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**The process of individual unlearning: a neglected topic in an under-researched field**

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# **The process of individual unlearning: a neglected topic in an under-researched field**

## **Abstract**

In a contemporary business environment where change is often regarded as continuous, the ability of people or organizations to be able to successfully adapt and respond to change is key. Change often involves not only the learning of new behaviours, ideas or practices, but also giving up, or abandoning some established ones. Despite both these elements generally being important to change, academic focus on processes of abandoning or giving up established knowledge and practices i.e. unlearning, is lacking. This conceptual paper draws on a range of literature to suggest that the process of individual unlearning may have particular features. The review defines the concept of unlearning, differentiates between two different types of individual unlearning, and suggests that each type of individual unlearning may have its own distinctive features and dynamics. The paper builds from this insight through developing a typology, which distinguishes between four types of individual unlearning. The paper concludes with an agenda for future empirical research to examine and validate the concepts presented.

## **Keywords**

Unlearning, unlearning processes, unlearning typology, learning, emotion

## **The process of individual unlearning: A neglected topic in an under-researched field**

### **Introduction**

Increasing pressure from globalisation, technological developments, changes in legislation and government policy, and increased competition has meant that change can be regarded as a continuous feature of the contemporary business environment (Burnes 2004). The ability of people or organizations to adapt and respond to change engendered by these stimuli is vital to succeed in such an environment. Whether at the level of the individual, or the organization change typically involves not only the learning of new behaviours, ideas or practices, but also giving up, or abandoning some established ones. Despite both these elements being equally important to change, there has been a significantly greater academic focus on processes of learning and acquiring new knowledge and practices than there has been on processes of abandoning or giving up established knowledge and practices (Tsang and Zahra 2008). The objective of this paper is to make a contribution to addressing this neglect through undertaking a detailed examination of individual-level processes of abandoning or giving up knowledge, which is more formally defined as unlearning.

The capability to unlearn is important as the inability to give up or abandon knowledge, values, beliefs, and/or practices can produce a rigidity in thinking and acting limiting a person or organization's adaptability (Akgün et al., 2006; Bettis and Prahalad 1995; Prahalad and Bettis 1986). The inability to question what may have been successful organizational norms, values, practices and knowledge results from what Prahalad and Bettis (1986) refer to as the institutionalization of a dominant logic. This institutionalization can produce cognitive blinkering that results in 'competency traps' (Shipton 2006), a situation where useful competencies become out dated through never being challenged, revised or

abandoned. Thus, the ability of people or organizations to unlearn established knowledge, behaviours or values can be a significant catalyst to and facilitator of change.

The analysis developed here builds from and extends the work of Tsang and Zahra (2008), who developed a conceptual analysis of organizational level unlearning processes. Tsang and Zahra (2008, p. 1454) concluded their paper with a number of suggestions regarding which knowledge on unlearning is still limited, and requires development. One key area where knowledge is particularly limited is the dynamics and character of individual-level processes of unlearning, and how they connect to and interact with organizational learning and unlearning. Individual level processes of unlearning represent a neglected topic in an under-researched field, where analysis has been relatively limited. Our concern here is to take a first step towards addressing this gap in knowledge.

This is a conceptual paper that draws on a range of literature to suggest that the process of individual unlearning may have particular features. The analysis of individual unlearning presented here is based on an overview of some of the most important contributions on this topic as well as a systematic review of the contemporary academic literature on unlearning. To help address themes that are relatively unexamined by this literature it also draws on a wider body of work on learning and change. After the paper unpacks and defines the concept of unlearning it considers some seminal and sceptical perspectives on unlearning before presenting the details of the literature search that was conducted. Following this is a large section that differentiates between two different types of individual unlearning, and which suggests that each type of individual unlearning may have its own distinctive features and dynamics. The final section of the paper builds from this insight through developing a typology, which distinguishes between four types of individual unlearning.

## **Clarifying and Developing the Unlearning Concept**

Thus far unlearning has been very broadly defined as abandoning or giving up knowledge, ideas or behaviours. However to fully understand the concept it is necessary to define it in greater detail.

If unlearning involves the giving up or abandonment of knowledge, values or behaviours, it needs to be acknowledged that this can happen both unconsciously and deliberately. The unconscious or accidental giving up of something is typically referred to as forgetting (De Holan and Phillips 2011; Easterby-Smith and Lyles 2011; Rushmer and Davies 2004). This process of forgetting contrasts with deliberate unlearning, which involves a process of consciously choosing to abandon or give up particular knowledge, values or behaviours. As with Tsang and Zahra (2008), the assumption here is that unlearning is a conscious and intentional process and as such is distinct from forgetting. De Holan and Phillips (2004; 2011), agree about the deliberate nature of unlearning, although they do not distinguish in the same way as others between forgetting and unlearning. Recently there have been a significant number of articles and book chapters on the topic of organizational level forgetting (see for example Casey and Olivera 2011; De Holan and Phillips 2011; Easterby-Smith and Lyles 2011; De Holan 2011b). Due to the assumption that the accidental and unconscious nature of forgetting makes it a different and distinctive process to deliberate processes of unlearning, as well as the fact that the contemporary literature on forgetting is focussed at the organizational level, this literature is not examined any further in this paper.

A second area of difference in the unlearning literature relates to whether the knowledge or behaviours being given up are obsolete, out dated, and in some way inferior to new knowledge or behaviours which are subsequently acquired. As highlighted in Table 1 (see later), a number of papers make this assumption (Casillas et al., 2010; Srithika and Bhattacharyya 2009; Rebernic and Sirec 2007). Thus, for example, Srithika and

Bhattacharyya (2009, p. 68) define organizational unlearning as, '*the identification or removal of ineffective or obsolete knowledge*'. However, making such a value judgement regarding the inferiority of the knowledge to be abandoned is unnecessarily restrictive and judgemental. Thus, similar to Tsang and Zahra (2008), we suggest that it is more appropriate to define unlearning simply as abandoning or giving up knowledge or behaviours without making any judgement on the status of the knowledge or behaviours being unlearned.

In considering individual unlearning, an issue that is typically neglected is what happens to the knowledge or behaviours that people unlearn. It is important to acknowledge that what is unlearned is not permanently 'lost' by people or destroyed, such that they are unable to think or act in the way that they had done previously. Arguably, the only ways via which the unlearning of particular knowledge and behaviours could become permanently lost is through a lack of use over time or through some type of medical, neurological intervention (drugs, surgery etc.), or through someone developing an illness or having an accident (such as having a stroke or a car accident which results in brain injury). Thus, the type of deliberate, individual unlearning considered here does not involve the permanent loss of something, but instead involves a person consciously discarding, abandoning or giving up particular values, knowledge or behaviour, by consciously choosing not to continue using them. In summary, the perspective on individual unlearning adopted here is that knowledge and values are not necessarily permanent, as either consciously, or unconsciously, people may at some point in the future begin to reuse that which they had previously abandoned or unlearned. An example of this would be when someone changed how he or she undertook a task by returning to do it in a way that had been previously abandoned.

The final issue in developing the concept of unlearning is how it relates to learning. Tsang and Zahra (2008) consider that unlearning may precede learning, occur simultaneously with, or independent of learning. However, the dominant perspective in the unlearning

literature regarding the relationship between the sequencing of unlearning and learning (which follows the way Hedberg (1981) defines the relationship) is that unlearning is a unique stage and is a prerequisite to, and a precursor of, learning (Akgün et al., 2007b; Becker et al. 2006; Cegarra-Navarro et al., 2010a; Fotaki 2007; MacDonald 2002). For example, Cegarra-Navarro et al. (2010a, p. 901) define unlearning as, *‘the elimination of obsolete knowledge’*, which is regarded as a necessary precursor to learning, or *‘the creation and absorption of new knowledge’*. However, an alternative way to conceptualize the relationship between unlearning and learning is to consider unlearning as a distinctive type of learning (Antonacopoulou 2009). This is the perspective utilized by Argyris and Schön (1996, p. 3-4), who argued that, *‘we may also speak of the particular kind of learning that consists of “unlearning”: acquiring information that leads to subtracting something (an obsolete strategy, for example) from an organization’s existing store of knowledge’*.

In summary, in examining unlearning this section suggests that in contrast to the dominant perspective in the unlearning literature, that unlearning should be conceptualized as a distinctive type of learning. It involves a conscious process of choosing to give up, abandon or stop using knowledge, values or behaviours. No value judgement should be made regarding the value or status of what is abandoned, and that what is unlearned is not permanently lost to people and may be utilized again at some point in the future<sup>i</sup>.

## **Seminal and Sceptical Perspectives on Unlearning**

While unlearning can be traced back to the 1950s, until recently it has been largely neglected in the literature on learning and knowledge management. Akgün et al. (2007b) trace the origins of unlearning to literature on learning and cognitive psychology published in the 1950s and 1960s. Another perspective on unlearning emerged in the 1950s which explored “unlearning...the inherent dominative mode” (Williams 1958, p. 376: in Said 2003)



in relation to western thinking about the 'other'. The 'other' referred to how people in the west view people or perspectives they regard as non-western. Unlearning in this context concerned westerners trying to think beyond their own perspective to take account of others (Williams 1958). Indeed, some educational literature applied Williams' meaning to understand how trainee teachers could unlearn their attitudes to ethnic minority and working class young people (Connor 2010). Similarly, Mavin et al., (2004) utilizes unlearning in the same sense and suggests that an unlearning process is necessary to challenge the unquestioned and unchallenged gender blind and male-biased character of the academic business and management literature.

In this literature a number of influential writers including Hedberg, Starbuck and Nystrom, have published some important pieces of writing on the topic of unlearning (Hedberg 1981; Nystrom and Starbuck 1984; Starbuck et al. 1978). This section reviews these key works on the topic, and concludes by examining literature which is more critical and/or sceptical on the topic of unlearning.

The focus here is on Hedberg's (1981) book chapter, and Nystrom and Starbuck's (1984) journal article, as they have both been highly influential. While, as will be outlined, there are differences of focus and emphasis between these two pieces of work, there are more similarities than differences between them, thus they are examined simultaneously. One similarity is how they define unlearning, with Hedberg (1981, p. 18) defining unlearning as, '*a process through which learners discard knowledge*', while Nystrom and Starbuck (1984, p. 53) define it as '*discovering the inadequacy of and "discarding" existing ideas*'. Thus, both define unlearning as involving a process of 'discarding' knowledge or ideas which is compatible with the way individual unlearning was defined in the previous section.

Both studies see close links existing between individual and organizational level unlearning, and fundamentally regard organizational unlearning as being rooted in and

emanating from individual unlearning. Hedberg expresses this by saying that, '*organizations learn and unlearn via their members*', (p. 18). Nystrom and Starbuck have a similar view, but focus centrally on the learning and unlearning of senior/corporate management as they argue that they play a fundamentally important role in shaping the dominant logics that influence how organizations behave.

Finally, a number of other similarities in these outputs can be identified. Firstly, they are both largely conceptual and don't effectively substantiate the ideas developed with empirical evidence (Nystrom and Starbuck present some illustrative stories). Secondly, both regard unlearning and learning as being closely inter-related. Finally, both regard individual level unlearning to be a typically difficult, challenging and time consuming process to successfully undertake. This challenge is due to the extent to which people are attached to their existing knowledge and ideas, and their existing knowledge and ideas shape and blinker how they make sense of events, which can make it difficult to understand the limitations of existing knowledge and ideas. Therefore, the way unlearning is conceptualized in our paper is compatible with both these pieces of work.

It is also useful to examine some critiques that have been made of the concept of unlearning. One critique, articulated by Niaura (2002) connects with issues touched on earlier that abandoned knowledge is not completely lost or destroyed, and thus can't have been said to have been effectively unlearned. Niaura (2002) defines unlearning in strong or extreme terms, relating it to the extinction of conditioned responses. In doing so Niaura is sceptical about whether full unlearning can ever happen, as he argues that conditioned responses can never be completely destroyed. In supporting his case, Niaura uses the example of reformed drug addicts, arguing that while coping strategies can be developed to help avoid relapses into drug taking, drug taking behaviours can never be completely unlearned. We are sympathetic to his view. Our conceptualisation of individual unlearning does not involve the

permanent loss of knowledge, such as drug taking behaviours, but instead that the drug user discards or abandons their previous drug taking behaviours by consciously choosing not to continue them.

A more detailed and extensive critique of unlearning is Klein's (1989) paper on parenthetic learning. In essence, Klein's critique of the conceptualization of unlearning is that it is equated with single-loop learning, where one response to a situation is abandoned or discarded to be replaced by another. For Klein such an adaptation does not represent an improvement, as one response has simply been replaced by another without higher level learning having necessarily occurred. In contrast, Klein equates genuine change and improvement with double-loop learning, where change occurs in the logic and rules shaping how responses are selected. Such a process of learning is argued to be additive, where new, higher level knowledge is acquired, and that such learning cannot thus be characterized as unlearning, which involves the discarding or abandonment of knowledge. However, in our view, Klein's critique is more focussed on one particular way of defining unlearning, and one particular way of linking unlearning to change, rather than with the concept of unlearning more generally.

### **Reviewing the Academic Literature on Unlearning**

While Tsang and Zahra (2008) conducted a review of the unlearning literature, their central focus was organizational level unlearning, rather than individual unlearning. Their review identified 34 separate pieces of work. This included book chapters and journal articles published over a wide timeframe. Their search was not restricted to a particular time period

or database, and instead was intended to deliberately examine as many different definitions of organizational unlearning as possible.<sup>1</sup>

Due to the multidisciplinary nature of the interest in the topics of learning and unlearning, we searched several management (Business Source Complete, Emerald) psychological (PsycInfo) health (Medline) and education (ERIC) electronic databases for English language articles that were published between January 2000 and August 2012. We searched for articles, which had ‘unlearning’ in their title, abstracts, or keywords. Additionally, we searched for articles on ‘abandoning behavior or knowledge’ and ‘giving up behavior or knowledge’. This search generated over 330 articles. From these sources, we concentrated on those published in peer-reviewed scientific journals, leaving 261. After removing duplicate search results, we examined the abstracts of these articles and excluded studies that reported on animal-based, psychological or memory experiments. We also excluded personal viewpoint and unreferenced opinion articles, leaving about 100. After a first round of reading the collected articles, we selected those papers that investigated the topic of unlearning, either theoretically or empirically. This led to the exclusion of papers which used the term unlearning in their abstract or titles, but which were not fundamentally concerned with investigating it as a topic. While the focus in this paper is fundamentally on individual level unlearning, our initial review included all articles on unlearning, whether they were focussed on individual, team or organizational level unlearning (see Tables 1 and 2). We also searched the reference lists of all sources thus collected, and performed citation searches that helped to add several relevant articles.

**Insert Table 1 about here**

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<sup>1</sup> Personal communication with authors, August 2012.

A total of 35 articles were identified for analysis (see Table 1). An initial observation from the list is that the small number of relevant articles were identified in a time period of over 10 years highlights the extent to which the concept of unlearning is neglected and underdeveloped. This neglect is in stark contrast to the considerable level of interest in the topic of learning since the mid-1990s (Easterby Smith 1997; Scarbrough and Swan 2001; Shipton 2006).

In terms of how the literature defines unlearning (see Table 1 Column 2), while many authors develop their own particular form of words, what is noticeable about the way unlearning is defined (also found to be the case by Tsang and Zahra 2008) is the striking degree of homogeneity that exists. What is common to these definitions is that unlearning involves ‘abandoning’, ‘eliminating’, ‘rejecting’, ‘discarding’ or ‘giving’ up something – with that something ranging from, at the individual level, particular values, assumptions, knowledge or behaviour, and at the organizational level, knowledge, assumptions or routines.

In terms of the type of unlearning examined, as Table 2 highlights, there has been a greater focus on organizational or group/team unlearning (22 articles) than on individual level unlearning (16 articles). In this context, group or organizational unlearning, as with organizational learning, refers to norms, assumptions, behaviours and routines that are collectively shared and understood (Akgün et al., 2007b; Casillas et al., 2010). While a few papers look at multiple levels of unlearning (e.g. Cegarra-Navarro and Moya 2005), or the inter-relationship between different levels of unlearning (e.g. Cegarra-Navarro and Sanchez-Polo 2007), the vast majority of papers focus on one level of unlearning alone.

**Insert Table 2 about here**

Another difference in the focus of the reviewed papers was whether they examined the antecedents, process or consequences of unlearning. The largest proportion of papers, 18 examined the antecedents of unlearning, with unlearning facilitated by the organizational

context (e.g. Becker 2010; Cegarra-Navarro and Dewhurst 2006; Cegarra-Navarro et al., 2010a), environmental turbulence (e.g. Akgün et al., 2007a) and organizational size (e.g. Becker et al., 2006). Secondly, 14 of the reviewed papers examined the consequences of unlearning, with unlearning argued to be related to a diverse range of processes and outcomes including knowledge transfer processes (e.g. Yildiz and Fey 2010; Tsang 2008), processes of internationalization (e.g. Casillas et al., 2010; Zahra et al. 2011), the non-academic impact of academic scholarship (e.g. Antonacopoulou 2009), organizational performance (e.g. Cegarra-Navarro and Moya 2005; Sinkula 2002) and healthcare policies (e.g. Fotaki 2007). Finally, only 6 of the 34 papers examined the character and dynamics of unlearning processes.

Combining the above two categories reveals that of the 35 articles reviewed only two focused on individual processes of unlearning. These are the papers by Rushmer and Davies (2004), and MacDonald (2002). Further, of these two only MacDonald (2002) presents any empirical evidence, which was a reflection on personal experience. Thus, to say there is a conceptual and empirical gap in knowledge with regard to the process of individual unlearning is an understatement.

The following utilizes the work of MacDonald (2002) and Rushmer and Davies (2004), as well as some other literature on learning and change to consider the character and dynamics of the process of individual unlearning. In so doing it is suggested that distinctions can be made between different types of individual unlearning.

### **Types of Individual Unlearning**

As has been outlined thus far distinctions can be made between individual and organizational level unlearning, and between the unlearning of values/assumptions, beliefs, skills, knowledge and/or behaviours. A number of authors go beyond these distinctions to develop typologies of unlearning (Akgün et al., 2007a; Rushmer and Davies 2004; Sinkula

2002). For example, Akgün et al., (2007a) develop a typology which links differences in the nature of the business environment to the character of organizational unlearning. Sinkula (2002) on the other hand distinguishes between the unlearning of axiomatic and procedural knowledge. Here axiomatic knowledge is defined as fundamental unquestioned beliefs and values, and procedural knowledge is considered to be equivalent to Argyris and Schön's concept of 'theory in use', referring to the tacit knowledge which shapes the way people act.

However, the categorisation proposed by Rushmer and Davies (2004) is the most relevant to individual unlearning as it provides a useful distinction between three separate and distinctive types of individual unlearning: fading, wiping and deep unlearning (See Table 3). Each type of unlearning is argued to differ in respect of catalyst, intentionality, speed and impact. Firstly, fading or routine unlearning occurs gradually over time through lack of use. It is regarded as neither significant nor challenging for people. Indeed fading may not enter individuals' consciousness unless they are invited to identify lost skills or capabilities. However, as unlearning requires conscious and intentional action it is questionable whether fading can be conceptualized as unlearning. We argue that a lack of conscious action means that fading is more akin to a process of unintentional individual level forgetting, rather than unlearning. Consequently, fading is not considered in the remainder of this paper.

### **Insert Table 3 about here**

Wiping, the second category of individual unlearning identified by Rushmer and Davies (2004) does fit with the definition of unlearning outlined earlier. The catalyst for wiping is a change initiative external to the person. Wiping is can be defined as a process of unlearning that results from a deliberate process of change that has been externally imposed, for example, a change initiative or a change in job role. Wiping is deliberate, conscious and more significant than fading, and is typically focused on a relatively narrow practice or

activity where a change initiative requires a person to consciously make deliberate attempts to give up a particular way of thinking and acting.

Parallels between wiping and categories of unlearning developed by other authors can be discerned. For example, wiping is similar to ceasing a particular behaviour and making incremental change (Baumard and Starbuck 2005). The notion of wiping is reinforced and extended by other categories such as ‘operational level unlearning’, whereby performance routines (enacted by individuals) and ostentive routines (codified systems) are discarded as a result of evolutionary, continuous, incremental change (Tsang and Zahra 2008). Wiping is also similar to ‘adjustive unlearning’, where incremental changes in beliefs are accompanied by fundamental changes in routine, and to ‘operative unlearning’, which involves small scale changes in beliefs and routines (Akgün et al., 2007a).

The third category of individual unlearning proposed by Rushmer and Davies is deep unlearning. This radical form of unlearning is argued to occur rapidly as a result of an individual experience whose characteristics and/or outcomes are unexpected, and which bring into question some basic assumptions. For example an unexpected individual experience for a scientist, doctor or engineer could be a very surprising result occurring from a test or experiment where their existing assumptions and knowledge had led them to expect one particular type of outcome. Characteristically, such experiences can have a significant impact on the individuals who experience it, leading them to question their values and beliefs, and possibly their frame of reference. As a consequence, deep unlearning may be accompanied by challenging emotions such as anxiety, fear and confusion. Thus, in contrast to wiping, deep unlearning is more likely to involve the unlearning of values and assumptions, than simply the unlearning of particular behaviours or practices.

Like wiping, the notion of deep unlearning is echoed elsewhere. Baumard and Starbuck (2005) talk about challenging core beliefs, Tsang and Zahra (2008) characterise



deep unlearning as discarding values and norms as a result of episodic, discontinuous change. Deep unlearning is also similar to reinventive unlearning and formative unlearning identified by Akgün et al., (2007). Reinventive unlearning occurs when an organisation changes both beliefs and routines in response to a changing and highly unpredictable environment, while formative unlearning occurs when new beliefs structures are combined with incremental routine change. Finally, there are similarities between deep unlearning and what MacDonald (2002) defines as transformative unlearning (see later section on deep unlearning).

Finally, linking back to the idea that unlearning represents a distinctive type of learning, it can be suggested that while wiping has parallels with single-loop learning (incremental learning or change where basic assumptions remain unchallenged), deep unlearning can be equated more with double-loop learning (learning or change where existing assumptions and values are questioned and reflected upon).

## **The Nature of Individual Unlearning Processes**

The previous section only provides a brief overview of the general character of wiping and deep unlearning processes. Thus to develop a fuller understanding of the dynamics and character of the processes of wiping and deep unlearning it is necessary to consider both in more detail. The definitions suggest there are significant differences in the way people experience and understand wiping and deep unlearning, and in the process dynamics of wiping and deep unlearning. Therefore, it is useful to consider each separately which is done in the following two sub-sections.

### *Wiping*

In terms of the relationship between unlearning and change, the dominant perspective in the unlearning literature is that unlearning is a facilitator of change (Becker 2008, 2010;

Cegarra-Navarro and Sanchez-Polo 2007; Fotaki 2007; Mavin et al., 2004; Tsang 2008; Tsang and Zahra 2008). While this may be true in relation to wiping (see Table 3) it also needs to be acknowledged that the relationship works in the opposite direction, with external change acting as the prime catalyst for wiping. Thus, in the context of wiping, the primary reason why people engage in unlearning is because it is perceived as being a necessary element of a specific organizational change initiative. This is articulated explicitly in a textbook on change (Hayes 2002, p. 7), which, in talking about the importance of change for contemporary organizations says, '*people are being required to unlearn old ways and develop new competencies*'.

Although much of the unlearning literature suggests that the relationship between unlearning and change is close, it has only considered unlearning as being a facilitator of change, and hasn't examined the relationship between unlearning and change in any detail. Consequently, the literature provides limited insight into how change can be a facilitator of wiping, or how individuals experience the character and dynamics of the process of wiping. Two useful papers on the link between unlearning and change are Akgün et al (2007b) and Tsang & Zahra (2008). While these papers are focussed on organizational rather than individual unlearning, they still provide potentially useful insights into the relationship between organizational level change, and individual unlearning.

The most useful paper for considering the bi-directional relationship between unlearning/wiping and change is Akgün et al.'s (2007b) conceptual paper. In talking about the relationship between unlearning and change, it refers explicitly to Lewin's 3-stage model of change. This very simplified and much criticized model of change suggests that change happens via the sequential processes of unfreezing, change, and refreezing (Akgün et al., 2007b, p. 800-1; Hayes 2002, p. 52). Akgün et al., assume that unlearning and learning together constitute the second stage in Lewin's model. This conceptualization of the

wiping/change relationship, with unlearning being at the centre of change, highlights the bi-directional nature of the change/wiping relationship. However, the focus of Akgün et al.'s (2007b) paper is on organizational level unlearning/wiping, and thus it does not provide insights into the character and dynamics of individual level unlearning/wiping.

Tsang and Zahra (2008) also examine the relationship between learning, unlearning and organizational change. They distinguish between different types of change (continuous and episodic) and suggest that each type of change will involve a distinctive form of unlearning. They define continuous change as change that is incremental, and gradual in character. By contrast, episodic change is typically discontinuous, infrequent, is greater in scope than continuous change. Episodic change can also be linked to a process of double loop learning where basic assumptions are challenged. Thus, in relation to the types of unlearning considered here, continuous change can be linked more to wiping, whereas episodic change can be linked more to deep unlearning.

As wiping is so closely inter-related with processes of organizational change it is useful to refer to some change-related concepts. In this context, if organizational change provides the catalyst to wiping/unlearning, people's attitude to unlearning is likely to be closely linked to and virtually inseparable from their attitude to the change process that precipitated it. Thus, if people don't regard the changes being undertaken as favourable they are unlikely to have a positive attitude to any unlearning that flows from the change. Equally, if the opposite is the case and people do regard change as necessary and important, they are likely to have a more positive attitude to any unlearning it precipitates. While Tsang (2008) doesn't explicitly use the concept of resistance to change, the reluctance to unlearn and learn that he found in relation to the knowledge transfer processes that were examined can be argued to constitute resistance to change.

The concept of resistance to change is useful when considering people's attitudes to change and unlearning. The change literature suggests that due to the uncertainty caused by change, resistance is common. A key theme in the change literature is concerned with anticipating, managing and minimizing any potential resistance to change (Hayes 2002). While some of the unlearning literature touches on the topic of resistance to change (Rampersad 2004; Tsang and Zahra 2008), people's attitude to unlearning is neglected. This neglect may be because of the assumption that people will embrace wiping-type unlearning relatively willingly. However, this assumption represents an important omission because people's attitude to unlearning is likely to be shaped by their attitude to change. Thus to understand the character and dynamics of individual level wiping-type unlearning processes it is fundamentally necessary to take account of people's attitude to the change which precipitated it.

### *Deep unlearning*

In examining how individuals experience deep unlearning and the process through which it unfolds, few of the unlearning articles reviewed are relevant. Of the six papers which focus on the process of unlearning (see Table 2) only two examined processes of deep unlearning (MacDonald 2002; Rushmer and Davies 2004), while the other four are concerned with individual and organizational unlearning that is more equivalent to wiping. Although focusing on the antecedents of unlearning, Becker (2008 and 2010) also outlines a possible model of the process of unlearning. However, this model is not articulated in detail in either paper and treats the process of unlearning as a 'black box' (Becker, 2010). Therefore, we do not make further reference to it here. In tentatively outlining a model for the dynamics of the process of deep unlearning this section draws on MacDonald's (2002) empirical and conceptual work and links it with some wider, relevant literature on learning.

MacDonald (2002) suggests that the process of what she labels ‘transformative unlearning’, which has much in common with deep unlearning, has three distinctive but overlapping steps. The key features of transformative unlearning that resonate with deep unlearning are that it involves questioning, reflecting upon, and giving up some core values, assumptions, knowledge and practices, and also that this process is deeply emotional and challenging for people to undertake. Similar to the mainstream perspective in the unlearning literature, MacDonald conceptualizes unlearning as a necessary precursor to learning, and that both together are inter-linked components of change. Finally, the catalyst for transformative unlearning is a process of change that brings a person’s pre-existing values, assumptions knowledge and practices into question.

The first stage in MacDonald’s model is *receptiveness*, where a person accepts the possibility that there are perspectives and viewpoints which challenge their assumptions and that they are prepared to consider these perspectives. Following this is the second stage of *recognition*, which is the process through which a person acknowledges the veracity of these alternative viewpoints, and the limitations that exist in their own perspectives. Finally, is the process of *grieving*, which they suggest is the emotional core of transformative unlearning, whereby a person comes to terms with, ‘*the loss of prior ways of seeing – the loss of fundamental assumptions which until now had brought certainty and security*’, (p. 174). It is only after these three stages of the transformative unlearning process have been undertaken that a person is able to effectively change, and learn new assumptions, knowledge and practices.

While this model of the process of transformative unlearning has resonances with Rushmer and Davies’ concept of deep unlearning, it also differs from it in two key respects. Firstly, the catalyst for transformative unlearning was external change rather than some specific incident or experience. Secondly, a more significant difference was the timescale

over which transformative unlearning occurred. While Rushmer and Davies suggest that deep unlearning involves a sudden and rapid realization of the need for change, and an equally sudden process of change, in MacDonald's model, transformative unlearning was a slow process, which occurred over a period of years. As both transformative and deep unlearning involve the emotionally challenging process of unlearning fundamental assumptions and values, they represent comparable forms of unlearning. However, what MacDonald's perspective highlights is that not all deep unlearning occurs via the sort of sudden Archimedian epiphany that produces an instant change in behaviour. While particular events may lead people to question their values and assumptions it may take more time for behavioural change to follow.

Two other process models of learning from the learning literature also have potential relevance in understanding the character of deep unlearning processes. Firstly, is Garud et al.'s (2011) narrative model for learning from what they call, 'unusual experiences'. Unusual experiences are defined as, '*situations that bear little or no resemblance to the types of experiences that have occurred in the past*', (p. 587). A narrative is a rich textual account of a situation that people develop to make sense of events, which understands events from a particular perspective. Garud et al believe such narratives can help people learn from unusual experiences as they provide a way for people to both summarize how they have understood events, as well as share (and refine) these understandings through communicating them to others. While Garud et al. talk of learning rather than unlearning, there is the potential that in making sense of unusual experiences people's assumptions, values and practices may be brought into question, and a process of individual unlearning may be undertaken, whereby certain values and/or behaviours are abandoned and changed. However, a limitation of their framework is the lack of consideration given to emotional issues. Despite acknowledging that making sense of unusual experiences involves reflecting on basic assumptions, and that

dialogue with others in doing so may result in contrasting perspectives, issues of emotion are not considered. However, if account can be taken of such issues in Garud et al.'s (2011) model, it may be appropriate for understanding the dynamics of the process of deep unlearning.

A final very general model that is relevant for understanding the process of deep unlearning which has some synergy with MacDonald's model is the process of organizational inquiry outlined by Argyris and Schön (1996), which takes inspiration from the work of the pragmatist philosopher John Dewey. Similar to deep unlearning, and Garud et al.'s unusual experiences, the catalyst for a process of inquiry is the experience of doubt, which is defined as, the experience of a 'problematic situation', triggered by a mismatch between the expected results of action and the results actually achieved. Such experiences they argue, inhibit continued action, and encourage a process of reflection/inquiry aimed at resolving the doubt. Thus, the start of this process of inquiry can be considered equivalent to the initial stage of receptiveness in MacDonald's model, with the objective of resolving the sense of doubt that has been experienced providing the primary catalyst to this receptiveness. The process of inquiry outlined by Argyris and Schön (1996) is relatively generic, and lacking in detail, but involves combining reflection and action, as well as an active process of dialogue with others. The ultimate aim of this process of inquiry is doubt resolution, whereby the mismatch that was experienced is made sense of. Arguably this process of inquiry is equivalent to both the receptiveness and grieving stages of MacDonald's model. Once the process of inquiry has resulted in the doubt that was experienced being resolved this makes it possible for learning and change to occur, whereby people adapt their knowledge and actions to take account of the recently experienced mismatch.

Overall therefore, all three of the process models outlined above provide a potentially useful template for understanding how people experience and make sense of what is referred

to here as deep unlearning. However, none of them have been empirically evaluated. Thus further research is necessary to empirically test and evaluate these models before their validity as templates for understanding the process of deep unlearning can be established.

## **Discussion and Research Agenda**

Unlearning is a key factor in the successful implementation of organizational change, a constant feature of the contemporary business environment. This review has examined and synthesized the literature concerning the processes of individual unlearning. The first important contribution of this paper comes from this analysis by developing the concept of individual unlearning. In contrast to the mainstream perspective on unlearning (see earlier) we argue that individual unlearning is a distinctive type of learning, involving a conscious decision to give up knowledge, value or behaviours. However, this abandoned knowledge is not permanently lost, but is consciously discarded and remains retrievable for future use.

The second contribution of this paper is a new typology, which distinguishes between four separate types of individual unlearning. Building from the review and conceptualisation of individual unlearning types it was clear that there were inconsistencies in how the literature considers catalysts to individual unlearning. While Rushmer and Davies (2004) suggest that deep unlearning is typically initiated by some specific personal experience, an externally imposed change could also be a catalyst for deep unlearning. Further, Tsang and Zahra's (2008) analysis suggested that different types of change processes may be linked to different types of individual unlearning, with wiping being linked to more continuous-type change processes, while deep unlearning may be more connected with episodic and discontinuous change. Combining these insights resulted in a questioning of the assumption made by Rushmer and Davies that each type of individual unlearning they examined was linked to a different type of catalyst. Thus, arguably external change events or individual



events/experiences could be a catalyst to both wiping and deep unlearning. Combining Rushmer and Davies' (2004) two types of unlearning, with these two catalysts provided the basis for our new typology of individual unlearning.

For illustrative purposes, the typology (see Figure 1) is populated with examples. In the typology, wiping is relabelled behavioural unlearning. This refers to the individual unlearning of specific practices, activities or routines, which have no (or limited) impact on people's underlying values and assumptions. As in Rushmer and Davies' (2004) model behavioural unlearning like wiping does not have an affective impact. Deep unlearning, relabelled as 'cognitive unlearning' is emotionally charged as it involves giving up or abandoning more deeply held values and assumptions. In making this distinction, we speculate that while behavioural unlearning may be restricted to this domain, cognitive unlearning is likely to be accompanied by or lead to behavioural unlearning. As suggested in the typology, change events, or individual experiences may be a catalyst to either behavioural or cognitive unlearning.

Further, the character and dynamics of each of the four types of individual unlearning identified are likely to be distinctive, as they will be shaped not only by the type of individual unlearning that people are experiencing/undertaking, but also by the character of the catalyst, which initiated it. Thus, the process of cognitive unlearning which has been initiated by an external change event is likely to be different from cognitive unlearning that has been initiated by a specific, individual experience.

**Insert Figure 1 about here**

These two contributions in the paper begin the process of addressing the significant conceptual gap that was highlighted in the earlier review of the unlearning literature

regarding how both the nature and process of individual unlearning are understood. To finish the paper we point towards a number of ways in which understanding on this topic could be developed in the future. Previous research has focused more on organizational rather than individual unlearning. However, both areas remain lacking in attention. Further, few studies have attempted to consider multiple levels of unlearning or inter-relationships between different levels of unlearning and empirical analysis is still required for several aspects of the unlearning concept. In particular, further research is needed to examine the process of unlearning at both the individual and organizational level. MacDonald's (2002) model may provide a useful starting point for investigation but has not been examined empirically so its generalizability is still not confirmed. Another useful stream of investigation for future studies is the examination of relationships between individual unlearning and change. In particular, this review indicates that attention should be devoted to examining people's attitudes to the change that precipitated a particular type of unlearning. Finally, further empirical research, which provides insights to the nature of individual unlearning processes, is necessary to understand the character and dynamics of each type of individual unlearning identified, and to validate the proposed typology of individual unlearning.

For practitioners, further understanding of the character and dynamics of individual unlearning processes would be valuable. This understanding may help to identify likely causes of resistance to change, and organisational structures and employers' actions that may (inadvertently) present barriers to unlearning and therefore barriers to achieving desired change. Recognising employees attitudes to change will provide an indication of how receptive they are likely to be to new change events that require them to abandon previous knowledge or ways of working. Further, a better understanding of the process of individual unlearning will also enable practitioners to have more realistic expectations regarding the

impacts of a change process, and the likely time required for new practices and procedures to become embedded.

In-depth qualitative research would be the most suitable to explore this complex phenomenon, in a range of contexts and environments. In particular, as the time between the catalyst for individual unlearning and changes in attitudes or behaviour may vary in duration, longitudinal studies that involve participants recording changes in their behaviour and attitudes in research diaries could be of particular value. This approach would also enable the study of inhibitors and facilitators to individual unlearning and their relationship with the different stages of the unlearning process.

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**Table 1. Academic articles on unlearning (2000-2011)**

<b>Author</b>	<b>Definition of Unlearning</b>	<b>Topic</b>	<b>Details of Empirical Study</b>
Cegarra-Navarro et al., (2012)	Unlearning defined as, ' <i>the changing of beliefs, norms, values, procedures and routines</i> ' p.234	How organizational context can counteract the negative effects of counter-knowledge and facilitate individual unlearning	Survey of 164 small and medium enterprises in the Spanish construction industry.
Wong et al., (2012)	Presents multiple definitions used by others – no clear definition.	Develops and tests conceptual model to study effect of unlearning on the relationship between organizational learning (OL) and organizational success.	Survey of 200 professionals in consultant offices and contractor firms in Hong Kong
De Holan (2011a)	No formal definition of unlearning	(Brief) introduction to papers on a journal special issue on organizational unlearning, forgetting and memory systems	None – conceptual paper.
Cegarra-Navarro et al., (2011a)	No formal definition of unlearning	How organizational context facilitates individual unlearning of technology knowledge in a healthcare environment	Survey of 117 Nurse managers and medical managers
Cegarra-Navarro et al., (2011b)	No formal definition of unlearning	How organizational context facilitates unlearning and influences organizational performance	Survey of 263 Spanish metal industry firms
Lee (2011)	Team unlearning defined as ' <i>ability ... to change beliefs and routines to address rapidly changing environments</i> ' p.1843	Studies role of challenge and hindrance stressors on team unlearning	Survey of 200 New Product Development teams based in three science parks in Taiwan.
Lee and Sukoco (2011)	Organizational Unlearning defined as ' <i>actively reviewing and breaking down the organization's long-held routines, assumptions, and beliefs</i> ' p.412	Studies role of team reflexivity and team stress on unlearning and product innovation	Survey of 200 New Product Development teams based in three science parks in Taiwan.
Low (2011)	Presents multiple definitions used by others – no clear definition.	Explores the antecedents of individual unlearning	Three focus groups with a total of 25 educators

<b>Author</b>	<b>Definition of Unlearning</b>	<b>Topic</b>	<b>Details of Empirical Study</b>
Pighin and Marzona (2011)	Unlearning defined as <i>'throwing away concepts learnt in the past to give space for possible new learning'</i> . p.59	Examines role of unlearning for business process reengineering based on the reorganization of information systems	Single case study
Zahra et al., (2011)	Use Tsang and Zahra (2008) definition of organizational unlearning, <i>'the discarding of old routines to make way for new ones, if any'</i> (p. 324).	How organizational context may influence unlearning and entrepreneurial capability	None – conceptual paper
Becker (2010)	<i>'A process of releasing old ways ...'</i> , p. 252.	Examines factors that facilitate and inhibit unlearning during a change process	Survey of people involved in change in one Australian company.
Casillas et al., (2010)	Organizational unlearning defined, as per Cegarra-Navarro and Mayo 2005, as eliminating, <i>'ineffective and obsolete knowledge and routines'</i> , (p. 162-3	How organizational unlearning affects internationalization	Survey of 103 Spanish SMEs
Cegarra-Navarro et al., (2010a)	Individual unlearning defined as, <i>'the elimination of obsolete knowledge'</i> , p. 901, which is regarded as a necessary precursor to learning ( <i>'the creation and absorption of new knowledge'</i> , p. 901).	How organizational context facilitates individual unlearning	Semi-structured interviews with 9 staff in a Spanish regional hospital.
Cegarra-Navarro et al., (2010b)	Individual unlearning defined as per Cegarra-Navarro et al. (2010a)	How unlearning affects knowledge of the business environment.	Survey of 127 Spanish hospitality companies.
Conner (2010)	Unlearning defined as <i>'any time when prospective teachers describe instances or ways in which they come to recognize and rethink previously held views and attitudes.'</i> p.1171	Role of unlearning in changing perspectives and attitudes of low-income, urban youth.	Interviews with and survey of 21 prospective educators
Yildiz and Fey (2010)	Use Tsang and Zahra (2008) definition of organizational unlearning, <i>'the discarding of old routines to make way for new ones, if any'</i> (p. 450).	Develops theoretical model regarding the role of organizational unlearning in knowledge transfer processes	None – conceptual paper



Author	Definition of Unlearning	Topic	Details of Empirical Study
Srithika and Bhattacharyya (2009)	Organizational unlearning defined as the, ' <i>identification and removal of ineffective or obsolete knowledge</i> ', p. 68.	How Appreciative Inquiry (a particular type of organizational development intervention) can facilitate the process of organizational unlearning.	None – conceptual paper
Becker (2008)	Presents multiple definitions used by others – no clear definition.	Examines factors that facilitate and inhibit unlearning during a change process	Qualitative case studies of change in 3 Australian companies (23 interviews)
Tsang and Zahra (2008)	Organizational unlearning defined as, ' <i>the discarding of old routines to make way for new ones, if any</i> ', p. 1437.	Developing understanding of the concept of organizational unlearning	None – literature review
Tsang (2008)	Organizational unlearning defined as, ' <i>the discarding of old routines to make way for new ones</i> ', p. 7. (doesn't have the 'if any' element of definition in Tsang and Zahra	How organizational unlearning affects knowledge transfer processes	Interview-based study of a number of technology transfer joint venture initiatives.
Akgün et al., (2007a)	Unlearning defined as, ' <i>changes in beliefs and routines in the organization</i> ', p. 207.	How environmental turbulence affect team unlearning and team unlearning affects team performance	Survey of 197 firms on North East region of USA
Akgün et al., (2007b)	Individual and organizational unlearning defined as, ' <i>eliminating memory</i> ', p. 797	Develop understanding of unlearning concept through linking it to the literature on change and organizational memory	None – conceptual paper
Fotaki (2007)	Unlearning defined as, ' <i>the absence of in-depth questioning of predominant paradigms</i> ', p. 1063	Lack of learning by UK and Swedish governments in relation to patient choice regarding healthcare	None – conceptual paper
Rebernic and Sirec (2007)	Abandoning, ' <i>obsolete tacit knowledge</i> ', p. 406.	The problems and challenges related to managing and unlearning tacit knowledge	None – conceptual paper
Cegarra-Navarro and Sanchez-Polo (2007)	Definition of individual unlearning not clearly specified	The effect that individual unlearning had on organizational relearning	Survey of 130 SMEs in the Spanish telecommunications sector

<b>Author</b>	<b>Definition of Unlearning</b>	<b>Topic</b>	<b>Details of Empirical Study</b>
Cegarra-Navarro and Dewhurst (2006)	Individual unlearning defined as, ' <i>process in which obsolete and misleading knowledge is rejected</i> ', p. 50	How organizational context facilitates individual unlearning	Survey of 139 Spanish optometrists
Akgün et al., (2006)	Team unlearning defined as ' <i>changes in beliefs and routines</i> ', p. 73.	How the business environment affects team unlearning, as well as some consequences of	Survey of 319 new product development teams in the USA
Becker et al., (2006)	Unlearning defined as, ' <i>the process by which individuals and organizations acknowledge and release prior learning (including assumptions and mental frameworks) in order to accommodate new information and behaviours</i> ', p.610.	The extent to which different type of organization take account of unlearning in HRD interventions.	Survey of 70 Australian HR and operational managers
Cegarra-Navarro and Moya (2005)	Individual unlearning defined as, ' <i>the capacity of individuals to reflect on their performance in order to identify and promote actions that will result in improved performance</i> ', p. 162.	How individual and group unlearning contributes to org performance	Survey of 139 Spanish optometrists
Rushmer and Davies (2004)	Individual unlearning defined as, ' <i>getting people to stop doing things</i> ', p. ii10.	Developing the concept of unlearning by examining processes of unlearning and distinguishing between different type of unlearning	None – conceptual paper
Rampersad (2004)	No formal definition of unlearning	Developing analysis which regards change as fundamentally involving learning and unlearning	None – conceptual paper
Mavin et al., (2004)	Defines unlearning as ' <i>raising and challenging taken for granted assumptions</i> ', p. 572	The 'gender blind' and male-biased nature of management education	None – conceptual paper
Sheaffer and Mano-Negrin (2003)	Defines unlearning as ' <i>systematically rethinking and overhauling prescribed procedures, programmes, policies, and strategies underlying flexible corporate vision.</i> ' p.581	Assesses the extent to which companies unlearning capability predicts their are crisis preparedness	Survey of 130 CEOs, or VP for HRM in Israeli firms

<b>Author</b>	<b>Definition of Unlearning</b>	<b>Topic</b>	<b>Details of Empirical Study</b>
Sinkula (2002)	Organizational unlearning defined as, ' <i>process by which firms eliminate old logics and make room for new ones</i> ', p. 255	Develops a conceptual model to map how organizational unlearning linked to organizational performance	None – conceptual paper
MacDonald (2002)	Transformative unlearning regarded as a complex, challenging and lengthy process. About giving up established practices/knowledge/assumptions which may be linked to sense of identity	Develop understanding of the character, dynamics and emotional challenges of 'transformative unlearning'	Detailed reflection on personal experience

**Table 2. Focus of unlearning articles**

<b>Author</b>	<b>Individual or Organizational unlearning</b>	<b>Aspect of Unlearning Examined (Antecedent, process or consequences)</b>
Cegarra-Navarro et al., (2012)	Individual	Antecedent
Wong et al., (2012)	Organizational	Consequences
Cegarra-Navarro et al., (2011a)	Individual	Antecedent
Cegarra-Navarro et al., (2011b)	Organizational	Antecedent
Lee (2011)	Team	Antecedent
Lee and Sukoco (2011)	Organizational	Antecedent
Low (2011)	Individual	Antecedent
Pighin and Marzona (2011)	Organizational	Antecedent
De Holan (2011a)	Organizational	Consequences
Zahra et al., (2011)	Organizational	Antecedent
Becker (2010)	Individual	Antecedent
Casillas et al., (2010)	Organizational	Consequences
Cegarra-Navarro et al., (2010a)	Individual	Antecedent
Cegarra-Navarro et al., (2010b)	Individual	Consequences
Conner (2010)	Individual	Antecedent
Yildiz and Fey (2010)	Organizational	Consequences
Srithika and Bhattacharyya (2009)	Organizational	Process
Becker (2008)	Individual	Antecedent
Tsang and Zahra (2008)	Organizational	Process
Tsang (2008)	Organizational	Consequences
Akgün et al., (2007a)	Team	Antecedent and Consequences
Akgün et al., (2007b)	Organizational	Antecedent and Process/types of unlearning
Fotaki (2007)	Organizational	Consequences
Rebernic and Sirec (2007)	Individual	Consequences
Cegarra-Navarro and Sanchez-Polo (2007)	Individual	Consequences
Cegarra-Navarro and Dewhurst (2006)	Individual	Antecedent
Akgün et al., (2006)	Team	Antecedents and Consequences
Becker et al., (2006)	Individual and Organizational	Antecedent
Cegarra-Navarro and Moya (2005)	Individual and Team/group	Consequences
Rushmer and Davies (2004)	Individual	Process/types of unlearning
Rampersad (2004)	Organizational	Process
Mavin et al., (2004)	Individual and group	Consequences
Sheaffer and Mano-Negrin (2003)	Organizational	Antecedent
Sinkula (2002)	Organizational	Consequences
MacDonald (2002)	Individual	Process

**Table 3. Characteristics of unlearning types**

Category	Wiping	Deep Unlearning
Catalyst	Imposed Change event	Unexpected individual experience
Level/type of impact on individual (identity, values, knowledge, behaviour)	Mainly behavioural, but may involve abandoning knowledge	Typically significant – not only behaviour/knowledge questioned, but also values and/or identity
Speed of unlearning	Variable	Typically sudden
Extent of emotional impact/challenge	Typically not significant	Typically significant

**Figure 1. A Typology of individual unlearning**

		<b>TYPE OF UNLEARNING</b>	
<b>CATALYST OF UNLEARNING</b>	Individual experience	Behavioural Unlearning (Wiping)	Cognitive Unlearning (Deep Unlearning)
	Change event	<p>A healthcare manager is charged with engaging staff in an efficiency improving initiative in order to release nursing time for direct patient care. As a result the healthcare manager abandons her normal fast, reactive approach to problem solving and adopts a more systematic, analytical approach by collecting and weighing evidence and considering different solutions.</p>	<p>When a grievance is taken out against a manager, she gives up her non-hierarchical view of herself in relation to her team and her informal approach to staffing issues. She accepts the need to behave as a manager rather than a colleague and starts to exert her authority.</p>
		<p>A government health department introduces a requirement for all healthcare organizations to use a competency framework, which results in a more technical approach to the conduct of appraisals. As a consequence a healthcare manager gives up her previous practice of conducting in-depth reviews, although she remains unconvinced about the value of the imposed change.</p>	<p>Funding cuts within a healthcare organization lead to an information services manager losing her only member of staff. As a result the manager gives up her assumption that everyone in the organization values information services. She restructures the delivery of information services and is more proactive in promoting the service.</p>

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<sup>i</sup> The future re-use of knowledge that has been unlearned could be labelled relearning. However, if and how this happens is separate and distinct to unlearning, and thus not a topic of relevance to the focus of this paper.