

The Cue is Key:
Designing for Real-Life Remembering

Elise van den Hoven^{1,2} and Berry Eggen²

¹Design, Architecture & Building

University of Technology, Sydney

Australia

elise.vandenhoven@uts.edu.au

²Industrial Design

Eindhoven University of Technology

The Netherlands

{e.v.d.hoven; j.h.eggen}@tue.nl

Elise van den Hoven is corresponding author, her additional contact information:

Office phone: +61 2 9514 8967

Office fax: +61 2 9514 8787

Abstract

This paper aims to put the memory cue in the spotlight. We will show how memory cues are incorporated in the area of interaction design. The focus will be on external memory cues: cues that exist outside the human mind but have an internal effect on memory reconstruction. Examples of external cues include people, environments and things, where the latter are most relevant for the aim of this paper since these cues can be incorporated in designs. The contribution of this paper is two-fold: 1- providing insights into how memory research informs the design of devices to facilitate personal memory recall; and 2- by taking a design perspective, raising questions about memory cues as part of real-life remembering to inform psychological memory research. Since memory theory inspires design and both fields would benefit from collaboration, we would like these questions to be inspiration for future memory research, in particular targeting external memory cues.

Keywords: memory cues, personal remembering, augmented memory systems, interaction design, design research

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*"a more complex interaction between stored information and certain features
of the retrieval environment seems to be involved in
converting a potential memory into conscious awareness"*

(p. 352-353, Tulving & Thomson, 1973)

Memory cuing is concerned with the bringing to consciousness of an unconscious state, and is in itself a complex interaction, as mentioned by Tulving and Thomson (1973). According to the Oxford dictionary (2013) a cue is 'a circumstance or piece of information which aids the memory in retrieving details not recalled spontaneously'. This broad definition shows that a retrieval cue can come in many shapes and sizes and that the cue and the context of cuing are important. This paper aims at getting a better understanding of what a cue is and whether a cue or cuing can be influenced through design. The focus will be on external memory cues, which are physical or digital cues in a tangible embodiment with an internal effect (as part of this complex interaction) on memory reconstruction. Examples of possible external memory cues include people, environments and things. Things (or part of things) are most relevant for the aim of this paper since these potentially can be designed themselves. Instances of these external tangible cues can be completely personal and seemingly infinitely diverse, e.g. a birthday gift from a close friend, a heirloom piece, a souvenir, the colour of a fabric, or the traditional holiday photo album.

This paper will be about personal memories, as in autobiographical and episodic memories (for an overview, see Berntsen & Rubin, 2012), which can be retrieved

voluntary and involuntary (Berntsen, 2009). More specifically the focus is on everyday memory recall, which we define as remembering autobiographical memories while taking place in real life, in the real world as opposed to remembering taking place in lab conditions. These lab experiments are very useful for studying one or two variables in-depth, and these often involve the learning of artificial material (such as word lists) in artificial situations with a homogeneous subject population (typically students) (e.g., Chu & Downes, 2002, Rubin, Groth, & Goldsmith, 1984, Vaidya & Gabrieli, 2000). The often used "free recall" paradigm is not as free as it sounds, in that subjects are given the task to recall specific information and just like the "cued recall" paradigm the items-to-be-recalled are related to recently presented material that had to be memorised.

This is very different from our everyday remembering, which can happen anywhere, anytime, by anyone and through the use of any possible retrieval cue. The memories recalled can occur in all their richness, it can closely resemble the real experience and is not limited to remembering words. This everyday remembering is a truly free type of recall, which can happen both voluntary and involuntary.

Memory cues, and also the process of memory cuing, are important but not yet well understood. That is why these have been and still are highly relevant topics in memory research. The research focus, however, is predominantly on the psychology behind it all; therefore this paper takes a different perspective, namely the one from design, and in particular interaction design. The main assumption behind this design perspective is that the presentation of memory cues and the way in which this is done has an effect on remembering. Therefore, what is interesting for design concerns not so much the internal cues but the external ones instead: how are these currently used and presented in the real world. Ultimately we aim to use this knowledge to design tools that support everyday personal remembering. The term *supporting* can be interpreted in

many ways, as will become clear when examples of earlier work are listed in the Cues In Design section. In general, supporting concerns the personal remembering experience, for example, communicating about or sharing memories with other people. This is opposed to research that focuses on improving remembering skills, such as increasing the validity and accuracy of memories.

After more than ten years of experience in the area of designing to support remembering, the authors have concluded that one of the keys to success in terms of facilitating and supporting remembering is the memory cue, in particular understanding what it is and what the potential for design is. The focus in this paper is not the memory cuing *process*, which would include for example, depth of processing, availability, accessibility, attention, discriminability and the related fields of distributed and extended cognition, but instead the focus is on the memory cues itself. The appearance, presentation and perception of memory cues seem rather unexplored and are important for supporting everyday remembering. The next section will give some highlights of the cognitive psychology literature on memory cues, which by no means attempts to be complete. This will be used as the starting point from which to explain the design perspective on memory cues in later sections.

Cues In Cognitive Psychology

The terms memory trigger or memory prompt are used as synonyms for the term memory cue. Despite the fact that memory cues are very important for the remembering process and are studied in many ways, it appears to be difficult to find a proper definition. Assumedly this is the case, because memory cues (and perhaps the memory cuing process in general) are not yet well understood. A memory cue can loosely be

described as: a piece of information, a piece of mind or an experience, which facilitates memory recall.

However, most studies providing knowledge about memory cues are not focusing on the presented cue as such, but on studying the recall-capabilities of the subjects. These recall studies often use language as the cue and the to-be-learned material. The focus is on newly learned material, which has no relation to the everyday real world memories of the participants. For example, subjects have to recall recently learned lists of words with or without the presence of a memory cue (e.g. see Eich, 1980, for an overview). This cue is often presented in the shape of a written or printed word on paper, in the same style as the earlier presented lists. Sometimes cues are presented multiple times (*cue repetition*, e.g. Morris, Bransford & Franks, 1977), or not from the to-be-remembered-items lists (*extralist cuing*, e.g. Tulving & Thomson, 1973), but still presented congruently, in the same modality and presentation style.

Examples of memory studies that are more relevant to the work described in this paper, include the use of real-world memory cues, such as spoken memory cues that people also used when they are not part of a memory study. For example, a study on *cross-cuing* conducted by Harris, Keil, Sutton, Barnier and McIlwain (2011), describes how dyads, two people, cue each other in everyday conversations. Moving from real-world written musical language to real-world performed music, a musician also uses cues when performing a rehearsed piece (Chaffin, Logan & Begosh, 2009). Since making music requires several types of memory, musicians combine several types of internal 'performance cues'. Chaffin et al. (2009) identified *structural*, *expressive*, *interpretive* and *basic motor cues*. Another study (Herz, 2004) compared different modalities of seemingly generic cues to trigger museum visitor's memories. The cues included visual (5-second movies), auditory (5-second sound clips) and olfactory (sealed containers with air

flowing through an opening for sniffing) versions of popcorn, fresh-cut-grass and campfire. The findings showed that olfactory cues resulted in more emotional and evocative memories, but there were no differences found in terms of vividness and specificity across the different modalities.

All these examples focus on people using memory cues in the real world, and together they provide a nice example of the multitude of potential memory cues, which can occur in an everyday situation.

The cues mentioned before show an array of potential cues, which still lacks one, we believe, important category. The focus of this paper is on external memory cues and in particular on physical or *tangible cues* present in the environment of the rememberer, such as objects and other people. Some work has been done focusing on children, in which case these tangible memory cues came in the shape of small physical objects, such as archaeological tools (Hudson & Fivush, 1991) and magician's accessories (Pipe & Wilson, 1994). In addition, a study was done comparing media from an activity, including self-created objects (Hoven & Eggen, 2009).

So far, the memory cuing studies reviewed focus on different type of cues and their effectiveness in triggering autobiographical events from episodic memory. The way in which the retrieval of autobiographical memories happens is another relevant topic for everyday remembering. Two types of retrieval can be distinguished: voluntary and involuntary. Voluntary autobiographical memory is different from involuntary autobiographical memory (IAM), in that voluntary retrieval is conscious and intentional, where involuntary retrieval is conscious but unintentional (Berntsen, 2009). Voluntary retrieval is often described as a cyclic, goal-directed search process, where involuntary retrieval is not yet understood. Both voluntary and involuntary processes are relevant for everyday remembering, as focused on in this paper. According to Berntsen (2009)

cues for voluntary autobiographical remembering include pure sensory experiences and feeling states, but these do not seem effective for involuntary autobiographical remembering. Instead external cues seem to be used and effective (e.g. Ball, Mace & Corona, 2008, Berntsen, 2009), and received attention in studies, which makes the research on involuntary autobiographical memory particularly relevant for the focus of this paper. *External cues* are defined (Berntsen, 2009) as "present in the physical surroundings", as opposed to *internal cues* "only present in thoughts", and *mixed cues* "a combination of external and internal features". A review (Berntsen, 2009) of multiple studies into IAMs and cues showed similar results: most IAMs had external cues, than mixed cues, than internal cues, and the smallest number had no identifiable cues. To get a better understanding of the actual cues Berntsen and Hall (as presented in Berntsen 2009) categorised self-reported commonalities between IAMs and the retrieval context. It turned out that the most mentioned cue category was specific *objects* (17%), followed by personal life *themes, activities, persons* and *locations*. Also in the nostalgia research (e.g. Wildschut, Sedikides & Arndt, 2006) *tangibles* were listed as a separate category of objects. This shows the importance of looking further into tangible memory cues.

It is important to realise that for external cues to have an effect on recall they have to be distinct, present and recurrent in our lives, all in a salient manner (Berntsen, 2009). External cues will therefore be highly personal, depending on personal significance and on an individual's environment and activities. Apparently, IAMs typically come to mind when someone is engaged in activities that do not demand a lot of attention (Berntsen, 2009), such as daydreaming, relaxing or exercising.

Summarising, external and tangible memory cues, have not received much attention in research to date, but these tangible memory cues seem very powerful in particular for everyday remembering in the real world.

Design Perspective

The previous section highlighted some of the related work related to the understanding of external memory cues in cognitive psychology. This section will briefly explain what the design perspective is and how this is different from the psychology perspective, before moving onto the next section, which will give an overview of external memory cue work in the area of design.

As mentioned in the introduction, this paper tries to convey a design perspective on the area of designing to support everyday remembering. Design is a large field, which ranges from applied areas, such as fashion and furniture design, to theoretical areas, such as design theory. This paper narrows design down to an area that focuses on the design of products and systems that involve media that people use in everyday life as memory cues. Nowadays, these memory cues involve tangible and intangible cues, such as printed and digital photos. Incorporating the digital into physical products is done in the field of interaction design. This subfield of design focuses on interactive products, i.e. products that contain embedded electronics that respond to people's actions (Rogers, Sharp & Preece, 2011). Interaction design originates from the older field of Human-Computer Interaction, which came into existence with the appearance of computers. Nowadays, however, electronics and computing power can be embedded into almost anything, from smaller and less complex products, such as jewellery and clothing, to homes, cars, toys and household appliances. The field of interaction design deals with the conception, implementation and evaluation of these interactive products or systems.

Through the creation of future not-yet-existing interactive products, interaction design can be used in design-oriented research (Fallman, 2003) in order to generate knowledge. This means that the priority is to learn through and by designing for people

and, in this case, their remembering-related needs. The aim is not to create the optimal product for production or sales. In reality both pathways, research versus production, often have contradicting requirements and the products created for research purposes do not go beyond the prototyping stage.

Recent developments in interaction design research (Hoven et al., 2007) have shown the importance of designing products within everyday, challenging contexts of use, and the focus is shifting from ease-of-use to the user experience. A user experience is defined as "a person's perceptions and responses that result from the use or anticipated use of a product, system or service" (ISO standard 9241-210). This includes someone's emotions, physical and psychological responses and behaviours, before, during and after the interaction with an interactive product or system. Remembering can also be the resulting experience from a person's interaction with a product or system. The design of such an interactive product or system can be specifically aimed towards the facilitation or elicitation of such a remembering experience¹. Having a remembering experience is not necessarily the same as reliving the original event, it could also entail that the activity which includes remembering, e.g. the sharing of memories with others, is an experience in itself. Facilitated or elicited remembering experiences are almost always targeted to be pleasant.

Since interaction design research focuses on the creation of new, interactive products for complicated, everyday life environments, the measures of success include the creation of a working prototype and the use of that prototype in qualitative studies. Since prototypes are often not developed enough to be used over prolonged periods of time and design researchers lack the background and skills, it is difficult to measure the

¹ This should not be confused with the use of the term experience in memory literature, where it signifies the event that results in a memory, e.g. Conway (2009). This paper focuses on the experience someone has when remembering something.

impact of these products and technologies on the actual encoding or retrieving of someone's personal memories. However, this is the ultimate goal of designing for remembering, which can only be achieved through collaboration with memory experts. That is why this paper aims to address the community of memory experts and tries to show the relevance of design, but also the complicatedness of this area of research. Even though interaction design in itself is already multidisciplinary and needs input from design and engineering to create artefacts, it also requires input from experts in the application area, in this case memory. Apart from the combination of disciplines and the difference in measures of success used, another challenging factor is the combination of analysis and synthesis, in a typically iterative and flexible design process. All of this combined makes it possible to apply theory and knowledge about human memory to the area of designing for everyday personal remembering.

Qualitatively studying everyday remembering in the area of interaction design, as described above, often results in some differences compared to, for example, quantitative lab experiments.

One important difference is that design studies are often based on people's real personal *memories*, or 'extraexperimentally acquired memories' (free adaption of 'extraexperimentally acquired associations' by Bilodean, 1965, as seen in Tulving & Thomson, 1973). Those memories have personal meaning and value, people might have reservations to share them and the researchers often cannot (and will not) judge the validity, the time of encoding and the amount of rehearsal or processing over time. In addition, these memories can be very rich in the ways they are experienced and expressed, certainly when compared to remembering lists of recently learned words.

Related to this difference is the use of memory cues participants bring themselves and that, as a consequence, the researchers assume will cue their personal everyday

memories. These memory cues can be self-created or collected and come in a variety of materials, shapes and sizes, ranging from photographs, to maps, to inherited pieces, to everyday objects, to digital music files (e.g. Hoven & Eggen, 2008; Petrelli, Hoven & Whittaker, 2009).

Because these everyday personal memories and cues are often not controlled in any way, at times the cues are not even presented explicitly, it is also not controlled what people recall during the consequent studies. Adding this all up makes it clear why the focus in these studies typically is not on what someone remembers, but on whether and how we can support them to remember, judged through subjective self-reported experiences. The reported memories are often used to give qualitative examples of the knowledge gained.

This also explains the different uses of the term remembering. Where in cognitive psychology memory is studied with the idea of trying to understand the human brain and its workings, in design remembering is seen as an individual's activity with a personal goal or function. Even though it has been tried to bring psychology memory theory into design (e.g. Hoven & Eggen, 2008), it seems more useful for designers to identify real-life types of remembering that could be supported through interactive systems, such as the five R's (Sellen & Whittaker, 2010): recollecting, reminiscing, retrieving, reflecting and remembering intentions. These activities can serve as inspiring starting points for interaction designs presenting memory cues, which have resulted in design guidelines for these so-called augmented memory systems (e.g. Stevens, Abowd, Truong, & Vollmer, 2003, Hoven & Eggen, 2008, Kirk & Sellen, 2010, Whittaker et al., 2012).

In the next section some of the highlights will be presented of how memory cues are used in interaction design in order to support real-life remembering.

Cues In Interaction Design

Within interaction design, studies are often organised according to application area, this also holds for the area of designing for real-life remembering. Therefore, we will mention a number of these application areas, with example studies that all involve the creation, storage or retrieval of memory cues.

One of the more technology-driven application areas concerns *lifelogging*: effortless and all-encompassing digital capturing of everything someone experiences (e.g. Bush, 1945, Gemmell, Bell, Lueder, Drucker, & Wong, 2002, Gemmell, Williams, Wood, Lueder, & Bell, 2004; Mann, 2004), e.g. by wearing recording devices that create the cues (e.g. Hodges et al., 2006, Vermuri, Schmandt, Bender, Tellex, & Lassey, 2004). Often the incorrect assumption behind lifelogging is that recording equals remembering and thus prevents forgetting. Even though Sellen et al. (2007) found that using SenseCam (a wearable camera that automatically takes photographs) improves remembering compared to a control group, it only seems to do so short term. Recently it has been suggested (Whittaker et al., 2012) to adopt a more user-centred perspective of lifelogging, focusing more on reminiscing (defined as 're-living past experiences for emotional or sentimental reasons' by Sellen & Whittaker, 2010) and reflecting instead of factual recall.

Most application areas are not technology-driven but user-centred. A new and upcoming application area focuses on the needs of people with *memory challenges* and their carers. For example, Crete-Nishihata et al. (2012) designed life-review applications to support patients with Alzheimer's disease and mild cognitive impairments, their family members and carers. The applications, and thus memory cues, included multimedia biographies, narrated slideshows and a SenseCam-fed photo display.

Another user-centred application area focuses on how people want to be remembered in the *future*. For example, Lindley (2012) studied how older people actively prepare mementos to be passed on to family and friends. Also younger generations participate in similar activities when creating time capsules (Petrelli, Hoven & Whittaker, 2009). Both studies showed that people actively *create* new tangible objects that could later serve as memory cues, *collect* and also *curate* already-owned objects. It seems the older participants annotated their materials more than the younger generation.

A related application area focuses on remembering the *deceased*. For example, novel designs (Banks, Kirk & Sellen, 2012) are explored that are intended to become memorials after the owners have passed away. Other designs aim to support communication when in mourning over a lost one (Hoven et al., 2008). All these design examples serve as memory cues or hold memory cues, such as photos, a timeline and twitter feeds.

Recent work has also used memory cues to support *personal reflection*. For example, Cosley, Schwanda, Schultz, Peesapati and Lee (2012) have created the online Pensieve system, which presents social media items as memory cues to support reminiscence and reflection.

One of the most popular application areas of designing for real-life remembering is the sharing and recollecting of *personal memories*. For example, many systems have been built that facilitate storytelling through the use of photos, text, sound, videos, and souvenirs (e.g., Golsteijn & Hoven, 2013, Jansen, Hoven & Frohlich, 2013, Nunes, Greenberg & Neustaedter, 2009, O'Hara et al., 2012 and for an overview of earlier examples, see Hoven & Eggen, 2008). Also handcrafted beads representing important life

events (Reitsma, Smith, & Hoven, 2013) can be used as part of an interactive story recording system as memory cues.

What becomes clear from this overview is the diversity of memory cues used, created and incorporated in design. Photos, both printed and digital, seem the most popular. Physical objects have shown to be valued more for remembering purposes than digital objects (e.g., Golsteijn, Hoven, Frohlich & Sellen, 2012, Kirk & Sellen, 2010, Petrelli, Hoven & Whittaker, 2009, Petrelli & Whittaker, 2010) and therefore it is unsurprising that the majority of the memory cues used turn out to be physical and tangible.

Questions for Designing for Cues

This section will describe some of the questions designers face when designing for memory cues. These questions are based on previous work by the authors (e.g. Hoven forthcoming).

What is the cue? When looking at a situation in which someone is cued, it is unclear which elements of the environment play a role in the cuing process. Is it, e.g., the photograph, only a small part of it, is it the photograph in its frame, or the whole situation in which the photoframe is perceived? Does anything other than the photograph hinder or stimulate memory cuing in any way? What is the role of the presentation device? And in research, what is the effect of the researcher, the lab or the real world, the tasks given on cuing?

When does it become a cue? When someone picks up a sea shell from the beach, it is not yet a memory cue. However, years later it can act like one. How does this work? Does a cue grow over time, e.g. side-by-side with the long-term storage of the associated memory? Or is the cue already a cue as soon as it is perceived in the context of the

remembered event, but does a link have to be made between memory and cue? What is this link and is it flexible too? Can we influence this process?

What is the frequency of cuing? Berntsen (2009) found that IAMs on average only occur twice a day, while the number of potential cues seems endless. This must mean that either cuing happens more often, and e.g. we are not aware of being cued or we suppress potential cuing, or, on the other hand, it is rare to be cued, e.g. because it is difficult to get all the relevant conditions right.

When does something become a cue? Potential memory cues do not cue all the time, because then we could not walk past a photo frame without it. There must be many variables that make up the conditions in which something will or will not cue a memory. Potential variables are: the uniqueness (does it stand out from other cues), the strength (the effect a cue has on a person, e.g. depending on the senses being addressed), the relation to the environment it is in (should it stand out, or blend in), how the cue has changed over time (e.g. printed photos fade away and inherited furniture will show usage), the personal perception of the cue (one person might notice other elements or be more sensitive, but also the person's mood, state or available attentional resources might play a role), the preference of the remember (e.g. because someone is drawn to certain objects, might make cuing more likely).

What is the effect of time and timing on cuing? One of these complicated conditions seems to be timing. Memories change over time, so do memory cues (in appearance and effect), and perhaps the links between the two (since one object might cue many different memories). The whole situation is dynamic and flexible, so what is the effect on cuing and should we take it into account when designing for it? Should a memory cue be perceived with a certain frequency to keep the link between cue and memory active?

Do different types of cues have different effects on remembering? In case one would cue someone for a specific memory with a photograph, would this lead to a different response than if this person would have been cued for the same memory but with a word or a person or an environment? Since photos of activities seem to be better cues to memories (Burt, Mitchell, Raggatt, Jones, & Cowan, 1995) than photos of people, passively created cues, such as SenseCam images, which capture activities in an unorchestrated way might be better cues than actively created cues that might zoom on people and blur the activity at hand (Sellen et al., 2007)?

Can we identify a cue before it cues? According to Reder and Ritter (1992) people can make metamemory judgements about whether they can answer a question before answering it. They see the question as a cue and the answer as the memory, and called this *cue familiarity*. Can we then also look at a tangible object and know whether it has the potential to cue, before it does? If so, could a person select an object to become a future memory cue?

Can cues be designed? When talking about real-life memories and memory cues, are we limited to what people have or can new memory cues be purposefully created and linked to an existing memory? Can the memory of a cue cue too? And in that case, could we imitate or fake a memory cue? (Not intended for confabulation but for real memories.) If memory cues could be designed, a world of opportunities would open up in supporting remembering.

Does a cue need to have overlap with the associated memory? Cues often have an overlap with the memory they cue, e.g. a miniature Eiffel tower triggers memories of a trip to Paris including the actual Eiffel tower, but is this overlap necessary? Can we design cues that have no overlap, but still cue? People can influence their own memories, e.g. by only thinking of certain activities and not others, could this flexibility be used to

incorporate new links to objects that then become memory cues? This would open up opportunities for designing memory cues, since activities could be facilitated that incorporate these new cues.

Can a cue be identified and thus designed? If there are so many memory cue variables, and if cues are so personal, organic and sensitive to timing, is it then at all possible to identify a cue in real-life and use that information to design new cues? Might it be possible to predict the effect of a potential memory cue on the basis of the particular attributes a designer has used in its design?

Could we make existing cues more successful in cuing? Apart from looking at the memory cuing process, which we might be able to prime (Mace, 2005), what if we would adapt the memory cues themselves, or their presentation to the changing memories, remembering conditions and situation? Could we then increase the chances of a person being cued for a particular memory? For example, should some people be removed from photos, e.g. ex-partners, to allow the rememberer to focus on the event depicted in the photo? Or does the selection of appropriate physical objects increase the chance of remember as Jones and Martin (2006) suggest? Does strengthening a memory, e.g. through rehearsal and repetition, or weakening a memory, e.g. through neglect and avoidance, impact the effect of the memory cue?

Discussion

For people to benefit most from products supporting everyday remembering many questions still need answers. Designing for everyday remembering is a young field that we have only started to explore. Many interesting directions lie ahead, e.g. emerging trends (for an overview, see Hoven, Sas & Whittaker, 2012) include focusing on the facilitation of forgetting, supporting commemoration, cherishing the digital more,

increasing the longevity of digital media and understanding the effect of media type on memory. Even though it is clear that the psychology and design perspectives are quite different, as are the methods and approaches used, through this paper we hope to inspire future collaborations to answer some of the questions we have raised.

Concluding, this paper provided a design perspective on memory cues and the practical implementation in interaction design. An external memory cue from the design perspective is a physical or digital item that people create, receive, collect and keep for them to use (implicitly or explicitly) as a cue for their personal memories. Examples include: souvenirs, gifts, digital photographs, videos, audio recordings, artworks, furniture, seashells, and diaries. Most of these external memory cues are part of a tangible presentation device or system. The impact of these designs on the actual remembering is not yet understood. Designing for real-life remembering is a new area of design research, currently exploring different application areas, which show lots of potential for supporting people's remembering in everyday life.

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