9), "…I liked the on-the-fly accessibility… that I was able to connect to the content of the suggestions that readily…(…)…I wouldn't like them as an email…or website…if it was like twitter possibly…"(P16)

We also received some usability feedback on the process of the suggestions sending, on the suggestions display and on the mobile diary usage. Participants mentioned that a more extensive 'notes-taking' ability would be appreciated (i.e. ability to annotate more than once and in different ways a single note)

"I would like to have an extra 'note' ability…to add more notes on a note…"(P10), "if at home I prefer to handwrite for notes because I make graphs…so if I could do the same thing on the mobile that would be good! But it is still very useful when on road…on the move…on the bus…"(P12)

Also, a 'share' notes and suggestions options could enable transferability of their suggestions to other media such as laptops and email accounts

"…I would love to be able to export the link to share…to manipulate on desktop…email…I would also like to have pictures…(…) serious suggestions may be better sent by email…the 'light' ones better to send as texts in mobile…"(P7), "…if I were on desktop then I would share it with friends…"(P14), "…if the application related to my calendar…reminders on my regular phone…it would have been very useful!" (P2)

Snippets accompanied with images were another proposal suggested by our participants in order to improve the process of suggestions

"a snippet alongside with the suggestion would help to capture… grab the user…" (P1),"…maybe an abstract could help…" (P5)

Some of them felt that sharing would be necessary in order to create a network of suggestions-sharing. Categorisation of suggestions to receive was another option for improvement

"…would love to be able to send emails through the diary app… being able to share with others automatically…"(P10)

Another recommendation proposed by the participants was regarding the categorisation and thematization of the suggestions

"…maybe having options to sign-up to different categories… maybe 1 text per day…like newsletters?…6 per day was too overwhelming…"(P7)

Location-based suggestions were another point for improvements suggestions as participants valued the usefulness that location-customised suggestions could offer to them on particular contextual settings

"…suggestions based on location would be great!..would be useful…especially let's say during holidays…you could get to see things around…something like a travel assistant…but also in academia…while visiting other universities…needs thought to present new, exciting stuff…"(P7)

Archiving suggestions and creating a filing record for them was considered by the participants important to be looked at as handling a volume of suggestions inevitably will require some kind of filing even if it is on a basic level

"…text can be very simple…possibly with pictures would be better but it is important to be able to come back to the suggestions whenever you like…something like archiving them…"(P13)

Finally, glitches of the mobile system were reported such as inability to open properly portable document files (.pdfs) and limitations of the screen size.

"I had problems with opening pdfs…small screen but was checking links afterwards…on desktop at the end of the day…" (P2).

Participants emphasised the effect that screen size can have not only on the user experience but also on the feasibility of having a tool that presents information to them in a particular format (in this case.pdf files). Having a small screen size inevitably restricts the information that can be handled by the user and consequently the processing that can be done with it and through it.

5. The 'Rubber Domino' model of user responses and connection-making

5.1. Learning from suggestion-making and informing current models

Our findings from the qualitative data strongly support models of serendipity as reported by Sun et al. (2011) highlighting the importance of temporal, situated and social context in the process of experiencing serendipitous encounters. One has, firstly, to notice information, then examine and evaluate it in order to proceed to connection-making. Our data shows that examining as a process can be immediate and/or occur in a short-term and long-term context, thus allowing participants to re-evaluate their suggestions as they progress with their connection-making. Context and time are extremely important yet complex factors that intertwine together in connection-making.

Our data also confirmed existing models of serendipity, indicating that the social and physical environment particularly form a strong contextual environment wherein connection-making and potentially serendipitous encounters can occur as participants have been exploring ideas and connections via socializing, communicating and discussing the suggestions and ideas with others. Furthermore, while the physical environment can influence participants' response to the suggestions received, it also changes the way that people choose to comment upon the suggestions (e.g. use text notes comments over audio and photos when at work).

Models of serendipity should therefore incorporate situational environments to more explicitly acknowledging the influence that the natural environment (both social, physical and informational) may have in perceiving ideas, connection-making and serendipitous encounters generation. It is well known that people have cognitive and processing limitations (Miller, 1956) and that they can be prone to functional fixedness (Duncker, 1945), which is dependent on the task environment and which in turn can determine insight problem solving. In a similar manner, we theorise that such an effect could potentially manifest within the serendipity realm and based on our qualitative data natural and situational environments need to be accounted for in serendipity models and for designing tools for serendipitous encounters.

Our study suggests new insights regarding serendipity processes. While previous models of serendipity and research show that serendipity manifests via active information seeking, passive connection-making (McBirnie, 2008), synchronicity, sagacity and coincidence (Liestman, 1992) or via unexpectedness (Sun et al., 2011), connection-making, evaluation and reflection (Makri and Blandford, 2012), our current study extends these notions by unpacking several steps and aspects of serendipity models in the literature such as the steps of 'noticing and examining' and 'connection-making'.

Based on data retrieved from our study, a number of different behavioural patterns emerge and have helped us to formulate further models in an attempt to understand serendipity and connection-making better under this context. We have identified that a set of four stages occur during connection-making which may lead to serendipitous encounters as well. These are the following: (1) encountering information/enthusiasm for tool, (2) perception and recognition, (3) memory and reflection, and (4) opportunities for action. The identified stages support and extend previous behavioural stages in information encountering such as Erdelez's four elements of information experience (i.e. (1) information user who encounters information, (2) environment in which the information is encountered, (3) information characteristics and (4) information needs that emerge from the information encountering experience – Erdelez, 1999). For example, Erdelez's first element (i.e. information user) encompasses characteristics such as the ones we have identified within our first and second stages of connection-making (i.e. encountering information/enthusiasm for tool and perception and recognition). Both our first two stages of connection-making manifest personal characteristics of the user that encounters the information. Our third stage however, (i.e. memory and reflection) can be considered again as stages relevant to personal abilities and characteristics of the user contrary to Erdelez's other information encountering elements that focus on ecological environment (i.e. environment where the information is encountered) and on information characteristics. Finally, our fourth (and last) identified connection-making stage (i.e. opportunities for action) can be linked to Erdelez's last element of information encountering (i.e. information needs that emerge from encountering information). More specifically, opportunities for action incorporate active recognition of new ideas and actions that can be taken forward to complete a needed task or achieve a desired goal. Erdelez's element regarding identifying information needs is about identifying what a user needs to at a given moment while our stage of opportunities for action extends this element to actively identifying valid or feasible actions for future processing. More detail about each of our connection-making identified stages is provided below.

We propose a 'Rubber Domino' model – each step is necessary for the subsequent one to occur. Previously, Heinrich proposed a Domino theory for demonstrating the nature of chain events caused by an accident (sequential accident models) (Ferry, 1988; Qureshi, 2007). Our connection-making 'Rubber Domino' model evolves from our earlier thinking about Heinrich's Domino Theory and the 'swiss cheese' approach, commonly used in accident and error analysis to demonstrate how when a number of 'holes' in elements of a system line up, errors or accidents occur (Reason, 2000).Within the context of serendipity, the outcome of the alignment of the 'holes' is positive, rather than negative. According to Heinrich's Domino Theory, injuries (in an accident context) are results of *a sequence of factors* from which the last one is indeed the accident itself. More the ancestry or social environment of an individual causes a fault to be generated or triggered by that individual, which results to an unsafe act, physical or mechanical hazard. The hazard causes an accident and the accident consequently causes an injury to the individual or to others. This process was likened to a series of dominoes that knock each other in a row and it is a sequential process. Our data supports but also extends both Heinrich's Domino Theory and the 'Swiss Cheese' approaches in so far as (1) we observe the existence of a trigger mechanism that demonstrates a level of sequence and bi-directionality in making connections and responding to suggestions and (2) we also observe a level of flexibility in terms of the direction this sequence of connection-making and user responses manifests. For this reason we propose a 'Rubber Domino' model of connection making and user responses that allows and demonstrates bi-directional moves and knocks that our dominoes (i.e. factors interplaying in connection-making and user responses) make.

The following sections expand on this 'Rubber Domino' theory. Our 'Rubber Domino' model is presented in Fig. 5.

5.2. Encountering information and enthusiasm for tool for connection-making

All participants encountered information via text messaging and internet browsing using their smart phones in our study. No connection-making could have had occurred without them being exposed to information. This is the reason why in the model presented below, encountering information is the first step of serendipitous encounters and connection-making. This stage does not necessarily focus on any active seeking of information, e.g. as other prior behavioural elements that have been identified do (i.e. Erdelez's information encountering elements) – rather it focusses
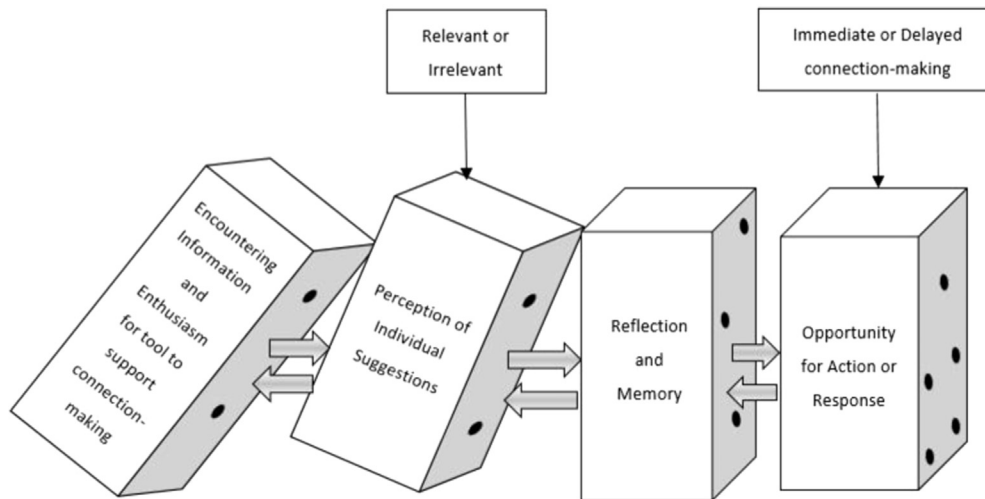
TECHNOLOGY USED IN CONTEXT

Fig. 5. The Rubber Domino model of user responses to mobile text suggestions and connection-making.

on users' open-mindedness and enthusiasm, which are closer to previously identified notions that promote serendipity (e.g. Friedel's, 2001; Makri and Blandford's, 2012 – serendipity is not just a happy accident; Gaver et al., 2003 – a user needs to be open for information augmentation and acceptance for experiencing serendipity). While this paper does not focus or discuss a new prototype tool, our participants expressed excitement, contentment with the provision of information (i.e. facilitating encountering information on-the-go) via our WoZ framework of sending text messages as suggestions for a period of time. As our participants manifested enthusiasm on the idea of having available a technological framework that exposes them to targeted yet broad information encountering while on-the-go, we felt that the concepts of encountering information and enthusiasm for tool within our context are tightly connected, therefore, we combined them in one single stage for our proposed 'rubber domino' theory.

5.3. Perception of individual suggestions/recognition

Participants expressed surprise, happiness and nostalgia based on suggestions that they have been receiving. Such emotions and reactions were followed by realisations of how this new or old reminded knowledge could be applied in their context, who could benefit and what planning they could do ahead. Such realisations could occur after reflections that would feed back to new realisations creating a loop of bidirectional feedback. The difference that this stage has from the 'noticing' stage of Sun et al.'s model is that this stage is modelled in a bidirectional level. Furthermore,- and as noted earlier – this stage refers to the active understanding of the information encountered but also to the recognition of the information usefulness for the users' current (or future) tasks and needs. This is different from previous identified behavioural elements of information encountering such as Erdelez's (Erdelez, 1999) environment of information encountering and information characteristics even though these elements can certainly contribute to our suggested recognition stage for connection-making. The notion of surprise and the emotions of happiness and nostalgia observed within our data converges with prior identified serendipity-related elements (e.g. Gaver et al., 2003 – surprise are associated factors for experiencing serendipity; Makri and Blandford (2012) serendipity process model in which unexpectedness plays pivotal role in generating insights that can lead to serendipity).

5.4. Memory and reflection

Some participants explicitly indicated that the model of information sharing that we applied in this study acted as a reminder for them of previous actions, habits and ideas that they had. In effect, this process triggered past memories that in most of the times had positive effects (e.g. either by triggering new connection-making or by leading the participants to re-visit old habits and ideas within different contexts). Participants actively reflected on the information and suggestions sent to them, sometimes superficially while other times on a deeper level depending on the context that they were in. This stage fits well with prior research suggesting that reflection and memory particularly can facilitate connection-making whether this is related to unexpected events or not. For example, Gaver et al. (2003) mentioned that reflection and surprise are associated factors for experiencing serendipity that need to be incorporated to designing innovative interactive tools while Maxwell et al. (2012) has presented design elements for reflection that can accommodate serendipitous encounters. Furthermore, our findings align with Auble et al. (1979) well established understandings that memory is a critical medium for facilitating *unexpected* connection-making – in other words, if someone lacks of memory, they have lower chances of having access to appropriate information and triggers that can lead to connection-making. Similarly, reflection has been recently emphasised that facilitates connection-making (Mann et al., 2009), something that is manifested within our study as well.

5.5. Opportunities for action and response

Once participants have gone through all of the above stages, they report planning to take action (or indeed taking action) in a short or long term. This could involve making further notes, searching more about the subject, sharing the information with friends and family, doing what the information was suggesting or even doing something that was not suggested at all but has been triggered by the suggestion sent. Sun et al.'s model does not account for any action taken in order for something to be within the serendipity realm. However, previous research has reported that certain actions such as microblogging and Social Media (Java et al., 2007), sharing with others (Short, 1993), face-to-face communications (Siemens, 2005; Barzilai and Zohar, 2006) and short semi-structured messages (Malone et al., 1987) can support and

promote connection-making. While the above research suggests the usefulness of 'sharing' information, knowledge and of communication indeed and making new connection, our study has particularly demonstrated that users actively identify new opportunities for short-term or long-term action in regards to the encountered and processed information – users not only, identify opportunities for action, but they also schedule these actions for future reference.

Below, we demonstrate some quotes from our participants that show the different stages of our proposed model. Each stage is being coded in the following way: Encountering information (INFO), Memory (MEMO), Reflection (REFL), Perception/Realisation (REAL) and Action (ACT).

> "the self-belief and problem solving link (INFO) reminded me of the 'make it or break it' (MEMO)– it is a very helpful link…it was a lesson for me…(REFL) made me think about judgment and balance and how this can be applied indeed…(REFL)(REAL)", "reminded me of when I was little and imagining if I had a 6th finger what she would be doing if she indeed had it (MEMO)…also reminded me of the theory of dreams in blind people (MEMO)… maybe something to look at later…(ACT)"
> "…found this (INFO) interesting (REFL) and I will go back to it for my PhD (ACT). Public sector initiatives can offer new ways for business to tackle inequality…(REFL) not something I would necessarily read on my phone though, need a button that resends links to my email to read at work!"

Fig. 5 shows how the above factors interact with each other and form our proposed 'Rubber Domino' model.

Table 3 shows how our empirical data and identified themes map onto our proposed 'Rubber Domino' theory model.

The adoption of the 'Rubber Domino' metaphor clearly demonstrates the importance of **all** of these stages yet it shows their – not necessarily serial – interplay amongst each other in a 'trigger'-like manner that promotes connection-making and user responses to the suggestions they received (whether these responses lead to immediate actions/connections or more retrospective ones planned for the future). The identification of these then provides a basis for implications for the design of technology to support elements of connection-making and – potentially – serendipity, enabling the making of connections between information and ideas that are interesting, unexpected, and have value to the individual.

6. Implications for the design of a tool that accommodates serendipitous encounters

How do we ensure that our technologies enable *encountering information and enthusiasm for the tool*, *perception and recognition of individual suggestions*, *memory and reflection*, and *opportunities for action and response* as our proposed 'Rubber Domino' model suggests?

A tool that can accommodate connections-making that it can, in turn, lead to serendipitous encounters, has to account and provide ways and space for reflection. One potential way to do such could be to design a dedicated space for reflection, evaluation and *re-evaluation*. *Re-evaluation* can be highly dependent on time, circumstances, goals, location and even individuals' mood and is an artefact of reflection, which was identified as a valuable mechanism for connection-making in our data and manifest within the "Reflection and Memory" stage of our Rubber Domino model. Furthermore, it is associated to the "Immediate or Delayed Connection-Making" phase of the proposed model, which interacts with the decision that users make on whether to follow-up a suggestion or not. For example, participants explicitly stated that their opinion about suggestions were and could be changed when viewed at a later stage and under different circumstances.

Table 3
Identified themes mapped onto the Rubber Domino model.

Themes	Quotes	Rubber Domino model
Value for receiving messages	"really useful as a concept to receive text messages as suggestions….(…)[ENTH]…really liked the hobby-like suggestions…it definitely works! [ENTH] (P7),	Enthusiasm for tool to support connection-making [ENTH]
Simplicity, Frequency and Timing	"received txt during meeting and so didn't check phone until later…I looked at the link and it looks pretty cool…[PERC] I love seeing how people have made cool stuff. I will check out the site on my laptop this evening and probably show it to my boyfriend"(P4)	Perception of individual suggestions [PERC]
Note-taking and Reflection (facilitation of combining data)	"I also received this text in meeting…after the meeting I looked at the webpage and briefly scanned it…the list of tips…etc…as I am writing my thesis at the moment it is very important to keep things like these in my mind [REFL]. I will print the page out later and keep it by my desk at home to remind me [REFL] when I am next writing"(P4)	Reflection and Memory [REFL]
	"the self-belief and problem solving link reminded me of the 'make it or break it' – it is a very helpful link…it was a lesson for me…made me think about judgment and balance and how this can be applied indeed…[ACT]"(P11),	Opportunity for action or response [ACT]
Creativity, Irrelevance and Obscurity (unexpectedness)	"the suggestions received helped me to broaden my horizons….to discover multi-disciplinary links….how for example, the same concepts are approached from different disciplines…[CONN] even the news blogs helped me to search further for the terms…[ACT]I enjoyed really reading them all!"(P13)	Immediate or late connection-making [CONN]
	"this is such a good find!!! [RIRR] Will definitely get access to this through the library and use it in my research [ACT]. I've read the writer's other stuff but never found a methodology paper!!! THANK YOU! This kind of thing feels so good when it is useful!! It is quite late at night but now I am excited and think about my PhD again…uh…oh!! [ENTH]") (P12)	Relevant or Irrelevant [RIRR]
The Path to Serendipity (Fun and Socialisation)	"OK, so I liked this link. Whilst it didn't have any bearing on my PhD research [RIRR], it gave me something to think about in respect of the open data stuff that I work on at work[REFL] [CONN]. It was an interesting article and I'm sure that some of the ideas will pop up in conversation. Also, as an additional note, tonight I found myself talking about the bilingualism article and discussing what language we thought in [ACT], which wouldn't have happened otherwise." (…)…so, first I have to say that I keep having conversations with people about the stuff that I've been sent during this trial[ACT]. Yesterday it started with me talking about the 'perfectionists' being tired article, and ended with me agreeing to write an article for a non-academic journal [ACT]. This is both exciting and weird [ENTH]. I mean, totally unpredictable.[REFL]"(P13)	Aspects of the whole 'Rubber Domino' Model

Therefore, a system that is connections-making-friendly, ought to provide an *interactive "memory"* where users can save and/or modify the suggestions received allowing them to re-evaluate them. As noted previously, our participants reported that they made connections, identified values and got reminded of previous enjoyable activities that they had forgotten about through the usage of our employed technological framework (i.e. WoZ approach for communicating suggestions on-the-go via text messaging).

A complementary element of a system that accommodates connections-making is to be *flexible* in response to *time and location* issues. For example, a number of our participants reported that they were not able to check the suggestions immediately after being received due to a number of reasons, many of which involved time-related (i.e. being on a meeting) and/or location-related circumstances (i.e. being on a day/night out with friends). Our Rubber Domino model indeed, demonstrates the need for flexibility in connection-making as has risen from our empirical data. The way that the model shows this need for flexibility is by the bidirectional triggers (in the model, links) that fire up new connections and that can occur not necessarily in a serial manner. Furthermore, a system that can facilitate connections-making needs to provide the *media to capture and further process information* whether this is visual, audio or of another form as our data suggests that location and surrounding information is vital to be recorded in an available and accessible manner for further *distribution* and/or processing that can assist connections-making. Indeed, we presented previously, our participants utilised different media to record their thoughts and impressions of suggestions (i.e. some of them used text solely, others used audio only while the majority of them used a mix of text, photos and audio). Our proposed 'Rubber Domino' model emphasises the need to accommodate reflection while facilitating opportunities for actions and responses. These can be accommodated better via the provision of different ways for recording and processing data. As our participants showed, they adopted different ways to record their thoughts and impressions on their received suggestions. For example, other participants utilised the audio feature of the mobile diary app, while others just used text. The majority of the participants used a mixture of these features demonstrating a need to have available different formats for data and thoughts capture. Both previous literature (e.g. Adomavicius and Tuzhilin, 2005) and our findings suggest that location and timing can potentially be considered as information sources on which some suggestions could be based on (i.e. when on holidays, to receive suggestions based on your location and on the time of the day). A suggestions feature would be of particular value for people that travel a lot and for people that visit conferences, academic and research events and who look forward to networking. We had participants who received suggestions while on particular locations, which inspired them to reflect not only upon the suggestions received but also they were able to perform connections-making that helped them to generalise and qualitatively evaluate their thoughts at the time while connecting this experience of connections-making with their current research. We saw other participants that received our suggestions being triggered by them to plan trips to capitalise on the suggestions received.

Despite the fact that personalisation of recommendations has been around in the field of recommender systems, our data supports the notion that personalisation – as known in the strict sense – it is not something desirable in a connections-making system as participants viewed this as restricting instead of nourishing the connection-making process. Participants reported that they enjoyed suggestions that were slightly *"off-topic"* yet they were *"somehow relevant"* and *surprising*. This links back to the "Relevant or Irrelevant" and "Perception of individual Suggestions" stages of

our proposed Rubber Domino model that was informed by our participants' responses on how they perceived the suggestions sent to them. The "off-topic", "somewhat relevant" and "surprising" perceptions of suggestions are indeed manifestations of the processes that our Rubber Domino Model suggests exist for receiving a relevant/irrelevant suggestion, processing it and solidifying *a* perception of value for it. A number of participants also reported that they would appreciate some ability from the system to *store information* (i.e. so that users can 'save' them and look at them later) even if these are considered 'off-topic'. Thus, a system that allows for continuous reflection is necessary in order to enhance and support connection-making. Hereby lie, indeed, the opportunities for serendipitous encounters through understanding and capturing the needs of participants without 'forcing' 'solutions' and suggestions to them. Instead, the system should allow for presenting *'easy-to-digest' information* in a neat and concise manner while giving the opportunity to the users to exercise an inner and reflective dialogue with the potential to proceed to rich evaluative processes and connections.

Participants repeatedly mentioned that *sharing ideas and impressions* is important; they tried to share suggestions and opinions about them with their inner and outer social and family circles. Sharing with others appears to accommodate the experience of connection-making as our data indicates that suggestions made led to actions taken after the suggestions have been discussed with others. Indeed, this is a form of incubation-a process which has been well reported that can support problem solving (Sio and Ormerod, 2009). Therefore, a system that supports connections-making and potential serendipitous encounters needs to incorporate sharing options for the users so that they can instantly distribute to others suggestions and thoughts, fostering opportunities for resources and peoples networking. Both *storing information* and *sharing ideas and impressions* are tightly linked to the "Opportunities for Actions and Response" stage of our Rubber Domino model. Our participants *acted* and *re-acted* to the suggestions received by sharing their ideas and suggestions they received with others, whether they were professional colleagues, friends or family. They indeed, expressed the need for being able to share these via a technological framework that allows them to make connections but also to share these connections with the anticipation that this *action* will trigger further connection-making. Furthermore, *storing information* for further processing also links back to the "Reflection and Memory" stage of our proposed Rubber Domino model. This Rubber Domino stage is based on our participants' expressed needs for having a tool that *archives and processes* their connection-making further.

Previous research (e.g. Kefalidou et al., 2012; Chitturi et al., 2008; Fleck 2003; Gaver et al., 2003; Leong 2009; André et al., 2009) has suggested and discussed the importance of 'delightful' design for promoting serendipitous encounters, connection-making, positive interactions and enhanced user experiences. Our previous work on design for delight suggested that people associate (and indeed seek) delight to concepts of (1) excitement and physicality, (2) ease of use, intuition and fun, (3) functional yet amazing GUI and (4) pleasure, satisfaction and excitement. Previous research (Kefalidou et al., 2012) has particularly highlighted the notion that 'delight' is something more: it is something that surpasses good expectations in an unexpected way. This links back to our empirical data presented here that suggests that enthusiasm for a simple yet enjoyable interactive tool that provides suggestions can trigger new connection-making. The majority of our participants expressed enthusiasm and excitement on the prospect of having available such a framework to make new connections while at the same time (ours and others) previous research suggest a clear link between delight and enhanced user experience (e.g. enthusiasm, positivity, happy unexpected

outcomes and connection-making). Furthermore, our qualitative data suggests that people experienced surpassed positive expectations regarding the perceived value of the suggestions they received. Consequently, a 'delightful' design for such a tool can further promote multimodality of media and interactions between people and between people and information in novel ways.

Receiving suggestions in a text format (as a simple SMS) allowed the users to be on-the-go yet able to provide to them a *simple platform* to reflect upon ideas, to learn about new things and for some to unexpectedly apply suggestions that they received in their everyday lives (independently of whether those applications were work-related or leisure-oriented). As such, a system that could accommodate serendipity should involve a simple platform for receiving suggestions, reflecting upon them and sharing them with others.

In Fig. 6. (next page), we present a requirements model (FIRM) for designing a tool that accommodates and facilitates connection-making and potentially serendipitous encounters. *Flexibility in time and location* is critical in order to allow for personalised services and interactions that account for peoples' personal space and lifestyle. For example, people reported that they have been looking and exploring the suggestions at different stages throughout a day, suggesting that they interacted with the information at different moments. Secondly, *Interactive memos* to support memory should be accommodated as our participants have repeatedly suggested that part of the information processing that they have been conducting and which –in some cases- led to serendipitous encounters involves being reminded of previous information. The provision of memories support could involve special alerts and storing. *Reflection* was found to be a major part of connection-making facilitating different methods for performing it some of which involved discussing with others, sharing information and actively writing down thoughts about the suggestions in the form of notes. Participants have reported that they found the action of note-taking (e.g. using the mobile diary application) allowed for re-thinking and reflection. Finally, the tool needs to provide affordances for *Multimodal*

information provision that is critically not restricted to related-to-the-user information as we have demonstrated earlier that irrelevant information can trigger new connection-making and inspiration.

Furthermore, users of a tool that supports inspiring connection-making should be able to make a *decision or comment* on particular ideas that they come up with and have appropriate technology to facilitate that. These decisions could be related to *rating information* and *filtering* it for further processing. Finally, users of such a system should be able to perform further actions based on the information that they processed. For example, participants in our study suggested that communicating their thoughts or even the information itself to others is something important for them in order to facilitate connection and sharing with the environment and the others.

7. General discussion

7.1. Limitations and Suggestions for further research

Fine-grained location analyses were not performed as this was not the primary focus of this study, but our study suggests that it would be valuable to embark into further analyses of the location information mainly driven from our qualitative data.

Our results suggest that participants' perception of the received suggestions was independent on the relevance of the suggestion to their interests. Qualitative data furthers this finding as participants have reported that even seemingly 'irrelevant' information to them is enjoyable as long as this information is unexpected providing some insight as to how people perceive text suggestions 'on-the-go' and what kind of content they appreciate (RQ2 and RQ4). This aligns with the models of serendipity that exist and provides information about the ways we can design and implement systems that can accommodate serendipitous encounters (RQ6).

Our rich qualitative data provided us with an insight into how, when and why connections were made based on the suggestions
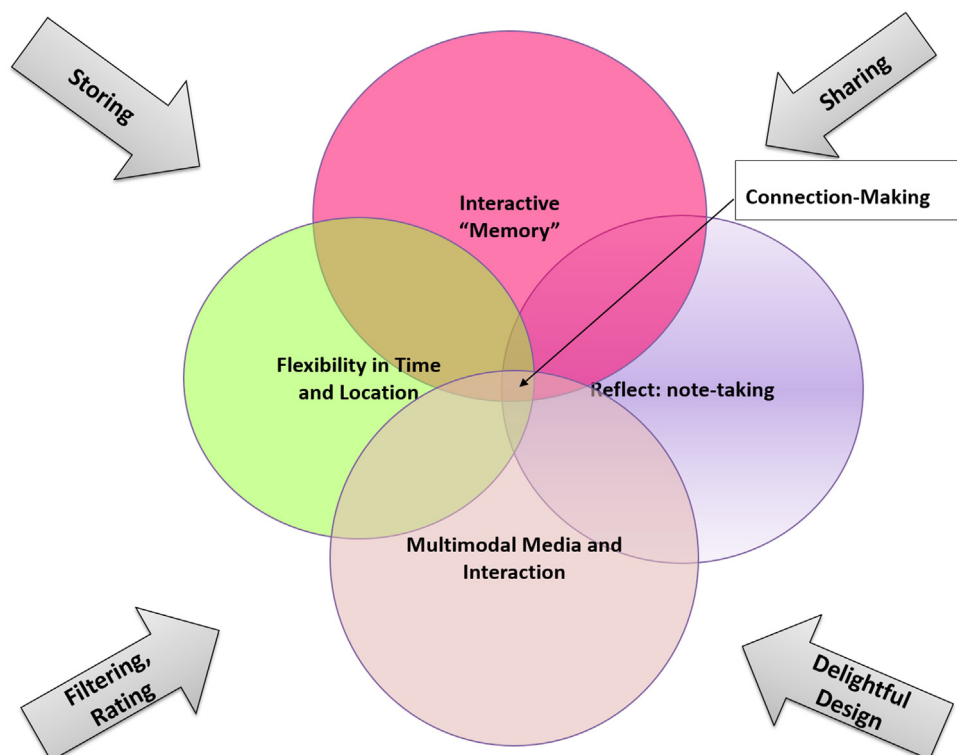

Fig. 6. Requirements model of a tool that supports connection-making (FIRM).

that the participants were receiving (RQ1, RQ2, RQ3 and RQ4). For example, it was revealed that unexpectedness is perceived by participants as a multi-dimensional concept that incorporates factors such as location, past experiences, memories, familiarity and non-familiarity. This is a new aspect within serendipity research that provides a new layer of granularity into how such a serendipity-related concept (i.e. unexpectedness) can incorporate and interplay with other factors that are more cognitive-based such as memory and how it can facilitate the generation of new associations between ideas and information (RQ4 and RQ5). Findings as such can greatly inform our design for a prototype for serendipitous encounters, especially under the new light of 'unexpectedness' multi-dimensionality (RQ6).

Furthermore, prototype design of systems informed by serendipity can incorporate seemingly 'irrelevant' suggestions if the number of suggestions pushed by the system remains low (around 4 per day maximum) (RQ6). However, more research is needed for identifying a 'threshold of irrelevance' for triggering new connections and potentially facilitating serendipity. The findings of this study reinforce previous findings on the 'examining' notion of serendipity (Sun et al., 2011) and emphasise the importance of time and context. For example, our qualitative data suggests, that peoples' response time to the text suggestions received depended on the time they received the suggestions and on the activities they performed (at home, at work or in transit) at that time (RQ1). People that received the text suggestions during work meetings, would not check them (and follow the suggestions' URL links) at the time of message's reception but instead they would check them later in the day – on the other hand, people that received the text suggestions while idle or during activities of lesser importance or attention demand, would be inclined to check the suggestions at the time of receipt (RQ1).

This paper also sheds morelight onto how connections are made and unpacks further the notions of unexpectedness and interestingness in suggestions. It further examined how a simple framework such as text-messaging can interact successfully with a mobile diary framework in order to provide an environment that supports connection-making and insightful thinking 'on-the-go' (RQ6). Participants reported that they made connections with suggestions they received by exploring further resources that they thought were interesting (RQ4, RQ5). Our results provide support to the notion that having a system that provides suggestions to users can provide an environment for experiencing serendipity as we had cases reported of participants' making-connections that wouldn't have been able to make otherwise (RQ6). This further supports previous research that explored the context of recommendation systems and how they provide a great test-bed to investigate the 'serendipity problem' (Lanquita et al., 2008). Our research extends recommendation systems research in two ways. Firstly, we propose a simpler framework for suggestions provision utilising already existing infrastructures such as simple text-messaging but also we propose the incorporation of mobile diary concepts (e.g. self-reflection) in order to support connection-making and serendipitous encounters (RQ6). Also, we found out that even 'irrelevant' information can be of use and of interest to people and can potentially facilitate connection-making and serendipity (RQ2, RQ4, RQ5 and RQ6). While existing research in recommender systems have been attempting to employ contextual factors in recommender systems (e.g. Adomavicius et al., 2005), our research suggests that the level of relevance/irrelevance of a suggestion appears to play an important role in connection-making (RQ4, RQ5, RQ6). What our qualitative research findings suggest is that there is more to 'irrelevant' suggestions than meets the eye. Connection-making, insightful and useful ideas can spring from seemingly 'irrelevant' suggestions as well. We believe that this is an important finding that needs to be incorporated within

the design of not only new recommender systems but of new 'serendipity' systems.

Furthermore, our qualitative data also suggests that over-customization that produces too 'relevant' suggestions may indeed be boring for the participants, which leads to disengagement with the suggestions, not to mention the lack of connections-making (RQ2 and RQ4). This finding aligns with previous research from Gup (1997) where it is being argued that overspecialisation impairs serendipity. According to McNee et al. (2006) 'inaccuracy' can be detrimental in a system that makes recommendations. In our case, our data suggests that for a system to accommodate serendipitous connections-making, it has to provide not 'inaccurate' suggestions but suggestions that can be irrelevant yet surprising, relevant yet not boring and suggestions that participants feel can be of value to them and interesting. Therefore, similarly to McNee et al. (2006), our data suggests that there can be an element of 'irrelevance' in the suggestions given in order to potentially trigger connections-making while providing a good level of satisfaction to the user.

McCay-Peet and Toms (2011) have previously identified that *connection-making and exploration* between information, exposing people to *unexpected and varied information*, accommodating *browsing of information*, promoting *divergence and triggering curiosity* facilitate serendipity encounters. Within our presented research here, suggested that these elements are also relevant for connection-making on-the-go (RQ4 and RQ5). We have demonstrated too that these elements play critical role in promoting connection-making that may -or may not- lead to serendipity. Nevertheless, these elements appear to lead to valuable experiences that can promote both immediate and delayed connection-making.

Our empirical data also supports and unpacks aspects of Erdelez's (1999) elements of information experience (i.e. information user who encounters information, environment in which the information is encountered, information characteristics and information needs that emerge from the information encountering experience). For example, we found out that the provision of simple yet effective technological frameworks (e.g. WoZ approach coupled with text messaging and the interplay of loosely with tightly-tailored suggestions) can promote connection-making offering a mobile environment for people to encounter varied and unexpected information. We found out that the information characteristics of the suggestions sent did not have to be necessarily tightly-matched to participants' interests (whether these were job-related or hobby-related) but instead the information needs and information characteristics were dependent on a 'golden ratio' of relevance that allowed for fun, unexpected yet interesting connection-making (RQ2, RQ4, RQ5). Furthermore, while serendipity may presuppose active-seeking, connection-making may also take place in a non-seeking mode by utilising reminders and reflections on forgotten material (RQ2, RQ4, RQ5).

In contrast with past research (Tsang et al., 2004), the majority of the participants in this study reported positive responses towards the suggestions received, even when their content was 'irrelevant' (RQ2 and RQ4). Information that appears to be irrelevant but is exciting or surprising can be beneficial as well, as participants reported that it made them think in other ways and produce unexpected outcomes (RQ2 and RQ4). This comes in contrast to previous findings from marketing and advertising (Conti et al., 2012).

Finally, while previous research (e.g. Pennebaker et al., 2003) suggested that syntactic and grammatical structures within a single sentence may influence consequent actions and interactions of the people that are exposed to these structures, our data did not appear to support such an influence (RQ3). We also found that the way text suggestions were phrased (i.e. text vs. question-like

sentences) did not seem to influence the way or promptness that people responded to the suggestions (RQ3). Indeed, the majority of our participants did not even notice the changes in phrasing of the suggestions. The few, however, people that noticed, mentioned that particular phrasing utilised in the suggestions (i.e. question-like sentences) triggered their curiosity and prompted them to open the suggestion link quicker than they would normally do. This may have been due to the familiarity of participants towards grammatically-manipulated text messages and snapshots of information (e.g. people are already overexposed to surrounding information that incorporates such characteristics). Another reason may be that participants' attention was more focused towards the content of the text suggestions rather than the phrasing of it (e.g. participants being at a heightened state of awareness may have been focusing on only one aspect of the study design manipulation). Another explanation for why the majority of our participants did not even notice the difference in phrasing, might lie in the frequency the suggestions were sent, which may have impacted on the alertness of participants. This would be an artefact that would necessitate further examination in a future study that will employ a lower number of suggestions messages to be sent to participants per day.

The data we presented above gives further support to the notion that having a tool that that feeds you with suggestions is a simple and neat way and that allows you to reflect upon can be beneficial, consistent with arguments in Maxwell et al.'s (2012) paper. Participants, if in an appropriate time and place, are willing to accept and act upon push suggestions as long as the number of suggestions is not overwhelming.

Manipulations of temporal context and phrasing of the suggestions appear not to influence participants' positivity towards the sent suggestions, although the qualitative data did highlight the role of context in a number of cases. Timing and perceived value of the suggestions received constitute important elements of connection-making as our qualitative data has indicated. Quantity and timing of messages needs careful thought, and may require preferences to be stated by the user of a system that was presenting suggestions. In conjunction with the fact that participants reported being happy with the general format of the suggestions, this data supports the notion of using 'push' suggestions to present unexpected information to users; such suggestions can form a valuable element of a system to support and accommodate serendipity.

A limitation of our current study includes the possibility of participants being at a heightened state of mind while experiencing and responding to the text suggestions. Perhaps participants may have had a different response to the text suggestions if they were exposed to a different 'in-the-wild' context. However, on the other hand, the service which this study represents i.e. the facilitation of a framework to support connection-making 'on-the-go', could be an 'opt-in' service rather than 'opt-out' one, therefore, participants may be said to be at a higher state of awareness for receiving and perceiving text messages (as suggestions) anyway. Thus, the aforementioned limitation may actually present a viable facsimilie of 'real world' 'in-the-wild' situation that this study aims to unpack.

8. Conclusion

In this paper we unpacked processes that trigger and promote immediate and delayed connection-making on-the-go by adopting a novel WoZ approach and offering a synergized technological framework consisting of text messaging and mobile diary for responding to the suggestions. Through our rich empirical qualitative data we have unearthed important factors that interplay and

promote connection-making providing us with new insights as to how people can enhance their connection-making, how they can process their ideas and how by reflecting on them they can make new associations on-the-go. Our WoZ approach has demonstrated key stages on how to construct tailored and loosely-tailored suggestions that they can indeed, provide value and new connections to people. This can be of particular importance for designing future recommendation systems that are more user-friendly, user-tailored yet they provide an element of surprise and excitement to the users. Within this paper we have introduced our empirically-driven novel models of (1) connection-making and user response (that we call "Rubber Domino") inspired by previous research on accident aetiology and (2) our requirements model for a tool that supports connection-making (that we call FIRM). While our "Rubber Domino" model demonstrates the different stages for people to make new associations, our FIRM model unpacks the needs to take into account for designing novel recommendation systems that promote inspiration and connection-making. Some future steps in our research include the further unpacking of phrasing of suggestions in connection-making by e.g. sending fewer text suggestions per day. Another future study would be to perform a longitudinal study that lasts for longer period of time – this will provide more opportunities to explore further issues of context and interactions with other people as a process of connection-making. Unpacking users' perceptions would also be a next research step extending this study by exploring further the way that people classify, re-classify and value the suggestions over time.Nevertheless, our presented work here has demonstrated that simple and familiar ways of communication (i.e. text messaging, one-sentence suggestions, mobile diary application) alongside with a coupled tailored/loosely-tailored suggestions mechanism can synergise in facilitating both connection-making and positive user interactions.

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