ForgetIT
Concise Preservation by Combining Managed Forgetting
and Contextualization Remembering

Grant Agreement No. 600826

Deliverable D2.2

Work-package	WP2:
Deliverable	D2.2: Foundations of Forgetting and Remembering – Preliminary Report
Deliverable Leader	Robert Logie
Quality Assessor	Vasilis Mezaris
Estimation of PM spent	8 PM
Dissemination level	PU
Delivery date in Annex I	2014-02-01
Actual delivery date	4. March 2014
Revisions	6
Status	Draft for internal review
Keywords:	Human Memory and Forgetting, Personal Preservation, Organizational Preservation, Digital Memory Support for Human Memory

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Executive Summary

This deliverable from Workpackage 2 is concerned with a preliminary report on the review of research literature on human memory and forgetting, of organizational memory, and of the interaction between digital memory systems and human memory, including the initial results of a public, multi-country and multi-language survey of human use of photographs to support memory. It is noted that human memory relies on using a lifetime accumulation of knowledge about the world and about the self to set the context for both preserving and retrieving details of events, and that retrieval involves a process of context based reconstruction, not the recall of a veridical record. This process is very efficient for storage and retrieval and works extremely well for most scenarios, but it results in rapid and substantial forgetting of detail. The reconstruction process can lead to errors and is subject to interference from subsequent and previous experiences, with the individual being unaware that their recall is inaccurate. Organizational memory is sometimes considered as analogous to human memory, although this analogy may be misleading and organizational policies and practice can be used to compensate for corporate forgetting, such as when an employee leaves.

Digital storage can be used to support human memory, but the usability of systems is constrained because too much detail is recorded, much of which may be irrelevant or redundant, giving rise to difficulties in retrieval of information required for particular purposes. Context based preservation and retrieval may offer a solution, with the digital system complementing human memory rather than attempting to replace it.

Preliminary results of a large Internet based survey of personal storage of life events using photographs are reported.

1 Introduction

This deliverable is intended to offer a preliminary report of a review of the research literature on human and organizational forgetting and remembering. First, a brief review of each of the main areas of research on human memory is presented along with a summary of the key features of human memory that have been identified from that research.

It should be noted that research on these topics typically involves designing and running experiments with human volunteers who are presented with material and are subsequently tested on their memory for that material. Experiments are designed according to theoretical, conceptual models of how a specific aspect of human memory might function, and conclusions are drawn from detailed analyses of the pattern of memory errors that result from different experimental manipulations or different kinds of material. Some of the experiments involve assessing the processes and accuracy of retrieval of real life events, whereas others involve relatively artificial materials. There is also a large amount of research of this kind with volunteers who have suffered specific forms of brain damage, and these studies can reveal some of the characteristics of healthy human memory as well as the nature of memory impairments from which the patients suffer. Other experiments involve exploring the patterns of brain activation while human volunteers are completing memory tasks. The development of the theoretical, conceptual models is driven by the patterns of results from these experiments.

There are some general principles of memory function about which researchers on these topics agree, but there are ongoing debates about the details of the conceptual models and the interpretation of patterns of results. As a result, there is currently no universally accepted conceptual model of human memory. An example of one conceptual model of human memory is illustrated in Figure 1.1 Some of the details of this model have been developed by the first author of this deliverable (e.g. Logie, 1995; 2003; 2011), based on a simpler model originally proposed by Baddeley and Hitch (1974). However, it has characteristics that are similar to other contemporary conceptual models.

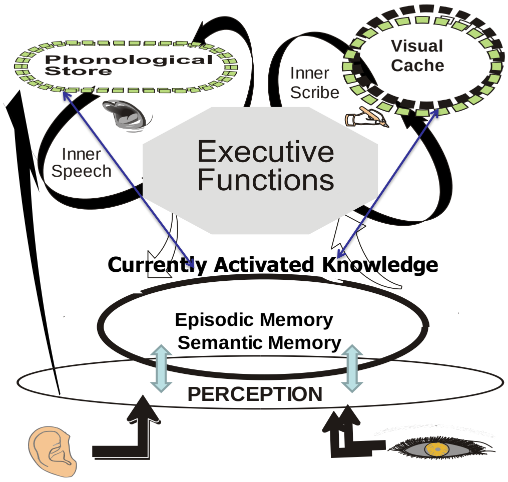

Figure 1.1: Conceptual Model of Human Memory

In summary, this conceptual model indicates that information from auditory, visual and other forms of perception (e.g. tactile) activates stored knowledge accumulated over a lifetime regarding knowledge about the world and about the self (Semantic Memory) and preserved information about individual events (Episodic Memory) related to the perceived stimuli. Some of the activated knowledge is held on a temporary basis in a collection of interacting, domain-specific temporary memory systems, or components of working memory, and processed by a range of executive functions. For example, combinations of meaning, shape and sound may be held together as currently activated knowledge. Details of recently perceived stimuli that have been seen or heard may be held as sound-based codes in the Phonological Store component or as visually based codes in the Visual Cache component. Both types of code decay within around 2 seconds, but the Inner Speech component can allow the sound-based codes to be held for longer by mentally repeating the sounds. The Inner Scribe component holds and can mentally rehearse sequences of movements and can allow visual codes to be held for longer by mentally rehearsing the codes held in the Visual Cache.

It should be noted that the theoretical conceptual models of human memory such as the one shown in the Figure are used as frameworks to generate hypotheses and to guide the design of memory experiments. They are not formal computational models with clearly defined characteristics for each component or precisely what information flows along the arrows between components. There are some formal computational models of specific functions of human memory (for example of the phonological loop shown in Figure 1.1), and these are used to run simulations of the behavioural data patterns obtained from memory experiments with human volunteers. However, these formal models are beyond the scope of the current deliverable. Figure 1.1 is included here to set a context for the reader who is unfamiliar with the approaches and style of research summarised in Section 2 of this document.

The deliverable also provides a brief overview of some of the research on the design and use of digital storage systems to support human memory and indicates how the understanding of human memory might contribute to the characteristics of digital systems that allow for managed short-term and long-term preservation as well as managed forgetting and why forgetting is important to include in digital systems.

Finally, the deliverable provides initial results of an internet based survey that has been made available in multiple languages to assess how photographs are used to support human memory and what user expectations there might be of a future digital system that would offer managed preservation and managed forgetting of these kinds of personal records of lifetime experiences. The survey will be available for completion throughout year 2 of the ForgetIT project, and so no formal analyses are provided at this stage.

2 Human Memory and Forgetting

2.1 What is human memory?

Human memory takes many forms and serves a wide range of purposes that are essential for humans to function in everyday personal and working life. Among the lay public, it is most widely associated with preservation and retrieval of information about public and personal events. However scientific study takes a much broader view of human memory to include the acquisition, preservation and retrieval of knowledge and skills (semantic memory), events and experiences across a person’s lifetime (episodic memory), and remembering to carry out intended actions (prospective memory). It also applies to the temporary storage and moment-to-moment updating of information required for a focus on the current task, an ability known as ‘working memory’. Finally, it applies to a range of control functions that can suppress or inhibit information that is irrelevant or redundant, that can detect or recognise whether information has been encountered previously or is linked with previously preserved information. The review of research in this deliverable will focus on the memory and forgetting functions. Deliverables 2.3 and 2.4 will consider control functions in greater detail.

2.2 Semantic and Episodic Memory

A key distinction is between semantic and episodic memory. Semantic Memory includes knowledge (e.g. language, facts about the world, people and the self) and acquired skills (e.g. swimming, riding a bicycle, mathematics) while memory for specific events that took place at a particular place and at a particular time (e.g. a particular holiday, meeting, lecture or social event or what you had for dinner yesterday) is referred to as episodic memory. Tulving (1972) introduced the concept of episodic memory as a system that underlies the ‘what-when-where’ specifics of an event, and as such is distinct from factual knowledge in *semantic memory* (Tulving, 1983). Forgetting from episodic memory is rapid and substantial. Forgetting from semantic memory is much less rapid and information is well preserved over long periods or never lost. Semantic memory is thought to develop across the lifetime by extracting features that are common across similar events, and building what are known as schema for specific types of events, a concept first proposed by Bartlett (1932). Details of the occasion on which the information was first encountered are forgotten. For example, a restaurant schema includes tables, menus, food, conversation, waiting staff, and paying a bill, but we probably cannot recall when we first learned these features of restaurants. In the same way, we know that the capital of France is Paris, but are unlikely to remember when that fact was first encountered. This means that the schema sets the general context for each restaurant visit, and provides a ‘framework’ on which to build the memory for key details of specific visits to restaurants. The features that are common to each restaurant visit need not be stored on every occasion. The same is true of any common experience, such as a working day, a visit to a swimming pool, a train or aeroplane journey. The framework or context can then be used to aid retrieval of information about specific events. When recalling a restaurant visit, we can assume that there was a menu, food, a table, a bill etc. and so only have to store and retrieve the key information such as who else was at the table, and what was important about the conversation. In summary, the human memory tends to preserve generic information that is repeated across similar experiences and events without ‘tagging’ that information with a time and place. Human memory tends to forget details that are unique to individual experiences or events, except when the unique features of a particular event are particularly important for the individual.

A further role for a schema or context is in the understanding, or interpretation of presented information or events. Take, for example, the following paragraph from a study by Bransford (1979, pp 134-5).

> ‘The procedure is actually quite simple. First you arrange the items into different groups. Of course one pile might be sufficient depending on how much there is to do. If you have to go somewhere else due to lack of facilities, that is the next step; otherwise, you are pretty well set. It is important not to overdo things. That is, it is better to do too few things at once than too many. In the short run this may not seem important but complications can easily arise. A mistake can be expensive as well. After the procedure is completed one arranges the material into different groups again. They then can be put into their appropriate places. Eventually they will be used once more and the whole cycle will then have to be repeated.’

This passage is difficult to understand and also is difficult to remember because there is no context. Most of the material from the passage will already have been forgotten as you are reading this sentence. However, after the context for the passage is given as ‘washing clothes’, then the interpretation of the text is trivial and memory for the sequence of procedures can be generated from existing knowledge in the schema without having to remember the exact wording. The use of the schema can be repeated every time this kind of activity is required, and precise details of each occasion do not have to be preserved in memory, unless, for example an error on one occasion is to be avoided on future occasions, or a small change to the procedure results in a benefit that should be remembered for future repetition. However, even when a context is available, substantial forgetting of detail occurs within minutes. For example, although the general meaning of the washing clothes paragraph could be regenerated, the precise wording is unlikely to be remembered accurately. Likewise, within a few seconds of reading the text of the current paragraph, any reader will have forgotten the exact wording used but will remember the meaning of text. For readers who are not already familiar with the topic of how human memory functions (i.e. have no accurate or detailed existing schema or context) many of the detailed facts presented in the deliverable will be forgotten within an hour after it has been read, unless this material is relearned before this forgetting occurs (Karpicke & Roediger, 2010; see section 2.5).

Therefore, a great deal of information concerning an event is never stored in memory. Because there is a large number of schema and a large amount of information accumulated in semantic memory over the lifetime of each individual, the human memory system can select what information is necessary to set the context for the current environment or information presented, and can inhibit or ignore information that is irrelevant or can be assumed from the context. This aspect of human memory is a major strength in that it avoids the distraction of information that is irrelevant or redundant for the current task, and avoids the storage of large amounts of irrelevant or redundant information, making it very efficient for storing and retrieving key details about an event, or retrieving key facts and skills that are required for the current task.

2.2.1 Forgetting from Episodic and Semantic memory

The process of forgetting from semantic or episodic human memory typically refers to the inability to retrieve information that has previously been stored, and this is often viewed as an unwelcome limitation. However, detailed analysis shows forgetting to be more complex, and to be a benefit to humans most of the time. As should be clear from the previous section, a substantial amount of detail is never encoded in memory. It is equally well established that of the detail that is encoded, a substantial amount is forgotten within a short time after the initial experience. This prevents the memory system from being filled with information for which there is no clear context, or that is largely irrelevant, or which is required only on a temporary basis and preservation is not normally required. Consequently, only information that is important for understanding and functioning in the world tends to be preserved.

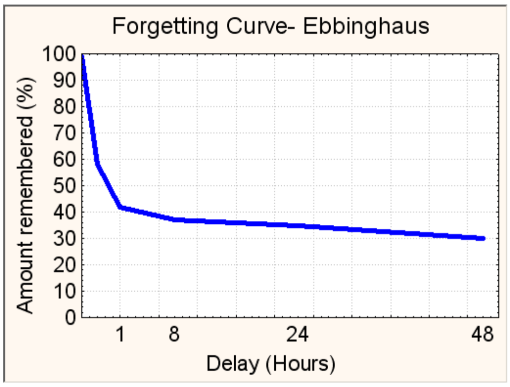

Figure 2.1: Forgetting Curve

The forgetting of information that lacks context was first subject to systematic study by the German researcher Ebbinghaus (1885) who spent much of his life learning and remembering 'nonsense material', specifically three letter syllables (e.g BAZ FUB YOX DAX LEQ VUM....) for which he had no established schema. Therefore, this kind of material was selected to assess 'pure' episodic memory without the support of semantic memory. In his experiments, he would spend several minutes trying to learn sequences of these nonsense syllables, and then tested his memory at different time periods after the learning. Typical results from his experiments are shown in Figure 2.1. It is clear from the figure that most of the forgetting had occurred within one hour of the learning, and the small amount of material that was retained after one hour was retained for at least 48 hours.

Although the work of Ebbinghaus was important for understanding memory and forgetting, it was unclear as to why the material was being forgotten. The research also was criticized because of the reliance on memory for nonsense material. It is rare that adult humans are required to remember material for which they have no schema or context.

The issue of what might be the main causes of forgetting has been the subject of scientific debate ever since the time of Ebbinghaus, with the major possibilities being decay of the material over time or other material causing interference with the memory representation. In the case of decay, information that is lost over time through gradual deletion from memory of material that is never accessed. In the case of interference the forgetting may arise from an inability to retrieve key details of an event because of interference from previously stored details about similar events (proactive interference - e.g. Underwood, 1957), or because of interference from stored details of similar subsequent events (retroactive interference, e.g. McGeoch & McDonald, 1931). More recent studies have demonstrated interference based forgetting of a first language when trying to learn a second language (Isurin & McDonald, 2001), an example of retroactive interference: learning of the new language interferes with memory for the previously learned language. Other studies have shown that parking a car in different spaces in the same car park multiple times (e.g. at work or near a retail centre) can make it difficult to remember where the car was parked today (Pinto & Baddeley, 1991). This is a common experience and often suggests to people that their car has been stolen until they realise that they are looking in the space that they used for their car yesterday or last week. This is an example of proactive interference: multiple similar previous experiences interfere with ability to remember details of the most recent instance of this experience.

However, it turns out that the Ebbinghaus forgetting function applies also to the forgetting of material that can be supported by context from semantic memory. Take, for example, the results form a study published 100 years after the Ebbinghaus studies. McKenna and Glendon (1985) tested memory in people who had undertaken and successfully completed a first aid course. At intervals varying from 3 months to 36 months, they were tested on their memory for their ability to diagnose the health problem associated with particular symptoms, their resuscitation technique and performance as well as on a total score for the knowledge they had retained from the course. Despite spending several days on the first aid course, and passing the test at the end of the course, within three months they had forgotten 70% of their knowledge about diagnosis, and after six months they had forgotten 60% of even their best preserved ability, namely their technique for cardiopulmonary resuscitation (CPR). However, over the following 30 months, the rate of forgetting was very much slower than it was during the first six months. In the case of Ebbinghaus, learning took place over a few minutes with no schema or context, and forgetting was over periods of minutes and hours. In the McKenna and Glendon study, learning took place over several days and involved information and skills within the schema or context of first aid care. In this latter case the forgetting was over periods of months rather than hours. So, context greatly slows down the speed of forgetting. However, the shapes of the forgetting functions were remarkably similar, even if over different time periods. Equivalent results were found by Bahrick (1984) for English native speakers remembering Spanish learned at school over delays of up to 50 years, and retention of information learned at University up to 30 years later (Conway, Cohen & Stanhope, 1992). In both studies, there was substantial forgetting within the first few years after leaving the formal learning environment, but then a much slower rate of forgetting thereafter.

These well established studies show that when memory is supported by context or schema, then the material can be retained for periods of months or years, but even with this support, most of the forgetting of details still occurs within a relatively short period and the material that remains after that initial period is forgotten much more slowly. If never 'relearned' from time to time (see 2.1.5), all of the information may be forgotten. For example, the people in the Bahrick (1984) study who used Spanish in their daily lives after leaving school retained their knowledge of Spanish very much more successfully than those who did not or had few opportunities to practice using the Spanish they had learned. The same was true of the material learned at university in the Conway et al. (1992) study. The difference in forgetting supported by context and without such support is illustrated in Figure 2.2.

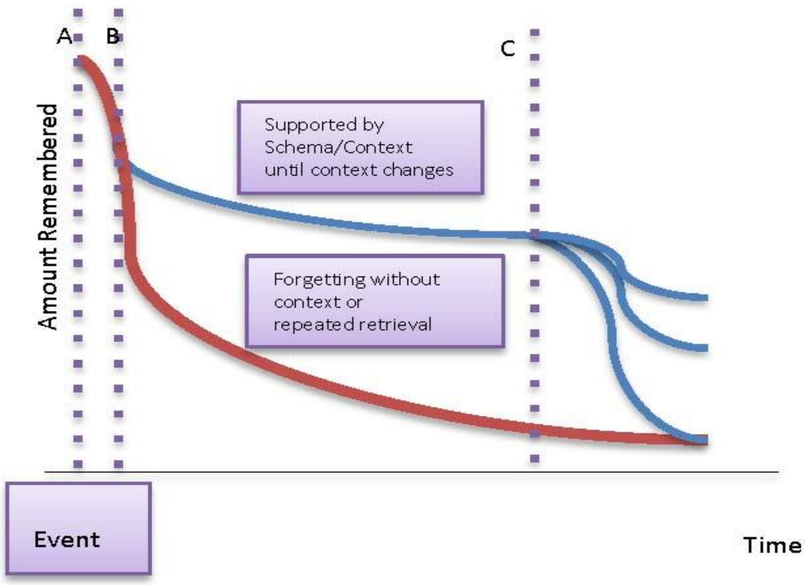

Figure 2.2: Forgetting with context support vs. Forgetting without context support

A further everyday example of the support from context (also illustrated in 2) is remembering the number of a hotel room for the period of staying in the hotel, or remembering a flight number. The context of being in a particular hotel is supported by the repeated requirement to retrieve the room number when asking for the key, going into breakfast, or returning to the room, but after leaving the hotel, there is no requirement to retrieve the room number and so it is forgotten. The same is true for the flight number which need only be retrieved while at the airport but it not retrieved again after the travelling is complete, and so is forgotten. Paper and electronic aids are of course extremely useful in these circumstances, and are used widely to avoid the need to retain this kind of information in memory even on a temporary basis.

Context and schema work well in supporting memory most of the time, but because much of memory retrieval involves reconstruction of details based on schema rather than actual memory for details, the reconstruction process can result in major errors and false memories that the individual is convinced are genuine. For example a witness to a crime or accident can have a false memory of details of the people present or of the incident. These false memories arise because people assume 'what must have happened' based on their schema for such events rather than what actually happened. False memories can also arise because of subsequent experiences (retroactive interference) such as accusing an innocent bystander of being the criminal, or recognising a face as vaguely familiar and falsely remembering them as the person who had committed the crime. For example, a psychology researcher who is also qualified as a legal practitioner, Donald Thomson was involved in the case of a witness identifying their attacker as someone (Thomson himself) who was appearing on a live television programme that the witness was watching at the time of the attack. Thomson was arrested by the police but rapidly was able to prove that he was somewhere else at the time of the incident. False memories also arise because of the phrasing of questions to the witness: a question such as 'how fast was the car travelling when it smashed into the wall?' will generate higher estimates of speed than the question 'how fast was the car travelling when it hit the wall?', even although exactly the same incident was witnessed. The memory for the speed estimate is changed by the use of the phrase 'smashed into', when questioning the witness (Loftus & Palmer, 1974). There are hundreds of documented cases of innocent people being arrested and convicted of crimes on the basis of mistaken eyewitness identification, but for whom subsequent DNA or other evidence has proved their innocence. In many cases their innocence was established after many years in prison, or in some cases after imposition of the death penalty. Despite this, the legal system in many countries relies heavily on the testimony of eyewitnesses and many members of the legal profession, including judges seem unaware of the fallibility of human memory for events (for reviews of eyewitness research see Lindsay, Ross, Read and Toglia, 2007). So, while one of the strengths of human memory is in the use of schema to allow memory reconstruction and avoid overloading with redundant or irrelevant information, this process can also generate errors with serious consequences. Some of these errors could be avoided with the use of external devices that can record events as they occur to support accuracy in subsequent recall, as in the case of the eyewitness.

2.3 Forgetting Intentions

A further key everyday aspect of memory is the forming of intentions to carry out an activity at some point in the future, and then remembering to do so. This ability is often referred to as prospective memory, in contrast to episodic memory which is retrospective. Failures of prospective memory can also result in embarrassment or irritation when forgetting to meet a friend or mistakenly using shaving cream on the toothbrush instead of toothpaste. However, failures of prospective memory also can result in serious consequences, for example if a flight is missed, medicine is not taken, forgetting to put on a parachute when skydiving, or failing to close the entrance ramp of a car ferry when leaving the harbour. These are just few examples of numerous real incidents that also include major aeroplane and train crashes, and major industrial accidents, resulting from this kind of human memory error (Reason, 1990). Ironically, many such errors arise from highly practiced activities which might have been performed many hundreds if not thousands of times previously, so are performed automatically. A novel distraction or preoccupation with a worry such as an upcoming exam, important interview, a sudden technical failure in equipment, or the breakdown in a relationship, removes the very small amount of attention required to ensure that these highly practiced activities are performed successfully, resulting in an error that is sometimes referred to as 'absent mindedness'. This could result in absent-mindedly starting to drive on the route to work on a Saturday evening instead of to the theatre. It could also result in an experienced pilot switching off the starboard engine on an aeroplane instead of the port engine which is on fire. The underlying type of memory error is the same, but the consequences are dramatically different.

Absent-minded errors occur over periods of a few seconds or minutes when a novel or threatening scenario displaces an intended action in current memory, or working memory.

Prospective memory failures also occur over longer periods of time when it is impractical to 'keep the intention in mind' or in working memory, and other activities or thoughts intervene. For example, setting off to walk to work with the intention of posting a letter during the 40 minute journey can result in arriving at work without the letter being posted, unless posting the letter is the only thought kept active while walking. A cue or reminder such as passing a post box can reduce the chance of a prospective memory failure, but remembering to keep an appointment or the date of a wedding anniversary would not be monitored continuously over periods of days, weeks or years. In the absence of external aids such as a calendar or a reminder on a smart phone, it has been argued that some of the intentions are activated automatically from time to time, thereby acting as internal memory cues (e.g. McDaniel & Einstein, 2000; 2007). However, if there are too many intentions formed then errors are extremely likely without some form of external paper or electronic aid. It is also likely that an intention will be remembered at the correct time (e.g. to catch a flight), but that details required to carry out that intention (e.g. the exact flight time or flight number) might require some external memory aid. An external device that could monitor actions required in specific contexts would also reduce the likelihood of memory errors, for example by preventing departure from the aeroplane at 3000 metres unless the parachute is in place correctly.

2.4 Temporary Memory and Working Memory

Equally crucial for every day functioning is the human ability to retain information on a temporary basis to allow completion of a current task or to function in a novel environment. This ability is often referred to as working memory (e.g. Baddeley & Logie, 1999; Cowan, 2005). Here, information is held for only a few seconds and continually updated, so forgetting of details is almost immediate. For example, in order to understand the text you are reading now, it is important to remember the text that you have just read, and the most recently read text is continually being updated as you progress through the document. Likewise, successful driving on the motorway requires continual updating of memory for the position of nearby traffic and this is continually updated with rapidly changing traffic patterns. In neither example is there normally any requirement to retain precise details such as the exact wording and font of the text read 10 minutes ago, or the precise position, model and colour of the car that was overtaking 15 minutes ago. Those details are important at the time, but not subsequently, and so are held for just a few seconds and then are forgotten as the contents of working memory are updated. Working memory is used for almost every activity while humans are awake; mental arithmetic, navigating around unfamiliar environments, keeping track of current intentions and the flow of a conversation, making a meal, creative thinking, or keying a telephone number. It is thought to have capacity for around 3 or 4 items at any one time (e.g. Cowan, 2005), but items can be grouped together so as to have 3 or 4 groups or chunks of information. However, its capacity can also be shown to be larger when using rehearsal or when storing different types of information. So there is capacity for holding 7 plus or minus 2 random numbers if the numbers are mentally rehearsed (Miller, 1956), and 7 random numbers can be retained at the same time as a random visual matrix pattern (Cocchini, Logie, Della Sala & MacPherson, 2002). Without rehearsal items in working memory are readily replaced by new material on a second to second basis.

2.5 When Human Forgetting is Minimised

There are three major factors that have been shown to be associated with minimal forgetting:

(a) Expertise
(b) Re-learning
(c) Vivid Memories

These are explained in more detail below.

(a) Expertise in the present context refers to the accumulation of specialist and advanced knowledge in a particular domain, typically as a result of many hundreds or thousands of hours of learning and practice in that domain. The expert has very detailed schema that can support memory for details of past events related to the area of expertise. For example expert chess players can readily remember the positions of pieces from multiple chess game positions (De Groot, 1965), soccer fans can remember multiple scores from matches played between teams with which they are familiar (Morris, Tweedy & Gruneberg, 1985). Even residential burglars show superior memory for details of houses that are related to their area of activity (Logie, Wright & Decker, 1992). The expertise can also be very specific. For example, Ericsson, Chase & Falloon (1980) trained an individual (Falloon) to be able to repeat back random sequences of up to 80 digits. Falloon had significant expertise in athletics and learned to group parts of the sequences as numbers related to his area of expertise. For example, the sequence 354 would be encoded as 3 minutes 54 seconds or a record time for running a mile. By creating multiple combinations of numbers and making these meaningful in the context of athletics, his expertise allowed memory for number sequences that greatly exceeded the typical maximum random sequence length of 7 plus or minus 2 digits that most adults are capable of recalling (Miller, 1956). However, the expertise did not confer any general enhancement of memory for material outside the areas of expertise: Chess experts are not better than chess novices when remembering the position of pieces shown at random positions on the board, rather than from a real chess game, soccer experts are no better than those lacking an interest in the game when trying to recall random sets of scores rather than scores from real games, burglars can remember if a house had a burglar alarm but not the colour of the curtains in the window, and Steve Falloon could not remember any more than 7 random letters or words. In summary, the more accumulated knowledge that a person has about a topic, the easier it is for him/her to remember details related to that knowledge whether that be information technology, cognitive psychology, journalism or stamp collecting.

(b) Relearning material effectively starts the process of transferring details about a specific event (episodic memory) into knowledge and expertise about the topic of that material (semantic memory). If the relearning occurs very soon after the initial encounter with the material, and before most of the forgetting has occurred, this slows down the rate of forgetting. This then allows a longer time before relearning is required, and this expanding spacing of learning has been shown to be effective in dramatically reducing the rate and amount of forgetting that occurs (Landauer & Bjork, 1978). An example is illustrated in Figure 2.3. More recently, Karpicke and Roediger (2010) have shown that attempting to retrieve information from memory (self-test), is even more effective than re-reading or being re-presented with the same material.

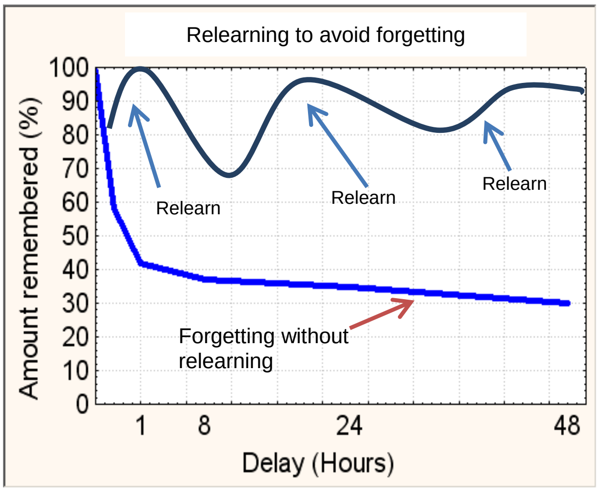

Figure 2.3: Reducing Forgetting by Relearning

(c) Vivid memories are associated with events that are of major personal importance, such as one's own wedding, start of a new job, birth of one's child, or of major public importance such political assassinations and resignations, natural disasters, major accidents, important sporting events, or major human achievements. In these cases, people report having remarkably vivid memories that include many details that are normally forgotten. The best known report was of people remembering where they were, who they were with, what they were doing and what the weather was like at the time that they heard, in 1963, that the US President John F Kennedy had been assassinated, or that Martin Luther King has been assassinated several years later. These memories were reported as remaining vivid more than ten years after the original event (e.g. Brown & Kulik, 1977). Similar long term preservation of vivid memories has been recorded for the first moon landing in 1969, the surprise resignation of the British Prime Minister Margaret Thatcher in 1990 (Conway et al., 1994), and the attack on the World Trade Centre in 2001 (Pezdek, 2003). However, even in the case of public events, memories were more vivid for events that were of personal interest. The resignation of Margaret Thatcher was recalled most vividly among UK citizens who had an interest in politics, and the death of the UK Princess Diana in 1997 was more vividly recalled by UK than Italian citizens, although the 2001 attack on the World Trade Centre was remembered equally well in the UK and Italy (Kvavilashvili, Mirani, Schlagman & Kornbrot, 2003). The claimed vividness and detail associated with these event-based memories appeared to suggest that these kind of memories included a great deal more detail and were much more accurate and consistent over time than are memories for other kinds of events (for a review see Luminet & Curci, 2009), including details specifically about place, informant, activity, own affect, and aftermath (Kaya Kizilöz & Tekcan, 2013).

Many researchers conclude that these vivid memories arise because there is considerable media coverage at the time, for some time afterwards and on anniversaries of each event. Major public events are also the main topic of conversation for people at the time and for several days, if not weeks afterwards. In sum, the memories for the events are recalled and rehearsed many times over when discussing with friends and through media coverage, making it very likely that those memories will be preserved. The same is true of personal memories of events that are important for the individual. One's own wedding will be a topic of conversation and mental activity for many months in advance and for months and years after the event. So, repeatedly recalling events leads to long term preservation in memory.

However, it is worth noting, that although many people experience these vivid memories, many of the details that they recall are incorrect, and are not consistent over time, even although people are convinced of their accuracy. A number of researchers have argued that the main difference between vivid memories and memories for other events is that people are much more confident about their recall of the former rather than there being an actual difference in the amount of accurate detail remembered (e.g. Cubelli & Della Sala, 2008; 2013; Talarico & Rubin, 2003). For example, many people in the United States confidently report a vivid memory of watching the television broadcast of the first plane to hit the World Trade Centre on September 11th, 2001, but that event was not recorded or televised. Only the aftermath of the crash and the video recording of the second plane crashing into the building were available. This major error was not only true of many US citizens (Pezdek, 2003), but also of the US President George W Bush (Greenberg, 2004). Similar recall errors have been found for other vivid memories of major public events. So, vivid memories are subject to the same process of reconstruction as are other memories. These kinds of memories were originally referred to as 'flashbulb' memories, suggesting that they involve preservation in memory of considerably more detail than is the case for most memories of events. However, the finding that these memories are often not accurate has led to more widespread use of the term 'vivid memories' to reflect the personal experience of individuals rather than the accuracy of the preserved memory (although not all researchers agree, see Curci & Conway, 2013). That is, they follow the same general principles of remembering and forgetting of episodic memory, but may be subject to considerably more rehearsal, are experienced as more vivid, often have more emotional content, and are recalled with greater confidence than other memories. Moreover, they are just as error prone and therefore do not appear to be subject to any different forms of processing or memory preservation compared with other memories (Cubelli & Della Sala, 2013).

2.6 Autobiographical or Personal Memory

One major focus within the ForgetIT project is the preservation of personal information, and thus far we have referred to this kind of information to illustrate how a concept regarding human memory might account for aspects of how people experience and use memory in their daily lives. However, there is a large research literature involving both experimental research and theoretical development of conceptual frameworks regarding how personal memories are stored and accessed. Personal memories can be understood broadly within the same set of memory systems described earlier, with *episodic memory* the host for memories of personal events, *semantic memory* being the host for general information about oneself, and *working memory* for holding in mind information regarding current activities. However, when referring to personal memory, the term autobiographical memory is often used to emphasise that the research is focused on memory for real-life every day personal experiences, as distinct from episodic memory for numbers, letters, word lists or visual patterns that are used when studying this form of memory in controlled laboratory experiments. Tulving (2002) extended the concept of episodic memory to include: a sense of subjective time (that we mentally revisit/travel back in time), autonoetic awareness (that we are aware of our memory experience as different to our experience of the immediate environment and present) and a sense of self (specifically, a sense of self that can exist in subjective time). He has also argued (Tulving, 1983, 2002) that memory measures of a task completed in a laboratory should not be considered autobiographical because they are focused on 'what' (remembering content) rather than an episodic integration of 'what-when-where' information.

Specific terminology of an *autobiographical-event memory* (e.g. Maguire, 2001) can be used to refer to a memory with personal relevance and experience, though some authors do not include episodic memory within their conception of autobiographical memory (e.g. Conway & Pleydell-Pearce, 2000). Such an approach again requires that the memory preserves "specific spatio-temporal context", though it may be from the recent or distant past, and acknowledges that event-specific recall will draw upon and be influenced by more general knowledge about the world and general knowledge about the self (history, different life periods, name, etc.) from semantic memory.

The distinction between autobiographical episodic memory and autobiographical semantic memory was demonstrated by Tulving, Schacter, McLachlan and Moscovitch (1988). They described an individual, who, following brain damage showed a severe impairment of memory for autobiographical events while having intact semantic memory about family and personal history, occupation, residence and car owned. More recently (Renoult et al., 2012) argued for a further distinction between 'personal semantics' (consisting of knowledge about one's self, of self identity, and one's experiences) and general semantic knowledge (facts about the world).

Conway and Pleydell-Pearce (2000) propose a Self-Memory System as a conceptual model of autobiographical memory. This relates development over the lifetime of autobiographical memory knowledge to event-specific knowledge (after Wheeler, Stuss & Tulving, 1997), through reciprocal connections with a *working-self*. The *working-self* refers to current short-term goals that are embedded within a hierarchy of longer-term (including life-long) goals, which are in turn framed and constrained by self-image and autobiographical knowledge. Tulving (2001) argued that information represented in episodic memory is the product of sensory information passing along a serial processing chain through perceptual representation and semantic representation systems, which may or may not result in an episodic representation. In contrast, Williams, Conway and Baddeley (2008) maintain that episodic representations "originate in working memory, where they derive from mental models of 'online' experience" (p 40). Such episodic representations are given conceptual context by stored autobiographical knowledge, through automatic access to stored knowledge and through operations of the *working self*, such as inhibiting information that is not relevant to the current goal, that competes with the current goal or that is unrelated to one's own representation of self.

Conway and Loveday (2010) have argued further that autobiographical knowledge can also be represented as a hierarchical, nested structure comprising a semantic memory of the self in which episodic memories can become integrated with representations of 'general life events' (repeated events with common structure, property or theme), which are themselves further represented within 'lifetime periods' (such as 'when I worked at a specific institution', 'when I was mother to a young child') which are further represented as life stories, contributing to self-images and ultimately a 'conceptual self'. Short-term goals that an individual sets can become part of an autobiographical record of specific memories integrated with an immediate context, or with general life events or a lifetime history. Conway's concept of a Self Memory System (Conway & Pleydell-Pearce, 2000; Conway 2005, 2009) allows for creation of a 'personal history' and ability to access memories in varied ways, for different reasons, throughout changing personal contexts and personal circumstances, while still maintaining an over-arching sense of self throughout the lifetime.

Episodic memories may or may not become integrated with autobiographical memories, which is partly dependent upon the richness and detail of conceptual context available at encoding, and upon subsequent retrieval (among other influences, see Conway & Loveday, 2010). As Conway (2009) emphasises, "the function of episodic memories is to keep a record of progress with short-term goals and access to most episodic memories is lost soon after their formation" (pp 2305), consistent with the broader characteristics of memory identified by Ebbinghaus in 1885. Additionally, Conway (2009) has noted that within episodic memory not all components of a memory are equally accessible and has suggested that goal structure at the time of the experience determines the activation, and subsequent accessibility, of features within a memory (for retrieval within that memory context). If episodic memories are to be voluntarily recalled, they must be further integrated into autobiographical knowledge to enable generative retrieval - an often strategic and iterative process of cue-elaboration; if this integration is lacking, episodic memories may be brought into awareness only through direct cueing. This latter (involuntary) process would require an unlikely-encountered specificity of cue to directly access elements of an episodic memory (Conway & Loveday, 2010). A similar concept was proposed by Tulving (1983; 2002) who suggested the principle of encoding specificity, namely that details encoded and set in a particular context at the time of an event will act as effective cues for prompting later recall of details of the event. For example, if the reader is given the cue 'washing clothes', that can act as a cue to retrieve a passage of text given in Section 2.1.1., because that context was used to encode the information in memory. The cue word 'expensive' is a much less effective cue for retrieving that same passage, because it was most likely not used as part of the context or schema for encoding, even although the word appeared in that text. If we consider the notion that each individual has a 'schema of the self', then this schema can set the context for experiences and be used to help retrieve whatever was preserved in memory from those experiences.

As implied in the above model of Conway and colleagues (2000, 2005, 2009, 2010), recalling an autobiographical memory requires an interplay and interaction of episodic information and semantic elements of an individual's personal history. As noted in Section 2.1, recall of a memory is always a reconstruction from those details of an event that have been encoded within the context of a schema that is used to make assumptions about details that have been forgotten. It is not a veridical record of the event. Cabeza and St Jacques (2007) list the most influential factors in determining the episodic versus semantic composition of an event during the reconstruction process at recall: *age of memories, event frequency, rehearsal* and *age of participants.* As may be expected, in the real world context of a person's life history these factors do not operate in isolation, rather they interact.

Using a method originally devised by Galton (1879), in which participants are asked to provide memories in response to cue words (for example, think of a memory for an event related to the word ‘river’ or the word ‘holiday’), Crovitz and Shiffman, (1974) demonstrated that fewer memories are produced from early life years. Participants are less likely to recall memories from the first five years of their childhood and more likely to recall detailed memories from the more recent past. Moreover, older autobiographical memories contain less detail and are more abstract than those from the more recent past (Cabeza & St Jacques, 2007; Piolino, Desgranges & Eustache, 2009).

An exception to the pattern of memory recall frequency is a *reminiscence bump* found in participants over 40 years of age who produce many memories from their early adulthood (age 18-30 years old; Rubin, Wetzler & Nebes, 1986). It has been suggested that such a period may contain life ‘firsts’ and meaningful, life-defining events (such as jobs, children and marriage; Bernsten & Rubin, 2004; see also section 2.1.5c),which serve as anchors in our memory and a basis upon which our life story (or *narrative*) is built. Glück and Bluck (2007) observed a reminiscence bump only for positive (not negative or neutral) memories, in which participants indicated they had perceived themselves as having had control of their situation. This is consistent with the idea that individuals create a positive and defining life story for themselves (see also Conway, 2009). A bias towards recall of positive life events is especially present in older adults (Mather & Carstensen, 2005).

Detailed memory for events throughout the lifespan requires a complex interplay of a number of aspects of the memory system (see e.g. Conway, 2009) in addition to decline with age in the integrity of the brain. Levine and colleagues (2002) reviewed the history of research showing negative effects of age on recall of episodic memories. They demonstrated that older adults provide answers with fewer episodic details and more semantic content than do younger adults, even when probes for episodic detail are provided. St Jacques and Levine (2007) demonstrated further that this age pattern of fewer episodic details provided by older than younger adults holds true for emotional memories, even when positive emotional memories elicit more episodic details than do neutral memories.

As noted by Marsh and Roediger (2013) memory for personal events is subject to the same general principles as other types of memory – such as proactive and retroactive interference (see Section 2.1.2). As people age, so the number of similar experiences increases, therefore the effects of interference among memories of those experiences also increase. Meeting thousands of people over one’s lifetime, many of whom have similar first names, builds up a lifetime of proactive interference. This makes it increasingly difficult with age to remember the name of someone just met for the first time. It also builds up retroactive interference, making it increasingly difficult to remember the name of someone met a few years ago because of experiencing the names of all of the people met subsequently. This problem with names applies to memory for details of many similar events that have been experienced over a lifetime, making it more likely that there will be increasing reliance on more reconstruction from generic and less specific semantic knowledge and schema for supporting recall (Cabeza and Jacques, 2007). Reconstruction takes place even for events which appear to be unique in many aspects and which the individual believes that they retain in a detailed, episodic format.

2.7 Photograph Use and Event Memory

A key use-case scenario within the ForgetIT project is the use of personal photographs, a topic that has been researched in both controlled laboratory settings and in every day settings. In a laboratory based experiment, Koutsaal et al. (1998) investigated the effect of viewing photographs on event memory. Participants watched a video of action taking place and their memory for the content of this video was tested. Subsequent to watching the video, but prior to testing, participants were shown photographs that included elements from parts of the video, or presented with verbal descriptions of these elements. Koutsaal et al. found older and younger adults remembered more from the parts of the video that had been viewed in the photographs or verbally reviewed than they did sections that had not been reviewed. Such an increase in memory performance following photograph viewing after (witnessing) events was also replicated by Schacter and colleagues (1997). However, despite evidence that reviewing photographs is supportive and beneficial to memory (Koutsaal et al., 1998; Schacter et al., 1997; St Jacques & Schacter, 2013), further evidence suggests that photo use may not be without negative consequences. For example, following presentation of photographs that contained images indicating items which were either present or absent in a previously viewed video, older adult participants cued on these latter items were also more likely to attribute them to having been present in the video; Schacter et al., 1997). More recently, St Jacques and Schacter (2013) asked participants to complete a tour of a museum, wearing a camera which automatically took pictures during the tour. They were then presented with photographs which were either strong cues (photographs from a natural perspective) or weak cues (photographs from an unusual perspective) to memory for aspects of the tour; the authors then presented photos of entirely novel items, or other items from the tour, and asked participants whether the items had been a part of their visit. Strong cues produced a higher level of accuracy than weak cues in detecting photographs that depicted items from the tour, but also produced an increase in erroneous selection of photographs of objects that had not been seen on the tour. This result reinforces the general conclusion discussed above that memories are reconstructed and subject to change. The study also highlights how photographs can influence the reconstruction process.

Work by Koutsaal and colleagues (e.g. Koutsaal et al., 1999), cautions against possible effects of selective rehearsal when seemingly viewing photographs to help memory. Such effects were demonstrated when participants were asked to view photographs that pertained to elements of a series of activities in which they had been involved in the laboratory; tasks carried out but that were not reviewed were more poorly recalled than both reviewed activities and performance of a control group who carried out the same tasks as a baseline condition where no reviewing took place. That is, selectively reviewing certain elements of associated activities (or sub-events) led to a *reduction* in memory recall for activities not studied. Recent results by Henkel (2013) have also been used to advocate a need for further understanding of how *the act* of taking photographs interacts with our natural memory abilities. Henkel employed a constricted, contrived experience whereby participants were instructed, throughout an art museum tour, to visit a list of objects and to either only look at them or to look at them and photograph them (with the relevant action for each object dictated by experimenter). Subsequently, the number of objects, and amount of detail, remembered between these two conditions was compared. In a second experiment, an additional condition was introduced where participants were instructed to zoom in to specific sections of objects-to-be-photographed. When required to perform the zoomed-in photography task, participants' memory (recognition of objects or for detail) was comparable to the observation only (no photography) condition. This was true for the original specific part of the object that was photographed as well as for other parts of items that were not included in the photograph. In comparison, in both experiments, memory was poorer for objects that participants had been instructed to photograph (without zooming). While participants were told in initial instructions that they would be asked about the appearance of the objects of art, Henkel suggests results indicate a reliance on out-sourced memory storage that has negative effects for our own memory. Specifically, that "taking a photo could serve as a cue to 'dismiss and forget', as in directed forgetting" (Henkel, 2013, p2). The cognitive effort and attention expended on a zooming task appears to counteract this effect. However, as acknowledged by Henkel, this apparent detriment to memory may not extend to situations in which people exert a choice over taking a photograph, or where the photograph is driven by interest. Further work to disentangle the factors that may contribute to memory in a real-life situation has been called for (Henkel, 2013).

2.8 Summary of the Key Features of Human Memory

i. Human memory is often considered to be ‘episodic’, referring to details about specific events, or ‘semantic’, referring to knowledge accumulated over the lifetime. Within semantic memory are domains of knowledge or schema that group key features that are repeatedly experienced in specific scenarios. There are schema that are similar across people, such as for a restaurant, the office, the home, the swimming pool, a holiday etc.. Each individual also has a schema of the ‘self’, including knowledge of life periods, name, date of birth, relationships etc..

ii. Preservation of information about specific events in human memory is heavily influenced by contextualising the information about those events within schema. Recall from memory involves reconstruction of details of events based on schema, rather than retrieval of a veridical record.

iii. The level of detail for preservation in human memory is determined by what is required to set the context and to preserve the key features of an event. This means that many details of an event will not be stored. For example, the fact that a particular restaurant was visited on holiday and who else was at the meal may be preserved in memory, but the precise colours and design of the walls and floor coverings, the food eaten and layout of the food on the plate will not be stored in memory or will be forgotten rapidly, unless these were key features of the experience.

iv. Forgetting of details of events is extremely rapid and substantial, with most details of any given event forgotten within minutes or hours. The amount forgotten and the rate of forgetting is largely determined by the length of time spent on experiencing the event or actively attempting to preserve in memory details of that event, and the links with a context or existing schema. What information remains after the initial period of forgetting is preserved in memory long term.

v. Some details of an event are required only on a temporary basis in order to complete a particular task, and are unlikely ever to be required again in the future. These kinds of details may therefore be retained for only a few seconds, or in some cases for less than a second, and not preserved. Examples could be the positions, colours and models of cars seen briefly while travelling on a motorway, or retaining a telephone number only long enough to successfully press the keys on the telephone.

vi. Some details are required for periods of hours or days but are forgotten completely after they serve no purpose and are therefore not repeatedly recalled or supported by a different context. Examples here might be a flight number after a particular journey is complete, or the number of the room occupied in a hotel after returning home or moving to a different hotel.

vii. Memories for events can be changed as a result of interference from other experiences or information, such as viewing photographs, subsequent to the event, or as a result of the process of reconstructing memories from schema or context. This can result in ‘false memories’ or ‘memory illusions’ with the individual being unaware of the error and convinced of the accuracy of their retrieval.

viii. Memories for major public or personal events that are experienced as being vivid and highly detailed are preserved in memory largely because of rehearsal and multiple retrievals of those details at the time of the event and subsequently. Many of the details that are personally experienced as vivid may be false recollections as a result of many memories being reconstructions and rationalisations based on schema and context.

3 Organizational Memory and Forgetting – Conceptual Approaches

Organizational memory is seminally important for organizations to succeed – only if an organization can remember, it can act efficiently over time. Organizational memory is thereby, following the definition offered by de Holan and Philips (2004) a term covering a very wide range of assets, rules, procedures, routines, and related organizational attributes that shape behaviour.

On the one hand, the concept of organizational memory makes intuitive sense. As organizations accumulate knowledge about how to best do what they are doing, they are getting better at it. In economic terms, the unit cost is reduced with cumulative production (Benkard, 2000). This enables organizations to do more at constant cost or resources, or to do the same but at reduced cost. The capacity of an organization to create and utilize memory is thus linked with efficiency.

On the other hand, the concept of organizational memory is also a bit of a contradiction in terms. Organizations are founded on clear structure and well-defined processes that, once in place, create efficiency through application and repetition. In contrast organizational memory is most generally created through a process of learning. And learning itself is disrupting existing procedures and calling into question established structures. Learning is all about change, while organizations tend to be about stability.

Weick and Westley (1996) have argued that rather than aiming to solve this inherent tension, we should embrace it as a core feature. While their argument was targeted specifically at the process of organizational learning, the same can (and following their argument must) be said of its result, namely organizational memory. (Weick & Westley 1996)

Initially, organizational memory was confined to the distinct notion of accumulating knowledge at an organizational level, either formally or informally, either structured or unstructured, either explicitly or implicitly. It was the idea that over time knowledge would be added to the organization’s memory, which consequently would grow invariably as time progresses.

The best organization therefore would be one that could capture as much relevant knowledge as possible and add it to its memory, so that it could then be applied. This placed an emphasis on facilitating the creation of organizational memory, and on enabling its application. It was seen as a mostly additive process that would lead to the accumulation of knowledge as organizational memory, but with little thought given to the need to weed organizational memory of things that have become irrelevant, or even worse, reduce the value and import of subsequently acquired knowledge.

However, over the more recent decades, the concept of organizational memory in the academic literature has been extended and expanded to go beyond a focus on learning and remembering to include the opposite processes as well, of unlearning and forgetting. This broadened view acknowledges the importance of organizational memory as organic and dynamic, not just growing in parts but shrinking as well, and embraces the contraction of organizational memory as not necessarily a flaw but at times a necessity for organizations to succeed.

Extant academic research has put forward at least three broad perspectives to conceptualize organizational memory (Easterby-Smith & Lyles, 2011): the cognitive perspective, the behavioural perspective, and the social perspective. These will be briefly reviewed in the following.

3.1 The Cognitive Perspective

The cognitive perspective suggests that organizational memory works in a similar way to human memory as described in Section 2. Memory is perceived as the outcome of a process that while taking place at the level of an organization rather than at the level of the individual human being is nevertheless a distinctly cognitive one. Consequently, we are able to take insights gained from how individual humans remember and forget, how human memory works, and apply it to organizations and the knowledge dynamics within it.

Thus learning in an organization takes place when the shared mental models within the organization change or evolve (de Holan & Philips, 2004). And learning (that is the accrual, application, as well as eradication of memory) can be influenced through the processes that relate to and affect that shared mental model. As a result, for the proponents of the cognitive perspective it makes eminent sense to understand the underlying conditions, contexts, drivers, facilitators and hurdles that are at play within the shared mental model.

For instance, when a member of an organization leaves, this does not simply reduce the organization's memory. It often will prompt the remaining members of the organization to reframe the organization's memory so that it now conforms and is aligned with the new group composition. This process is the equivalent at the organizational level of what at the level of the individual is described as the reframing of memories of one's past to better align them with one's present values and preferences, and thus to lower cognitive dissonance. (Schacter, 2001)

3.2 The Behavioural Perspective

In contrast, the behavioural perspective highlights the creation of organizational memory through repeated behaviours and practices with an organization. The initial focus is not only on the incremental nature of the creation of organizational memory, but also on the importance of proficiency through repetition, and thus on a slow but steady improvement in efficiency. The first aim of the behavioural perspective on organizational memory is to underscore the fundamental quality of organizations to standardize processes and structures, and to alter them only slightly over time, so that they remain comparatively stable, but open to incremental advancement (Argote & Epple 1990). In contrast, learning radical changes are downplayed.

Therefore the emphasis is on studying these practices and procedures to see whether, when and under what conditions they change. This does not necessitate that these practices and procedures are explicit. From a behavioural viewpoint organizational memory is accepted often to be embedded and thus implicit in such practices and procedures.

More recently, some advocates of the behavioural perspective have suggested that higher, more abstract forms of organizational learning also fit within their model. This may open the behavioural perspective to accept more radical changes in organizational memory as part of the learning process, as long as these changes are the result of rather incremental steps at the higher level of abstraction. This would allow for an organizational memory that is less deterministically path dependent on a lower level, and would have a greater ability to adjust and learn from mistakes than the strict behavioural perspective might suggest.

3.3 The Social Perspective

A third perspective conceptualizes organizational memory as shaped by the social ties and connections of the members of the organization. As organizational memory and recall takes place through social ties, the creation, change, and loss of these ties shapes the overall memory available to the organization. Thus, for instance, a cognitive approach may highlight the loss of organization memory embedded in an individual when that individual leaves the organization, while the social approach emphasizes the loss of connectedness within the organization that this entails – and how this shapes the recall of existing and the creation of new organizational memory going forward.

As a consequence, advocates of the social perspective look at and investigate the nature of connectedness within an organization over time, and as the organization is exposed to challenges. Organizational memory creation would be facilitated by enabling the creation of connections, and by making it easier for those that are connected to maintain the connections they find useful while also putting them in a position to drop connections without having to fear organizational (or individual) backlash when such culling is in order.

The challenges through such a conceptual lens are thus not only how to incentivize the individuals to establish and maintain the appropriate connections (as the goal for an organization is not to simply have the highest number of connections, but the highest number of potentially valuable connections), but also how to create and maintain the organizational contexts in which such connectedness can flourish. (Burt 2007)

3.4 Conclusions

These three perspectives are helpful, as they emphasize different elements and qualities of organizational structures and processes that facilitate (or impede) organizational memory, and thus can provide guidance to those aiming to create tools that assist in the creation and use of organizational memory. Their implicit danger, however, is that they may encapsulate the process of organizational memory creation and application as too mechanistic, and thus lead to simplistic assumptions about the necessary or useful qualities of these tools. What must be avoided is too mechanistic a view of organizational memory.

Hence, in an important contribution to the field, Bannon and Kuuti (1996) underscored the organic and dynamic nature of organizational memory, and how it differs from an overly simplistic view of mechanistic storage and retrieval of knowledge. Organizational memory is substantially different from how binary code is committed to digital memory and retrieved with precision later. Organizational memory, perhaps even more so than individual memory, is constantly being constructed and reconstructed as the organization evolves. Thus any conceptual view of organizational memory – and by extension any attempt to create technical tools that aid and facilitate in the creation, capture, and retrieval of organizational memory – must embrace the constructive, organic and dynamic nature of it.

Fortunately, while arguably absent at the beginning of their work, researchers representing all three broad perspectives mentioned above over the last decade or so have emphasized and indeed studied the dynamic nature of organizational memory, and its constant construction (and destruction) within organizations.

Thus, when developing a conceptual framework of organizational memory and forgetting, and then evaluating the framework against specific cases, one needs to be careful to reflect the important dimensions highlighted by and contained in the three broad perspectives outlined, but emphasize that this had to happen before the backdrop of a view of organizational memory as constantly construed and reconstructed, not fixed but fluid, and not stable but emergent.

4 Remembering and Forgetting in IT Systems

This section discussed methods and technologies in IT, which are related to human remembering and forgetting. Partially they use similar mechanisms and partially they are designed to complement the processes of human remembering and forgetting.

The advent of Big Data and the development of ever more effective storage technologies may suggest that forgetting need not occur in digital systems, because there is sufficient storage to keep everything. However, forgetting mechanisms are still necessary, be it to ensure privacy (Bos 1995; Vargas et al., 2011; Mayer-Schönberger, 2013), to remove or correct errors (e.g. Mayer-Schönberger, 2009), or to ensure that the information which was selected for preservation can be retrieved and processed effectively without being swamped by stored irrelevant detail that need not have been preserved.

4.1 Inferences from Data

When making new inferences from existing data, we always face the problem of noise, i.e. data that look like they might be useful or applicable to the problem, but are not. Some of this noise could arise from information that is available but is trivial or irrelevant, and failure to exclude such information will result in misleading or completely incorrect inferences. This is the kind of information that human memory does not ever encode, because, as discussed in Section 2, initial selection of information to preserve, even on a temporary basis, is driven by context. Use of context derived from prior inferences about the kind of information being stored can help decisions about what data can be excluded from processing or preserving. A second source of noise is the recording of redundant or repeated information as separate sets of data records. Again, from Section 2, in the case of human memory, each repetition is not recorded separately, but repetitions accumulate by strengthening the representations in memory and using this accumulation to set a context when the same information is repeated in the future. Within a digital storage system that can recognise a data set as having been previously stored, this source of noise can be avoided if all that is recorded is the number of occasions on which this pattern of data occurred, tagged with the time and date and perhaps source of the occurrence, along with any minor changes in the data set from one occurrence to the next.

A third problem can arise from inconsistencies. These could perhaps be seen as an irritation, but may be highly informative. Take for example the task of deriving common features of the class of birds. Most birds can fly, but ostriches and penguins cannot. If we assume that all birds can fly, we have a contradiction. One approach would be to ignore the inconsistency by forgetting the information that causes it, so that the criteria for being a bird no longer includes the ability to fly. Numerous techniques have been proposed for identifying and eliminating variables that lead to such inconsistencies (Eiter & Wang, 2008; Lang & Marquis, 2010). In terms of ForgetIT, we can say that internally consistent information might have higher preservation value. However, if we consider the functioning of human memory, categorization can be based on a match with the majority of criteria rather than an exact match with all criteria, thereby allowing for exceptions. A human memory schema for a bird would contain the key criteria that are true of all birds (e.g. a warm blooded animal that lay eggs, has feathers, and modification of the forelimbs to form wings) plus the extremely useful information that most, but not all members of this category can fly. A similar problem emerges when we consider instance-based learning algorithms, where new examples are classified by retrieving similar items from a database and inferring the class of the new item from the class of these similar items. One approach for items that are irregular and that lead to misclassification is to eliminate them from the database, that is forgetting (Brighton & Mellish, 2002). However, using irregular items to refine the criteria in the database could lead to much greater accuracy in categorization, so penguins and ostriches would still be categorised correctly, and the information about the majority of the category members is not lost. So too in natural language processing, where irregular spellings and word forms abound, it is important to remember these irregular forms (Daelemans, van den Bosch, and Zavrel, 1999). Having a computational taxonomy learn from instances of exceptions, through a process of taxonomic revision can further enhance effectiveness (e.g. Alberdi, 1996; Alberdi & Sleeman, 1997; Lakatos, 1976; Sokal, 1974). Therefore inconsistencies should refine the context rather than be forgotten.

4.2 User Models and Companions

IT systems that are personalised to particular users often rely on detailed user models, which consist of general information about the user, such as gender and age, but which can also cover the history of interactions between system and user. Other information about the user such as the languages they speak and at what level of proficiency, or other particular skills and experience that they have might also be useful. Displaying a human-like memory for information about the user is key to appearing intelligent and responsive (Lim, 2012; Richards & Bransky, 2013), and so may maximise utility. This complements the notion of a schema for the self, discussed in section 2.6.

When it comes to maintaining such an interaction history, not everything should be stored. For example, Vargas et al. (2011) make a case for ensuring that privacy and confidentiality are preserved. Barua et al. (2011) propose to give users a degree of control over the information that is preserved and the information that is forgotten, which is key to addressing privacy issues. For example, the system might store information about 'work-related self' such as periods when the individual had particular sets of responsibilities or was at a particular stage in career. There could also be storage of work-related relationships with colleagues to support communication and networking. The representations of these relationships could be dynamic, with their prominence or 'memory buoyancy' driven by the frequency and recency of interactions. The user would make a personal choice about whether equivalent information about personal relationships and life periods would be included.

Agents that can simulate an autobiographical memory are often designed to recall significant experiences in great detail, equivalent to episodic specific knowledge, and compress everyday routines into scripts that simulate schema within semantic memory (Ho, Dautenhahn, & Nehaniv, 2008). Robot companions should be able to remember both their own experiences and those of the people over whom they watch. These experiences should be easy to retrieve (Lim, Aylett, Ho & Dias, 2011), with constraints on the level of detail set by the context at the time of retrieval.

The implementation of such digital memories is based on computational models of the neurobiology of memory, such as Adaptive Resonance Theory (Carpenter & Grossberg, 2010). Memories are stored in a network. Accessing a particular item of knowledge or experience activates related memories through a spreading activation framework that simulates relevant interactions between groups of neurons in the brain.

In actual robot companion systems, this autobiographical component is integrated into a memory model that covers a store for incoming perceptual information through sensors, working memory, and long-term memory (Ho et al., 2009). Throughout these systems, in particular when dealing with the details of sensory input, forgetting is key to keeping memory requirements in check (Subagdja et al, 2012). Forgetting can be implemented as removal of transient traces of incoming information, time decay (Lim et al., 2009), and generalisation (Vargas et al, 2010). Forgetting could also be implemented as developing schema for common features of repeated events, removing the requirement to store the repeated details of those events.

4.3 Reminder Systems and Decision Support

The classic example for technology that supports human memory are reminder systems, designed to support prospective memory by giving people cues that help them remember to do things (see 2.3). They can also cover warnings or alerts, and can support complex decision making. For example, computerised prescription order entry systems routinely warn prescribers about potentially problematic drug/drug interactions (e.g., Russ, Zillich, McManus, Doebbeling & Saleem, 2012).

Most of the extensive work on reminder and decision support systems focuses on safety-critical work places, such as aviation or medicine, while some authors have addressed solutions for the home (e.g., McGee-Lennon, Wolters & Brewster, 2011). Both reminders and key information to support decisions need to be intelligible and acceptable. Being intelligible means that people can perceive the reminder or other information and understand the message. Acceptability means that people are willing to attend to the reminder or to use the information when they make decisions, and that the information is relevant for the user. People often dismiss or disregard reminders because they have received too many irrelevant reminders in the past or because the reminder irritates them. This is alert fatigue, and it is one of the main reasons why reminder or alert systems fail (see Thimbleby, 2013 for medical devices). Similar problems arise when professional health care staff are provided with information about patients in their care that is in too complex a format or is simply not relevant to their specific health-care role (e.g. Logie et al., 1997; van der Meulen et al., 2010).

4.4 Augmented Memory for Personal Information

Another way in which technology can support human memory is by storing personal information so it can be recalled later. Here, we briefly review the literature on a particular type of personal data that will be at the core of the WP2 work on personal preservation, namely, digital photos (see also section 2.7).

Kirk, Sellen, Rother, and Wood (2006) studied what people do with their photos after these have been taken. They term these activities “photo work” and they encompass reviewing, downloading, organising, filing, and editing. Ames, Eckels, Naaman, Spasojevic, and House (2009) investigated photowork on camera phones and found a similar rich set of activities related to managing and manipulating photos. We explored some of these activities in our Personal Preservation survey (Section 5) in order to see where people add information that could facilitate contextual remembering, and where such information is lost.

Kirk et al. (2006) suggested that as part of photo work, people tend to browse rather than search photos. Browsing is a less goal-directed activity with room for serendipity and following new associations. Interfaces for browsing use a range of different design metaphors that are inspired by ways in which users arrange and sift through information. Harada, Naaman, Song, Wang, and Paepcke (2004) suggest a timeline for personal photos, while Lucero, Boberg, and Uusitalo (2009) propose a solution where photos are organised by location, and Vaittinen, Kärkkainen, and Roimela (2011) provided users with a choice of contexts that included data from their friends.

When it comes to preserving photos for later browsing, a key problem is preserving not just the photo itself, but also its meaning. People often forget details such as where or why a photo was taken or the names of people depicted. Such information is particularly difficult to recover if the person who decided to preserve the photo can no longer remember the event or is even dead. Many automatic analysis techniques have been developed for extracting content information from photos, such as automatic detection of people and faces, or automatic grouping of photos into events (Cooper, Foote, Girgensohn & Wilcox, 2005). These approaches are discussed extensively in the WP4 deliverables.

Here, we focus on solutions that are inspired by the way people interact with photos. For example, Frohlich and Fennell (2006) suggest several ways of embedding digital photos in a rich context that will preserve information about their meaning, such as linking them to other physical memorabilia or augmenting them with audio narrations.

An important aspect of photo context is the reason why a photo was taken. In a 2004 study of early cameraphones, Kindberg, Spasojevic, Fleck, and Sellen (2004) found that people took photos for both affective and functional reasons, and that photos could be either for oneself or for sharing with others. Affective reasons included documenting a shared experience, communicating with absent friends or family, and individual reflection and reminiscence. Photos taken for functional reasons contained information to support a task that was either personal or shared with others, who might or might not be at the same location.

Annotating photos with detailed tags that can then be stored as metadata would be ideal for retrieval and contextualisation, but it is a very burdensome activity that requires well-designed user interfaces to keep users engaged and motivated (Kärkkäinen, Kaakinen, Vainio & Väänainen-Vainio-Mattila, 2008).

Another form of annotating photos are interactions, where people share reactions, comments, and information. Platforms such as Flickr or Facebook offer this facility routinely, but only for typed interactions. Vennelakanti et al. (2012) proposed a system, Pixene, that can capture conversations about photos and record when each photos had been pointed to during a conversation.

4.5 Digital Heirlooms

Researchers in the field of digital heritage and personal digital archives have investigated how people use both physical and digital objects as mementos of the past. Van den Hoven and Eggen (2008) provided an overview of relevant systems up until 2007 and developed design principles for augmented memory systems that are inspired by autobiographical memory research. They recommend that augmented digital memories should rely heavily on memory cues that allow people to reconstruct memories. The memories held may not need to be related to specific episodes, they could also refer to lifetime periods or general life events as outlined by Conway and Loveday (2010), where specific information has been forgotten (see section 2.6). Digital memory systems should also consider different reasons for retrieving autobiographical memories – be it to support one's identity, to inform decision-making, or to share experiences with others.

From the user interface design point of view, augmented digital memory systems should be capable of integrating "souvenirs" – that is, auditory, visual, or tactile materials that are particularly good at evoking memories in users. As Kaye et al. (2006) have shown, when it comes to personal archives, the physical and the digital can be impossible to separate. Indeed, as Petrelli, van den Hoven and Whittaker (2009) found, when asked to construct a time capsule of their life, people preferred a few well-chosen, but barely annotated physical objects to a richly annotated large set of digital recordings. Barthel et al. (2011) report a solution for integrating physical objects into digital networks that relies on a tagging system. Objects are labelled using two-dimensional QR codes or RFID tags that link stories to objects.

Compared to physical objects, digital mementos are seen as less valuable, they are accessed less frequently, because sharing them can be cumbersome, and they are mostly limited to photos and videos (Petrelli & Whittaker, 2010).

Banks, Kirk, and Sellen (2012) reanalysed both their own data and other published studies to determine themes around the interaction with digital mementos. Four main themes emerged: how the mementos relate to people, how the mementos connect to memory, qualities of the objects serving as memento, and the kind of record that a memento represents. The “people” theme revolves around access. Are the mementos for oneself, to be shared with others, or can they be made public? This is an important distinction (Lindley 2012). Were they constructed specifically to be preserved for future generations? What are others expected to do with these mementos?

Mementos can be a record of many different things. They can be intended to capture a place – for example, the house of a deceased relative before it was sold, a timeline – for example, sets of school photos through the years, a life log, or a collection. They can also encompass material from different modalities, such as the smell of a favourite cologne or the sound of a voice singing. Objects that serve as mementos may also have specific qualities. They may show signs of wear and tear, they may have been crafted exquisitely well, or they may have been handmade with more love than skill. The main connection to memory is through narrative. Mementos serve as cues to stories (episodic specific knowledge in autobiographical memory) that can be retrieved and recounted. Mementos are also linked to the stories of the people who used to own that item.

Cosley, Sosik, Schultz, Peesapati and Lee (2012) use social media content as memory cues. Their Pensieve system sends users random snippets of the social media content that they have generated over the years. The aim of Pensieve is to encourage users to reminisce and reflect on past experiences.

4.6 Reminiscence Therapy

Reminiscence therapy uses artifacts related to people’s past to stimulate memories. It is particularly popular for people with dementia, as memories that are important for the individual (see Section 2.6) and that will have been retrieved many times during their lifetime are usually less vulnerable to the disease. This arises because each retrieval can strengthen the memory trace, even if memory for some of the details changes with each retrieval. Reminiscence therapy can take place both in person and remotely, through teleconferencing (Kuwarahra, Abe, Yasuda & Kuwabara, 2006).

Kalnikaitè and Whittaker (2011) designed a reminiscence system called MemoryLane that is based around pictures of mementos. Users can write or record stories about these mementos and store them in a home, a photo frame (for people), or assign them to places on a map.

One of the most sophisticated reminiscence systems is CIRCA (Gowans et al., 2004). The CIRCA system is designed to evoke memories in older users and to stimulate verbal or non-verbal communication about the material that is presented. Materials include songs, video, pictures, animation, text, and Virtual Reality reproductions of environments such as a 1930’s pub. They cover life experiences and events that were common to the older generation. The interface also uses metaphors that are familiar to older users. For example, songs can be played on a virtual record player, or they can come from an old radio.

An alternative to systems that are built around specific mementos of the past are systems that are built on ongoing lifelogging. The most popular example is SenseCam, developed by Microsoft. SenseCam is a camera worn on a lanyard around the neck that automatically takes photos at set intervals. SenseCam can be paused for up to seven minutes, taken off, or turned towards the user, if there is a need for more privacy (Kelly et al., 2013).

A variety of published case studies, such as Hodges, Berry, and Wood (2011), have shown that SenseCam can help people with memory impairments recall what has happened to them. Through reviewing SenseCam images, these patients were able to recall the events associated with those images far better and more vividly.

For people without memory impairments, SenseCam does not appear to be more efficient in stimulating recall of episodes than other techniques, such as social reminiscing (Seamon et al., 2013). However, Sellen et al. (2007) found that SenseCam helped healthy users activate background knowledge about other things that happened on the same day that the SenseCam images were taken.

5 Case Study: Survey of Photograph Use

The aim of the survey is to investigate existing personal practices for managing, storing, and preserving personal photos. The survey was deliberately designed to be short as it was intended for mass distribution. The questions were field tested during two iterations, a pilot survey documented in D9.1, and a shorter pen-and-paper version of the pilot survey used in the Edinburgh Festival Study that is described in D2.1.

The survey was originally written in English and has been translated into German, Swedish, Turkish, Greek, Czech, and Italian. It will be open for the whole of 2014, with repeated recruitment drives in each language. Additional languages may also be added, with a Chinese translation now underway. In this deliverable, we report intermediate results as of January 2014.

5.1 Survey Structure

The survey has five main parts:

- Taking Digital Photos: source of digital photos in the individual's collection, content of digital photos
- Searching and Managing Digital Photos: software used for organising digital photos, photo management practices, problems with finding digital photos
- Storing and Preserving Digital Photos: importance of preservation, storage options used, archiving and preservation practices
- About Yourself: age (in age groups), gender, nationality, native language, education, occupation, attitude to technology, privacy concerns, comments
- Keeping in Touch: volunteering for further studies or project newsletters

Privacy concern questions were adapted from the scale developed by Buchanan et al. (2007). The scale used to measure attitude to technology was developed based on the Computer Aversion, Attitudes, and Familiarity Index (CAAFI) of Schulenberg and Melton (2008). We reduced the CAAFI from 30 to 8 items and adapted some items to take into account recent developments in computer and Internet technology.

5.2 Method

The survey was conducted online using LimeSurvey. The original version of the survey was written in English and translated into the other languages by native speakers from the team.

For the English version of the survey, we recruited participants from First Year Psychology lectures at the University of Edinburgh. We also distributed the survey using snowball sampling, through the "survey of the week" mechanism of the Psychology Department's home page, and through members of the team announcing the survey in conference presentations.

The Swedish version of the survey was distributed through the mailing list of the Botnia Living Lab, Sweden.

The Turkish, Czech, Italian, and Greek versions were distributed through the partners' personal networks blog posts, and Turk Telekom's cloud storage web site, http://www.buluttdepo.com.

5.3 *Preliminary Report of Results.*

We have obtained a total of 352 complete responses at the time of writing. Ongoing tracking shows that about 60% of the people who view the entry page of the survey go on to complete it; of those who decide to enter the survey, around 80% complete it.

The distribution of responses is given in Table 5.1. Most of the respondents so far have been from the UK (first year Psychology students) and Sweden (Botnia Living Lab). While the Czech, Greek, Swedish, Italian, and Turkish surveys were homogeneous with respect to native language and nationality, 41 of the 123 respondents (33.3%) of the English survey did not come from an English-speaking country, and 34 (27.6%) stated a native language other than or in addition to English.
55.5% of respondents were male, 44% female, and 0.5% did not state a gender. Most of the female respondents came from the English data set.

Table 5.1: Number of Respondents and Gender Distribution

	Survey version	N	%
Respondents	Czech	38	10.8%
	English	123	34.9%
	Greek	38	10.8%
	Italian	16	4.5%
	Swedish	106	30.1%
	Turkish	31	8.8%
Gender (% male)	Czech	29	76.3%
	English	24	19.5%
	Greek	27	71.1%
	Italian	13	81.3%
	Swedish	83	78.3%
	Turkish	19	61.3%

There is also a clear skew towards younger people, again mostly due to the respondents to the English survey, as shown in Table 5.2.

Table 5.2 Distribution of Age Groups Across Survey Samples

Age Group	18-24	25-34	35-44	45-54	55-64	65+	Total
Czech	12 (32%)	14 (37%)	9 (24%)	1 (3%)	1 (3%)	1 (3%)	38
English	99 (80%)	10 (8%)	5 (4%)	4 (3%)	4 (3%)	1 (1%)	123
Greek	1 (3%)	23 (61%)	13 (34%)	0	0	1 (3%)	38
Italian	2 (12%)	5 (31%)	6 (38%)	1 (6%)	2 (12%)	0	16
Swedish	3 (3%)	20 (19%)	26 (25%)	29 (27%)	20 (19%)	8 (8%)	106
Turkish	6 (19%)	15 (48%)	6 (19%)	1 (3%)	2 (6%)	1 (3%)	31
Total	123 (35%)	87 (25%)	65 (18%)	36 (10%)	29 (8%)	12 (3%)	352

Note: no “prefer not to say”, only 2 over 75

Most of the sample were employed full-time (51.4%) or students (33.5%). 3.4% were employed part-time, and 4.0% were self-employed. 1.1% were homemakers, 3.4% were retired, and 0.9% were unemployed. 0.6% did not wish to give information about their occupation. Four respondents noted that they worked part-time while studying. These were classified as students. Table 5.3 breaks these data down by survey source.

Table 5.3 Occupation Status Across Survey Samples

Occupation	Employed	Student	Other	Total
Czech	22 (58%)	13 (34%)	2 (5%)	38
English	19 (15%)	101 (82%)	3 (2%)	123
Greek	36 (95%)	1 (3%)	1 (3%)	38
Italian	15 (94%)	1 (6%)	0	16
Swedish	86 (81%)	4 (4%)	16 (15%)	106
Turkish	29 (94%)	0	2 (2%)	31
Total	207 (59%)	118 (34%)	21 (6%)	352

Overall, participants were highly educated. Only two respondents in the Swedish and two in the English survey reported an education of up to 8 years, four did not state their education level.

Table 5.4 Education Levels Across Survey Samples

Education	Up to 13 years	13-18 years	19+ years	No info given	Total
Czech	2 (5%)	28 (74%)	8 (21%)	0	38
English	22 (18%)	92 (75%)	8 (7%)	1 (1%)	123
Greek	0	10 (26%)	28 (74%)	0	38
Italian	1 (6%)	7 (44%)	7 (44%)	1 (6%)	16
Swedish	24 (23%)	52 (49%)	29 (27%)	1 (1%)	106
Turkish	1 (3%)	17 (55%)	12 (39%)	1 (3%)	31
Total	50 (14%)	206 (59%)	92 (26%)	4 (1%)	352

Given these differences in the composition of the six samples, we will not break the data down by origin, age, gender, or occupation in the following report, since we cannot be sure how much variation is due to the source of the sample, and how much to actual age, gender, or occupation differences. A more detailed analysis will be provided in Deliverable 2.3 after the survey has closed.

The eight item scale measuring attitude to technology consisted of seven positively worded and one negatively worded items. The answer scale ranged from -3 (does not apply to me at all) to 3 (fully applies to me). Scores were adjusted for polarity, summed and divided by the number of items to yield a single score for attitude to technology. The mean score was 1.5 (SD: 0.7), which means that our sample was overall technophile. The Czech (mean: 1.4, SD: 1), Swedish (mean: 1.7, SD: 0.7), Italian (mean: 1.9, SD: 0.3) and Turkish samples (mean: 1.6, SD: 0.6) conformed well to the overall picture. The Greek sample (mean: 2.0, SD: 0.3) was significantly more technophile than all groups but the Turkish one, while the English group (M: 1.3, SD: 0.7) was slightly more technophobe than the Greek, Italian, and Swedish samples. As this is a preliminary report, and the sample sizes are relatively small, we present only a summary of the responses and no formal statistical comparisons have been carried out at this stage. A more detailed report will be included in D2.3.

Overall, two thirds of respondents are concerned about their privacy when they use the Internet. The main concerns are providing too much personal information and identity theft. Half of our participants were concerned about their digital photos or digital photos of them being shared without their consent.

Although most people take their own digital photos, many also receive photos from others through email or as photo collections. A third also download digital photos they have found online. 11 respondents mentioned other sources of digital photos such as photos that were shared with them using cloud services or social media, and scanned printed photos.

We asked people how often they took digital photos with various devices, including smartphones, simple camera phones, tablets, and digital cameras. 81.2% did not own a simple camera phone or if they did own one, they never took photos with it. For tablets, the corresponding figure was 56.5%. 10.2% never used a digital camera, and 8.8% never used a smart phone to take digital photos. Camera phones and tablets tended to be used rarely to take digital photos. Digital cameras were used monthly or less, while smartphones were used daily or weekly.

People were the most popular content type. Almost everyone took photos of their family and friends; far fewer photographed other people they knew. Two out of three respondents often took pictures of nature, such as landscapes or plants, and two out of five chose to photograph specific cityscapes, interiors, or buildings. When it comes to specific events and situations, respondents preferred to take photos of milestones. Food is just as important as work information when it comes to being deemed worthy of a quick picture. One in four also take photos of other information, such as signposts. Several people reported that they took pictures of animals and pets, others took photos that were linked to hobbies (genealogy, transport, paintings) or specific goals (documenting burglary and vandalism, taking pictures of things to be sold online, communicating with students).

Most respondents manage their photos using the file manager of their operating system or a photo management application on their smartphone. The next most popular option are web services such as Flickr or Facebook, which are used by around a third. One in five people use advanced photo editing software such as Aperture and Photoshop, followed by iPhoto, Picasa, and photo management software provided by the manufacturer of their digital camera.

Next, we asked people about the ways in which they sorted or annotated their photos. Most respondents use file names and folder structure to find their photos. Taken together, one in three adds some kind of descriptor to the content of photos either manually or automatically.

When searching for photos, people were mostly frustrated by problems with their filing system. Photos are not filed at all, not filed correctly, or not filed in a place that users can remember. Lack of information about the content, time, and location of a photo was only a problem for around a third of all respondents. This could be because, most people use their file manager or a photo app to manage their photos, and three quarters use file and folder.

Two thirds of respondents (69.9%) were worried or very worried about losing photos that were important to them, and 85.2% found it important or very important to pass some of their digital photos on to their offspring.

Next, respondents were asked where they kept photos that were taken in the last five years, and photos that were particularly important to them. People who tended to store photos older than five years on a specific medium also stored important photos on that medium. The most popular options are computers that are currently in use and SD cards. SD cards are default storage media in many digital cameras and most smartphones that run the Android operating system. Three in five respondents store important photos on a separate hard disk drive. Other options mentioned include CDs and DVDs.

The most popular archiving strategies are to keep copies of photos in multiple places, to print them off on paper, to store them safely, and to file them carefully. The safe storage strategy reflects the privacy concerns mentioned above. The emphasis on careful filing reflects problems with retrieving badly filed or unfiled photos. 33.8% of respondents make neither regular automatic nor regular manual backups of their photos, 12.2% use both strategies, and 54% use one or the other.

5.4 Discussion

Annotating photos with appropriate content is complex. Many people take pictures of other people, which can be captured using image detection, but when it comes to photos of nature or architecture, object detection may not be enough to capture key content. Accurate location data, ideally captured at the time the photo was taken, becomes important here. Similarly, in order to associate photos with particular situations, the ForgetIT system needs to associate information about the time and place a photo was taken with information about the time and place of relevant events in a person's life. This is exactly the kind of data enrichment that the PIMO (see D9.1 and D9.2) is designed to support, and the data that will be useful for making links with autobiographical memory.

We also need functionality for merging photo collections that come from different sources, which may lack some of the data (time, geolocation) that is routinely captured by digital cameras.

Most people file their photos manually using their file manager or the standard app that comes with their smartphone, but these filing systems often break down, partly because people cannot remember their structure, leading to long and frustrating searches.

Preservation was very important to our sample, even though the sample was skewed heavily towards younger people. People use a variety of preservation strategies; further analysis will be required to see whether there are typical clusters of preservation strategies, and how these might relate to strategies for managing and storing data.

As it stands, the survey still has some limitations. Currently, we have no balanced matching samples for all six main languages. This is mainly due to the different sampling strategies employed at each site. We expect that by January 2015, we will have enough respondents for each major language to allow us to undertake formal analyses of subsamples matched for age, gender, education, and occupation. The survey was also intentionally designed to be brief so as to maximize response rates.

6 Conclusion

The preliminary review of research on human memory has shown that most of human preservation in memory is determined by context which is derived from a lifetime accumulation of knowledge and experiences, including knowledge of the self. Most details of events experienced are forgotten very rapidly after the event. Retrieval from memory is reconstructive, based on the context at initial encoding in memory, but also as a result of subsequent experiences and the context at retrieval. This process is successful most of the time in supporting daily activities, but can lead to errors resulting from reconstruction rather than from veridical recall. Organizational memory errors can arise both from errors in the retrieval from memory of individuals within that organization, but also if individuals who are the only repositories of organizational memory leave the organization.

Digital storage systems that store every detail without knowledge-based contextualisation, and fail to forget, inevitably will accumulate erroneous information and large amounts of trivial or irrelevant information. This makes the information they preserve less and less useful in that it makes the process of retrieving information required for a specific purpose increasingly difficult. Digital systems that can use knowledge-based contextualisation when selecting which information to preserve may avoid the storage of irrelevant details, but may store details that are, or are likely to be relevant and that a human is likely to forget. The process of contextualisation should be dynamic in recognising data patterns that have been encountered previously, and in building representations of common features of repeated data sets. This allows the contextualisation process to be inspired by the understanding of human memory, and to complement human memory and offer support for identified weaknesses. Knowledge-based contextualisation also provides a basis for managed forgetting by using context, and recency and frequency of use to determine the ease with which information should be made available at any one time (memory buoyancy), what information should be held in a contextualised archive, and what information should be corrected, deleted, or never recorded in the first place.

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