# Temporal Snapshots: Unpacking Subjective Temporal Experiences in Dementia

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Fig. 1. The figure shows all the separate elements of the Temporal Snapshots probe. This includes six visual prompts, a jar with 17 envelopes, a pen, and a recorder. Each envelope includes a question, a couple of empty cards to write on, and some puzzle pieces as a reward. These items are used during the home visit and two-week study period.

Time is a growing topic of interest in HCI, exploring how humans perceive and engage with it through technology. However, technologies for people with altered time perception, like dementia, rely on objective time markers, including clocks and calendars, which exclude their diverse temporal experiences. We thus explored how people with dementia and their partners experience their subjective sense of time. To encourage reflection on past and future moments and uncover rich narratives, we designed the Temporal Snapshots probe, used by 12 participants over two weeks. We found that participants have fluid temporal associations, blurring the rigid boundaries between past and future. We introduced the Life Continuum Cones to visualize these associations, unpacking shared narratives and offering insights for assistive technologies. Our research underscores the need to design for subjective time in dementia, laying the foundation for technologies for people with non-conventional time perceptions.

CCS Concepts: • **Human-centered computing** → **Human computer interaction (HCI)**.

Additional Key Words and Phrases: Dementia, subjective time, temporal-aware design, time perception, reminiscence

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# 1 Introduction

Time and temporal experiences have emerged as areas of interest in Human-Computer Interaction (HCI) research, reflecting a broader trend toward understanding how people engage with and perceive time in their daily lives. Recent studies have highlighted the potential of HCI to delve into the nuances of temporal experience, particularly through an exploration of how non-conventional temporal concepts manifest in every day realities [6, 40, 42, 48–51]. For instance, Rapp et al. emphasized that HCI research can uncover how individuals live through time, connecting these temporal experiences to their broader existential concerns [51]. This connection between time and subjective experience is crucial, it moves beyond viewing time merely as a linear sequence of events and focuses on how time is an individually felt and lived experience

Despite this emerging interest, the design of technology interactions, especially in the context of groups having a more difficult and complex subjective temporal experience of time, remains underexplored. This gap becomes especially important in the context of dementia, a group of neurogenerative disorders that significantly disrupt an individual's temporal perception [28]. To help with this, technologies have been developed to assist with daily tasks [55] and provide simplified time information, such as day-night transitions, date, and time [13, 56, 64]. However, many of these technologies, which use clocks and calendars to communicate time, often fail to meet the needs of people with dementia, as the onset of the condition often erodes their understanding of objective time constructs [1, 34].

While these technologies address practical needs, dementia research has increasingly shifted from merely supporting cognitive and physical abilities to focussing on individual potential and lived experiences [27]. Therefore, this study aims to further explore the subjective, lived experience of time in dementia, particularly how individuals with dementia experience and relate to time. We explore this by encouraging them to reflect on past and future moments in the present, seeking to gain insights that can inform future HCI research and design.

Human perception of subjective time involves experiencing the present moment and mentally traversing past and future moments [35]. These subjective temporal experiences shape an individual's identity and contribute to their evolving sense of self [12, 46]. However, for individuals with dementia, the narrative structure of life—the continuous personal story that links past experiences to present and future intentions—begins to disintegrate. Memories that once provided this continuous thread become inaccessible or distorted, mirroring Han's description of modern time, where the rapid pace and pressures of contemporary life fragments the linear experience of time, leaving individuals trapped in an ever-present now, disconnected from a meaningful past or future [24].

Despite the distortions in episodic memory and time-processing abilities caused by dementia [16], the capacity to grasp subjective temporal experiences largely remains intact [59]. This retained ability is where reminiscence therapy, widely used in dementia care, plays a crucial role in enhancing well-being by helping individuals reconnect with their past [54, 71]. This therapy activates brain areas related to long-term memory and cognition, promoting the recall of memories and influencing present emotions and behavior [54]. However, reminiscence therapy typically uses the past as a means to elicit stories, largely excluding considerations of the future.

While the ability to imagine and plan for the future is impaired in dementia, it is not entirely lost [15]. This exclusion leaves a significant gap in HCI research, raising critical questions about why people with dementia are often stigmatized as having no future to relate to. Addressing this gap is essential for providing a holistic approach to their care and well-being. To explore how individuals reflect on and relate to their temporal experiences, including past and future moments, our research introduces the *Temporal Snapshots* probe. Designed for use by people with dementia and their partners over two to three weeks, this probe gathers responses to better understand their subjective experiences.

Building on previous research, which shows that events are recalled based on their specific details (what, where, when) or their placement within periodic cycles and continuous timelines [29], the Temporal Snapshots probe uses generic images and reflective questions to facilitate temporal reflection. This approach helps in understanding how individuals navigate and narrate their experiences across past and future moments. The results show fluidity in the narration of temporal experiences, indicating that the distinction between past, present, and future are often blurred when participants make associations.

Since people experience time and make associations in distinct ways, and dementia manifests uniquely in each individual, it is crucial to foreground the individual in these associations. To make sense of the data collected by our probe we introduce the *Life Continuum Cones* to visualize how individuals navigate through past, present, and future when making associations and sharing personal narratives. By focusing on dementia as a specific case, our research emphasizes the importance of temporality in interaction design and the need to reassess how temporal experiences should be designed for various differently-abled groups. Additionally, the insights gained from this study underscore the need to design for subjective time in other groups of individuals with unconventional temporal perceptions. Thus, our work sets the stage for further exploration of subjective time and positions Life Continuum Cones as a starting point for uncovering these experiences and informing the design of temporal-aware technologies.

## 2 Background

### 2.1 Temporality in HCI and Dementia

Conventional views of time have limited HCI possibilities by oversimplifying rhythms, categorizing time as merely fast or slow, viewing the present as uniform, seeing time as linear, tying temporality to artifacts, and reinforcing time hierarchies [48]. However, recent advancements in HCI research have begun to push against these traditional boundaries, offering new ways to think about and design for time. For example, some researchers have revisited the concept of time as a social construct, emphasizing that time is not just a neutral, objective measure but is deeply intertwined with social interactions [49]. Other studies have examined the evolving relationship of humans with technology over time [39], translating findings to express the passage of time through materials, form, and qualities, and exploring how intentionally designed interactions can foster more meaningful and reflective experiences [41]. Additionally, there has been growing interest in exploring the subjective, narrative-driven sense of time experienced in storytelling to better understand current experiences and develop new approaches for addressing issues such as disengagement, re-engagement, adapting to different paces, synchronizing participants, and facilitating interactions across time [6]. Moreover, temporality is being explored in more-than-human contexts, recognizing that human experiences of time are not isolated but are interconnected with ecological systems and non-human entities, and challenging the anthropocentric focus of HCI work [42, 50]. Despite these promising developments, HCI has yet to fully incorporate these alternative conceptions of time into its mainstream design practices. Many existing technologies remain constrained by traditional, linear models of temporality, overlooking the complex, layered, and subjective experiences of time that individuals encounter in their daily lives.

This need is particularly evident in the context of dementia. Time-related changes were among the earliest reported signs of the condition and these changes worsen as the condition progresses [61]. Tools like the Mini-Mental State Examination (MMSE) have been used for a long time to screen for cognitive impairment, including temporal orientation, through questions about the current year, season, date, day, and month [19, 34, 66]. The Clock Drawing Test, part of the MMSE, highlights the struggles individuals with dementia face in representing time visually [1]. Occupational

therapists suggest assistive technologies for time management to help individuals with dementia orient to time, reduce dependency on caregivers, boost their sense of control, and enhance overall independence [44]. These technologies include devices that simplify the communication of day-night cycles, dates, and time, day and date [8, 13, 56, 64], and embodied or digital agents for task reminders [47]. Despite these innovations, most assistive technologies still rely heavily on conventional clocks and calendars, which can be challenging for people with dementia to comprehend. This limitation extends to broader technology interactions designed for social support [11, 14, 18], companionship [10], and daily activities [55]. While subjective temporal experiences have been studied in fields such as neurology and psychiatry [23, 45, 52], these insights have not yet been fully integrated into the design of assistive technologies. Additionally, Kitwood's person-centered care approach, which emphasizes the subjective needs of individuals with dementia, remains a foundational aspect in dementia care practice [31, 32]. Despite this, most solutions continue to rely on outdated temporal frameworks.

## 2.2    Subjective Experience of Moments in Dementia

Subjective time integrates past, present, and future, shaping how individuals perceive their experiences and understand their world [20, 40]. The subjective present plays a crucial role in shaping identity and overall well-being [12, 46], with event-based memory contributing to a continuous sense of self, which fosters both stability and growth [36]. Much like how stories are structured through words, sentences, paragraphs, and chapters, human perception of time involves organizing experiences into discrete units [4], which we will refer to as moments. The event memory system captures snapshots of these moments, while episodic memory weaves the snapshots into coherent narratives forming past episodes [29]. Experiencing moments in subjective time involves unfolding each moment as discrete pictures or words [4] and the ability to mentally traverse past and future moments [35].

When time becomes fragmented, it disrupts the coherent narrative that anchors identity across past, present, and future, leading to a fragmented sense of self and feelings of alienation and existential uncertainty [24]. In dementia, these issues are heightened due to impaired time-processing abilities and memory, resulting in distorted episodic memory and difficulties in recalling time-related information or perceiving oneself within subjective time [16]. This disruption resonates with Han's reflection on the modern-day experience of time as increasingly fragmented and dyschronized, where the acceleration of modern life breaks down time into isolated, disconnected moments, causing disorientation and a lack of meaningful continuity.

Much like Han's depiction of the modern temporal crisis, individuals with dementia often experience fragmented moments, with no clear connection between what came before and what might follow. The desynchronization leads to social isolation, as people operating on their own accelerated timelines lose the shared rhythms that once fostered social cohesion [24]. For those with dementia, this desynchronization becomes deeply personal, as their internal sense of time no longer aligns with the external world, heightening their isolation [30]. They may find themselves stuck in moments that do not exist or confused by a present they cannot fully grasp, leading to confabulation where individuals provide false or contradictory information due to misplaced memories [22]. Although confabulation is typically viewed negatively, Orulv suggests it can serve as a mechanism for individuals to make sense of their present experiences and maintain a sense of personal identity [43]. These challenges highlight the need for therapeutic approaches that not only address memory loss but also strive to preserve a coherent sense of self.

Reminiscence therapy has been shown to enhance the overall well-being, cognition, communication, and mood of people with dementia by helping them connect with their past in meaningful ways [54, 69, 71]. This therapy uses audio and visual stimuli such as photos, videos, and life story books to facilitate interaction during the sessions [69, 71]. By

activating brain regions related to long-term memory and cognition, reminiscence therapy enhances the coherence of key life events and influences emotions and behavior [54]. Research indicates that reminiscence, particularly life review practices, can be highly effective in improving psychological well-being in older adults [7]. However, reminiscence therapy often focuses on past experiences, potentially limiting individuals' reflection on the future.

Research on subjective time in dementia prioritizes futures in addition to the past [17]. Maintaining a positive outlook on the future is crucial for well-being, as it supports constructive planning and action in the present [37]. The perception and memory of events are intricately connected, affecting actions and language use in the present and future [72]. Hawkins advocates for a holistic perspective on well-being, emphasizing that it should encompass the entirety of a person's life rather than focusing on isolated moments [26]. Therefore, understanding the interplay between past memories, present actions, and future aspirations becomes essential in fostering a holistic sense of well-being, especially in the context of progressive conditions like dementia. In this context, speculative futures frameworks, such as the future cone, offer valuable insights into visualizing personal temporal experiences [25]. These approaches have been instrumental in global foresight by envisioning diverse scenarios, guiding strategic planning, and exploring new possibilities [67]. They have also been used to examine the impact of circular economies [5] and extend product trends into innovative areas, offering fresh perspectives for design and technology [3]. Integrating speculative futures with inclusive frameworks can help create a more holistic approach to addressing the evolving needs of those with dementia.

Afrofuturism, with its focus on liberation and cultural competence, challenges traditional futurism by addressing colonial biases and marginalization narratives [9]. It can inspire a reframing of potential futures to be more inclusive and supportive, particularly in designing assistive technologies. This perspective shifts away from past-focused models, fostering the development of relevant and empowering futures that honor diverse experiences and aspirations. Incorporating such holistic and inclusive viewpoints is essential for enhancing dementia care, making it more empathetic and attuned to the complex temporal experiences of individuals.

### 2.3 Uncovering Personal Narratives

Foregrounding individual temporal experiences is essential for understanding how people perceive time subjectively. By focusing on the person and their life stories, their unique temporal realities can be emphasized, which is particularly important in dementia research. Involving people with dementia directly in research can allow for a more accurate understanding of their temporal experiences.

Previous studies have successfully engaged individuals with dementia through personal design probes, enabling them to express their needs, desires, values, and beliefs [68]. Conducting studies in familiar settings and involving caregivers has shown to be beneficial strategies in dementia research [] . Also, including informal caregivers, such as family members or close friends, in research can further enrich the research by providing insights into the nuanced temporal experiences of people with dementia. Caregivers, with their deep understanding of their loved one's temporal perceptions and daily routines, can offer a richer perspective. Additionally, carefully designed prompts can play a crucial role in inspiring and assisting people with dementia to make associations and construct narratives.

Effective cues and prompts are key in triggering associations, allowing individuals to articulate their temporal experiences [65]. Humans naturally segment activities into events and sub-events, shaping their perception and memory of experiences, which aids in recall and association [33]. For example, a supermarket trip might be divided into distinct phases such as going, shopping, and returning, based on physical changes or conceptual goals, demonstrating how they simplify complex, dynamic experiences into manageable, meaningful units. Events in this context range from brief moments like opening a door to longer ones like choosing groceries to several minutes like chatting with a friend

encountered at the store. By carefully designing cues that resonate with these natural segmentation processes, effective engagement with people with dementia is possible, enabling richer and more meaningful narratives to be discovered.

Two primary theories explain event recall: Tulving's theory emphasizes remembering events based on their what, where, and when, while Campbell's theory focuses on events within periodic cycles like days and seasons, as well as those within a continuous, non-repeating timeline [29]. Research by Tomita et al. indicates that when making associations, people often connect based on similarities in the time period, location, space, social settings, activities, and emotions [63]. Additionally, designing cues that are distinctive, relevant, consistent, contextually matched, and emotionally significant can greatly enhance the accuracy and effectiveness of memory recall [58, 65]. However, further studies are needed to explore these dimensions in the context of dementia. These future investigations can help refine the application of prompts in research, making them even more effective in eliciting comprehensive and meaningful narratives.

Previous dementia research on reminiscence has employed sensory stimuli, such as familiar scents, sounds, and tactile objects, to evoke memories and facilitate conversations among individuals with dementia. Astell et al. found that generic materials, like photographs, were more successful than personal items in prompting detailed narratives, as personal items often limit the scope of shared information [2]. This suggests that while personal items evoke strong memories, they may not always facilitate broad discussions, highlighting the importance of selecting stimuli that encourage expansive, rather than restrictive, storytelling.

## 3 Method

This section first explains the Temporal Snapshots probe and then presents the field study that explored the lived experience of time through past and future moments as experienced by people with dementia using the probe. Our main guiding methodology for analysis was an abductive approach [62], in which we moved between empirical observations and existing theories, allowing us to discover unexpected patterns in participants' experiences and better understand how disruptions in time perception shape the lived experiences of people with dementia

### 3.1 Temporal Snapshots Probe

The Temporal Snapshots probe aims to inspire participants to connect to moments from their past and future, eliciting rich, subjective responses that provide insights into their experiences, values, and contexts [21]

To gain a comprehensive understanding of these temporal experiences, the study involved both individuals with dementia and their partners. Partners were included because they are closely familiar with the routines and daily challenges faced by those with dementia. Their perspectives are equally valuable as they observe and adapt to the individual's temporal difficulties, such as managing routines, using assistive technology, and providing emotional support []. By incorporating both viewpoints, the study aimed to capture a fuller picture of how temporal experiences are navigated and narrated within the couple's daily life.

The Temporal Snapshots probe consists of two parts that are discussed below: 1) image prompts, and 2) jar activity.

*3.1.1 Image Prompts.* The goal of image prompts is to provide a broad visual landscape for inspiration that can trigger associations and lead to meaningful conversations for all participants. To effectively trigger a variety of associations, the contrast was provided in the time period, social settings, activities, location, space, and emotions [63]. It was ensured that the image prompt had multiple artifacts that contextualized the space. Also, care was taken to choose images without recognizable human faces or animals in them so no direct association or disassociation to personal life was
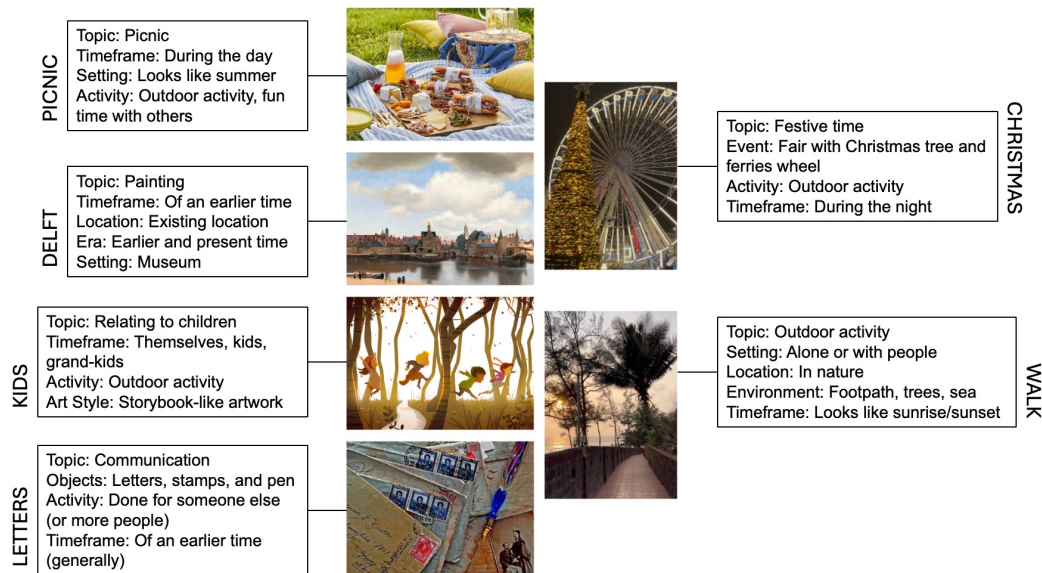
Fig. 2. Six Image Prompts with themes- Picnic, City, Christmas, Kids, Letters, and Walk

made. Based on this, the Image Prompt activity included a total of six images with the themes- Picnic, City, Kids, Christmas, Letters, and Walk- as shown in Figure 2. For diversity in visual styles, the image prompts include four photographs (Picnic, Christmas, Letters, and Walk) and two artworks (City and Kids).

*3.1.2 Jar Activity.* The questions in the jar activity aim to provide a starting point for conversation. The jar activity includes 17 questions packed into separate envelopes, and some empty cards to write on if desired. The participants were invited to take these envelopes and together discuss the question. The questions span over distinct time-periods-past, immediate past, and future and may either relate to recurring or non-recurring moments based on the person's interpretation. Based on these aspects, the questions are as shown in Table 1. In addition, each envelope included some puzzle pieces to reward the participants and motivate them to complete as many questions as possible.

## 3.2 Participants

The field study involved participants diagnosed with dementia and their partners recruited through snowball sampling from local care facilities and dementia support groups in the [country]. A total of twelve participants, that is, six dyads of a person with dementia and their partner, were recruited. Selection criteria included a diagnosis of dementia, living together with their spouse at home, the ability to communicate verbally, and consent to participate. The participants were 60–89 years old, [country] nationals, and white in ethnicity. The participants represented a diverse group in terms of gender, and type of dementia (Alzheimer's- 3, Mild Cognitive Impairment- 2, Huntington's disease 1), thus aiming to capture a wide range of experiences. Due to the progressive nature of dementia and the unique lived experience of individuals, the stage of dementia was difficult to state at the time of the interview. Of the six couples, two pairs (P3S3

| No. | Time-frame | Theme | Questions |
|---|---|---|---|
| 1. | Past | Family Event | Can you recall a time when your family got together for a special day or event? What makes it memorable for you? |
| 2. | | Travel | Can you recall a vacation or trip that you enjoyed? What made your trip special, and where did you go? |
| 3. | | Achieve-ment | Can you think of a moment when you achieved something important or felt proud of yourself? What was the accomplishment, and why was it significant to you? |
| 4. | | Food | Do you have a favorite food or recipe that you remember fondly? What was it, and why is it meaningful to you? |
| 5. | | Friend | Can you think of a close friend? What makes that friendship important to you? |
| 6. | | Pet | Did you have a pet that you loved and cared for? What was their name, and what fond memories do you have of them? |
| 7. | | Music | Do you have a favorite song or piece of music that you used to listen to when you were younger? What feelings and memories does it evoke? |
| 8. | | Book/ Movie | Do you have a favorite book or a movie that left a lasting impression on you? What was it about, and why did it impact you? |
| 9. | Re-cent Past | Hobby | Can you tell me about some games/hobbies you used to like when you were younger? Do you still enjoy them? What activities do you currently enjoy as hobbies? |
| 10. | | Out-doors | Do you like going outdoors? Can you tell me about a walk you went for recently? Where did you go, and what did you enjoy about it? |
| 11. | | Joy | What made you laugh or smile today/yesterday? Is there something funny or amusing that someone said or did recently? What brings you joy generally? |
| 12. | | Recent Victory | Tell me about a small victory or achievement you experienced today/yesterday. Is there something you want to do? |
| 13. | | Relax Activity | What is a relaxing activity for you? Why do you think it is relaxing? Can you describe how you feel? |
| 14. | Fu-ture | Family Event | Can you tell me about a family gathering or celebration that is coming up? Are you excited about it? Who would be there and what activities might take place? |
| 15. | | Future Activity | Can you tell me about an activity that you want to do? What would you like to do, and why does it make you excited? |
| 16. | | Next Travel | Is there a place you've been thinking about visiting or exploring? Where would you like to go, and what interests you about that place? |
| 17. | | Future Goal | Can you share a goal you have for the coming week or month? What is it, and why is it important to you? |

Table 1. Reflective Questions in the jar

and P4S4) opted to withdraw after the image prompt discussion but gave consent for their collected data to be used for the study. We refer to the the person with dementia as "P" and the spouse or partner as "S".

### 3.3 Ethical Considerations

Ethical approval for the study was obtained from the Ethical Review Board of [university]. Participants were given information on the aim of the study and study design in the introduction session of the first meeting. Participants provided both verbal and written consent, confirming they understood the study's purpose, procedures, and their right to withdraw at any time. Interviews were conducted in the language the participants were most comfortable in, using

short and simple sentences and repetition when required. During the interviews, the first author was accompanied by a second experienced researcher to help organize the sessions and conduct interviews in [language of the country]. To ensure the comfort of participants, the researchers picked on non-verbal and verbal cues and offered to stop, take a break, or continue with the interview. The interview setting was either the house (P1S1, P2S2, P5S5 and P6S6) or a frequently attended, familiar meeting center for people with dementia (P3S3 and P4S4) based on the couple's preference, ensuring a comfortable and known environment for the interview. Confidentiality was maintained by anonymizing all data, and the participants' identities were protected throughout the research process.

### 3.4 Study Procedure

The study includes two separate steps, first, an interview with image prompts discussion as part of it, and second, a jar activity. The interview session had 3 parts- an introduction (20 minutes), an image prompt discussion (30-45 minutes), a break (10 minutes), and an interview on the topic of reality (30-45 minutes). These were conducted by researchers in the homes of the participants for four couples and at a familiar care facility for two couples. The data on reality was for a different study and is reported as a separate paper. In the introduction session, participants were given details about the study, and their consent was taken for participation, ensuring they understood their rights, including the option to withdraw at any time. Following this, as part of the interview, the six image prompts were discussed. At the end of the interview session, demographic information (age, type, and stage of dementia) was collected and the jar activity was introduced.

*3.4.1 Image Prompt Discussions.* The six images were presented one at a time to the participants and each image was discussed for about 5-10 minutes. The discussions were led by the accompanying researcher who also had prior experience of doing research with people with dementia. Participants were allowed to observe and reflect on their personal associations, memories, and experiences related to each prompt with the open question- "What does this image make you think of?". Additional open-ended questions were asked to facilitate a discussion and explore further associations on dimensions such as activities, location, and time through what, where, and when questions. Participants were also asked to express their emotions related to the associated moment. The interview session was posed as a conversation rather than an interview and to facilitate this better, both researchers also shared parts of their associations to break the ice and facilitate better image prompt discussions. The interview sessions were audio and video recorded to capture verbal and non-verbal cues.

*3.4.2 Jar Activity.* Toward the end of the interview session, the participants were invited to join the Jar Activity for a period of two to three weeks. Participants were asked to open the envelopes one at a time and record their conversations after reading the question over the study period. They were encouraged to consider similar activities, locations, and people and build on associations they make. Participants were asked to go through as many questions as they could as part of the jar activity at their leisure and pace, before the next visit in two to three weeks, giving participants ample time to complete the jar activity. In the study, it was seen that the couples sometimes opened and answered multiple envelopes (maximum 3) one after the other. For the jar, the data was collected through audio recordings and written summaries (if they preferred to do so).

### 3.5 Data Analysis

All interviews were transcribed and translated verbatim by two research assistants and the first author went through them to ensure correctness.

We chose an abductive approach [62] for analyzing the data because it enabled us to iteratively engage with theoretical frameworks, specifically Han's philosophical reflection on time in modernity [24]. This approach allowed us to remain open to new insights from the data while engaging iteratively with relevant theories [60]. Abduction, which involves navigating between empirical observations and existing theory [62], was well-suited for exploring how dementia alters individuals' perceptions of time, much like modernity does. This approach helped us identify surprising patterns in participants' experiences of time, revealing moments of disorientation and enriching our understanding of how these disruptions shape the temporal perception of people with dementia. Additionally, we integrated abduction with thematic analysis, a widely accepted approach in qualitative research, which has been successfully used in a similar way in previous studies [53].

The analysis began with open coding of the transcripts, focusing on associative memories and the context of the images or questions posed. We then re-interpreted these codes in an iterative process, relating findings to participants' personal timelines and Han's perspectives to add depth to our findings. This process aimed to authentically capture each couple's unique experience with dementia. To ensure community of inquiry [62], the first author organized co-coding sessions with co-authors and seven other peer researchers who had expertise in dementia (6) or time (1) research. This collaborative approach helped introduce diverse perspectives, enriching the data interpretation and ensuring the codes' validity and reliability and contributing to the identification of themes.

## 4 Results

We present our interpretive analysis [57] of narrative moments making sense of associations participants made when using the Temporal Snapshots probe. Additionally, we make use of Life Continuum Cones as a visual framework to explore and unpack the subjectivity of time experienced by participants. Figure 3 shows the structure of how results are discussed.
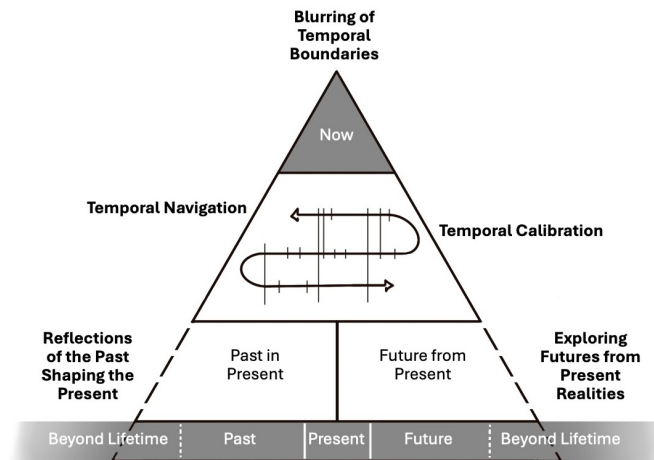


Fig. 3. Overview of Results

## 4.1 Blurring of Temporal Boundaries

Our study reveals how participants' navigation through memories and future anticipations significantly blurs temporal boundaries, with associations spanning various moments in time and traversing both past events and future possibilities. This merging of temporal boundaries underscores the importance of grounding these narratives in individual histories, preferences, and unique personal stories.

To address this, we foregrounded the person and remapped the collected data along a temporal direction from past to future. By visually representing the data for each individual, we highlighted all the topics discussed during the interactions and mapped the narrated moments and associations along this temporal line. This approach not only emphasized the interconnectedness of past, present, and future in participants' narratives but also provided a clearer understanding of how these temporal experiences influence each other.

*4.1.1 Visualizing Narrative Continuum.* The Life Continuum Cones are a visual tool we developed to represent the interconnected nature of personal narratives. Structured as a dual cone resembling an infinity symbol, the cones symbolize the convergence of past and future at the present moment, offering a visual narrative that captures the fluidity of temporal experiences. The left cone represents an individual's lived life, containing snapshots of their past experiences and memories. As this cone narrows towards the present, it signifies the accumulation of life moments that contribute to the current interaction during the Temporal Snapshots probe. Similarly, the right cone represents future possibilities, expanding outward from the present and encompassing potential scenarios that include what is desirable, possible, and improbable. The point where the two cones meet marks the present, and a plane at this intersection lists all the topics discussed during the activity. Each cone is divided into planes, separated by intervals of ten years, except for the first plates on either side of the center, which represent a one-year time span. Together, the Life Continuum Cones provide a comprehensive view of an individual's narrative continuum, seamlessly integrating past, present, and future experiences. Figure 4 shows Life Continuum Cones for P2 and S2.

> I am still finalizing how they look.

*4.1.2 Individual and Collaborative Associations.* When navigating through different temporal moments, all participants engage in both individual and collaborative associations. In both ways, participants connect the visual and question prompts with their own lives, drawing from personal memories and experiences. For example, when making individual association, P2 immediately associates the image of painting with the "Church tower of [location]", a familiar landmark from his past, saying, "Yes, I worked there." As he continues to analyze the visual, P2 compares the past and present landscapes, noting, "It must be [other location], perhaps? There is no water in [location], right? (But) there used to be water". Meanwhile, S2 approaches the image differently, stating, "I'm already looking in the corners to see if there's a name somewhere", indicating her strategy of searching for a signature to identify the painting. Despite their approaches, both participants find the process engaging, with P2 remarking, "That's certainly exciting, isn't it?".

On the other hand, when making collaborative associations, S2 recalls a Father's Day picnic and connects it to childhood memories, "If we go with the tractor, you would leave one large flat cart behind and we would all sit on it and then we would go to the stream and swim there in the stream. And we went on a picnic there". Her detailed recollection triggers P2's memory, prompting him to chime in with, "We went swimming there", as he recalls the same location. The excitement in S2's voice encourages P2 to elaborate, as he mumbles about where they swam. S2's energetic narration continues, as she excitedly names specific landmarks like the bridge and the dam with a waterfall. This shared recollection not only refreshes S2's and P2's individual memory but it also creates a fresh, joyful experience
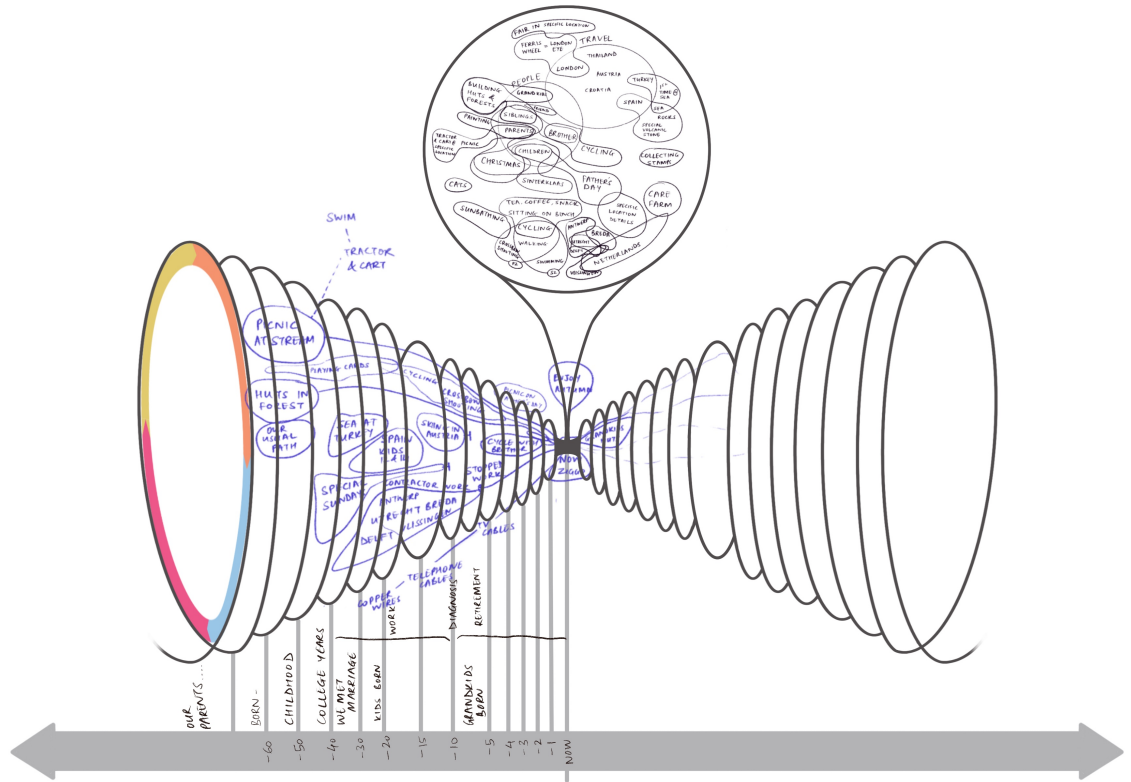
Fig. 4. Life Continuum Cones of P2 and S2

in the present moment for both. By piecing together their individual experiences into a shared narrative, allows them to enrich current interactions.

*4.1.3  Navigating Factual Discrepancies.* When making associations, factual discrepancies often arise, particularly concerning specific details such as the time period of the narrated events. Typically, in these instances, spouses correct or disagree with the factual details narrated by the person with dementia, either verbally or through non-verbal cues.

However, in the case of P5 and S5, the dynamic shifts, with P5 correcting details of S5's narrative. For instance, when S5 claims they had known each other since 1970, P5, typically precise with numbers, responds, "Longer, I think". S5 confirms her memory, explaining she was 17 at the time, to which P5, smiles and concedes, "Oh. Then not".

Throughout their conversations, S5 tends to focus on the experiential aspects of moments, while P5 emphasizes specifics and details. However, in this instance, P5 chooses to let go of the factual discrepancy, placing more importance on the emotional significance than on the accuracy of dates. This moment highlights how the richness of shared experiences can transcend the need for precise details, emphasizing the emotional depth that narratives hold over factual correctness.

### 4.2 Temporal Navigation and Calibration

When narrating moments fluidly, participants use personal markers, much like signposts on a road, to navigate through different time periods and articulate their narratives coherently. These markers either consist of singular, significant events or recurring patterns that help them contextualize and sequence their memories. However, dementia frequently disrupts participants' temporal awareness, causing them to lose hold of these markers. As a result, moments may blend or become misplaced, affecting the coherence and clarity of their narratives.

*4.2.1 Connecting Life Phases and Generations.* In their narratives, all participants connect different life phases along a linear timeline, referencing periods such as childhood, work life, and times before and after marriage.

As they make these connections, participants often highlight similarities and contrasts between their various life stages. For example, P2's experience highlights a stark contrast between the accelerated pace of working life and the relaxed tempo of retirement. He recalls, "My work started at 6:30 AM in [location], so I had to leave home by 5:00 AM", highlighting a life once governed by strict schedules and high pressure. In retirement, however, P2 describes a significant shift "Now, there's no need to be anywhere at a specific hour", allowing him the freedom to "enjoy time" without obligations, embracing a slower, more leisurely pace.

Similarly, P3's reflections on travel showcase a transition from adventurous exploration to a more measured approach. "Yes, we like to go every now and then... not just to [their own country] and its surroundings", P3 says with enthusiasm, reflecting a continued desire for exploration. S3 tempers this by acknowledging the growing challenges of travel due to dementia, prompting P3 to reflect and adapt. P3 says, "Occasionally, we go in the region. Not too far away or anything", recognizing the need to adjust their lifestyle due to his progressive condition. P3's narration of travel reflects a change in how they experience time—no longer rushing from one place to another but savoring their journeys at a slower pace, with P3 noting, "If you no longer have to work, you naturally have a lot of free time, so you can easily spread things out".

Additionally, the scope of associations extends beyond reflections on the participants' own lives to include and reflect upon the experiences, milestones, and futures of their children and grandchildren. For example, P5 fondly recalls Christmases spent with his family, "They all come and eat with you, and their children play," highlighting the importance of these gatherings in his life. S5 goes further back in time and adds, "The youngest [kid] has learned the most... he loved making fries and everything", reminiscing about how their children's volunteer work at a local theme park brought joy to the family. As their family grows, these traditions evolve, with S5 finding joy in adapting to the grandchildren's needs. Coming back to the present time, S5 says' "Now we have to adapt everything for the grandkids. It is different and fun again, right? Yes". Then she again goes further back in time and talks of Christmases with P5 from before their marriage and before having kids. This dialogue reflects how family traditions and the experiences of different generations intertwine, creating a rich tapestry of shared memories and evolving practices.

The key life moments spread over time provide a point of reference that anchors participants' narration, reinforcing both the emotional resonance and factual continuity of their shared experiences. As they revisit these personal markers, they trust the markers as signposts, not only in reflecting on the past but also as guiding elements that help shape their present and future interactions.

*4.2.2 Recurring time markers.* In addition to linear markers, all participants anchor their sense of time using recurring cultural events, seasonal rhythms, and weekly routines, which provide structure and continuity on a more granular level.
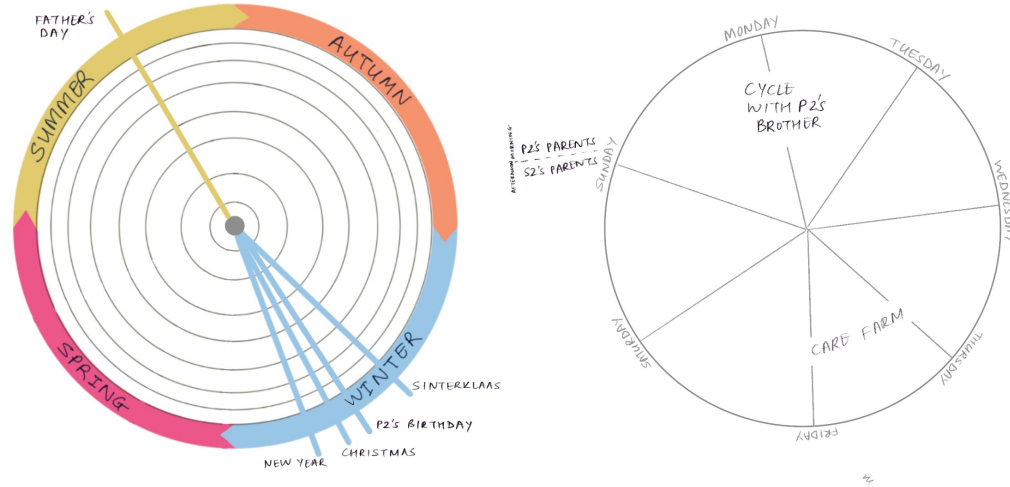
Fig. 5. Temporal granularity experienced by P2 and S2

Weekly routines, for example, offer participants a way to calibrate their temporal experience with regularity. P2 and S2 frequently discuss their regular activities, such as "P2 cycling every Monday with his brother", "P2 visiting the care farm on Thursdays and Fridays" and S2's "weekly bike rides to the nearby village". Figure 5 shows granularities mentioned by P2 and S2 when talking of time and moments. These routines illustrate how the rhythm of recurring activities often takes precedence over specific dates, providing a sense of continuity and structure.

> I am still finalizing how this looks. I might integrate this with the cones.

Cultural markers also play a significant role in structuring participants' time. For example, S5 describes the anticipation of setting up the Christmas tree by saying, "First [St. Nicholas] has to leave… as soon as December 5th has passed, the Christmas decorations will arrive". This statement underscores how precise cultural markers guide their transitions between events. P5 adds, "When all the children and grandchildren are gone, we can put it up", highlighting that social cues tied to cultural events shape a sense of time.

Similarly, annually recurring local events like carnivals provide markers for larger time spans in participants' social circles. For example, S6 says, "In [name of local area] they count like 'that was so many weeks before' and 'that was so many weeks after' carnival." Following this, P6 confirms with S6 that while carnival occurs around autumn or winter, "The fair is usually in summertime, yes?". This demonstrates how cultural events tied to seasonal changes help structure their perception of time over the year. All participants refer to seasons when talking about annual events and tasks. For instance, P6 reminisces about seasonal tasks at her childhood home, such as planting in spring and harvesting in autumn, saying, "Going through spring, autumn, summer, winter… you experience it all automatically". She maintains this connection to the seasons where tasks like "mowing the grass" and "pruning a little" are annual events tied to seasons helping her maintain a sense of continuity. This approach allows participants to grasp the passage of time over longer periods and maintain a sense of continuity across their lives.

> perhaps this can be stronger linked to the main argument you want to make regarding now and future?

*4.2.3  Slipping Through Time.* Most participants demonstrate a strong sense of temporal awareness when navigating different timeframes and organizing moments across various timescales with varying levels of detail. However, there

are instances where this awareness slips, particularly among the participants (all) with dementia, highlighting the complexities involved in managing temporal navigation.

For example, during a conversation about their homes, P6 recalls, "We shortly lived on the waterside... we quickly cycled up the dike and to the water", referring to a memory from childhood. S6 gently corrects him, saying, "But that was at your [childhood] home. I'm talking about our last home from last year". This slip shows how memories from different periods can merge, creating confusion in present recollections.

Similarly, when recalling instances of traveling to distant locations, P3 confidently states, "We do have, erm, we do have a number of long-distance trips. Well, erm, Indonesia. Thailand". S3, however, gently intervenes, shaking her head and correcting him, "No Thai... no Thailand. My son has been there". This moment reveals the nuances of their shared memories, where P3's recollection intertwines with the experiences of their family members, leading to a mix-up in details. In disbelief, P3 says, "She said no?" not realizing the mistake. S3 then turns to the researcher, clarifying with a slight chuckle, "No Thailand, heh."

These examples illustrate that, despite using personal markers as signposts, dementia can disrupt the ability to maintain a clear sense of time, resulting in confusion and a fragmented view that makes it harder for participants to share their personal narratives and grasp their current experiences.

### 4.3 Reflections of the Past Shaping the Present

Participants' narratives reveal how their perceptions and experiences from the past continue to shape and influence their present-day experiences.

*4.3.1 Timeless Themes.* Participants demonstrate a deep connection to certain timeless themes, reliving experiences that reveal their unique perceptions of time and significance.

For P2 and S2, timelessness is embodied in their experiences with water and sun. They describe moments spent by or in the water as though time stands still. P2 and S2 vividly recall childhood memories of experiences near water and jumping off rocks in Spain later in life. They evoke this timelessness through sensory details such as the "scent of the sea", the sensation of "leaping from rocks", the feeling of "levitating while swimming", and the experience of "unwinding while sunbathing". These recollections are filled with a sense of stillness and calm, where time appears to stretch infinitely.

In contrast, timelessness for P5 and S5 is tied to a specific location. When asked where he wants to go, P5 immediately mentions "[Name of the theme park]", to which S5 responds, "We go there every week!". Despite this, P5 maintains that it doesn't matter, underscoring his fondness for the place. This frequent visit to the theme park signifies a constant, enduring significance, offering P5 a unique kind of temporal comfort and continuity. Despite S5's suggestion to consider other meaningful destinations, places from their past, recent enjoyable experiences, and desire to visit some museums, P5's immediate preference for the theme park highlights how certain places can hold a special, unchanging value in one's life.

This contrast illustrates that while P2 and S2 experience timelessness through symbolic moments related to water and sun, P5 and S5 find it in recurring visits to a cherished location. This divergence underscores how different individuals encounter moments where time feels suspended, either through symbolic experiences or through specific, meaningful places.

*4.3.2 Objects as Storytellers.* The responses from participants revealed that objects can act as tangible links, serving as physical embodiments of their past experiences and connecting them with their personal histories.

For S6, travel souvenirs are cherished reminders of past journeys. When asked if they brought back souvenirs from holidays, P6 initially responds, "Well, not really", but S6 quickly counters, "Yes yes yes for sure... under the TV there are a whole load of souvenirs that we brought home from our travels". P6 then recalls specific items, "Yes, little things from New Zealand... Stork egg or an ostrich egg is there, [and] a kiwi". S6 adds, "Miniature Swarovski or stuff like that too". Reflecting on these items, P6 says, "You expect it would be nice to see them... I don't have to worry about them that much... they've been there for so long and I am so used to having them there that I don't actually see them that much anymore". However, P6 acknowledges their sentimental value, "I like that they are beaming with memories... they are nice memories. New Zealand, the US, yeah". Thus, these objects, while becoming a part of the background in daily life, continue to preserve and reflect cherished memories.

Artifacts also serve as tangible carriers of past moments and reminders of special people for participants. S2 illustrates this by pointing to rocks on the table brought back by their children from their first trip together to Spain. "That holiday from those rocks", S2 says, pointing to the rocks on the table, "That only comes to mind when I think of Spain". She emphasizes how these objects are physical links to past experiences, holding stories and emotions that persist through time.

For P2 and S2, their home and the objects offer a tangible connection to their past, reflecting the passage of time across generations. The family home that is passed down through generations, and the artifacts, such as paintings, act as slow carriers of time, linking past and present experiences. These objects encapsulate family history, connecting different generations through shared stories.

Overall, these conversations reveal how objects, from family heirlooms to travel souvenirs, act as tangible links to past experiences. They carry the weight of cherished memories and connect individuals with their histories, preserving stories that may extend beyond the participants' lifetimes.

*4.3.3  Weight of enduring Memories.* Certain memories, particularly those involving significant people or events, hold a timeless quality that continues to influence participants' lives. P2's reflections on his childhood friend and their adventures in the forest highlight how these moments remain vivid and cherished, even as time progresses. On multiple instances, he recalls building huts and spending time in the forest as experiences that stand still in his memory, demonstrating the enduring value of these shared moments.

Similarly, S2 reflects fondly on past family gatherings, such as Christmas with parents, describing it as "a nice time, with the whole family together". The fact that these gatherings are no longer possible with their parents makes the memories even more precious. S2 expresses, "It is mainly memorable because we can't do it anymore with our parents. That makes it so memorable, I remember that fondly". These reflections underscore how past experiences with loved ones create lasting impressions that continue to shape participant's sense of what is meaningful and irreplaceable.

In contrast, P4 reflects on a significant negative memory from the famine of [year], recounting, "A very fundamental memory is the famine from [year]... When I was 9 years old... To [location]... To see if we could get something to eat from the farmers". P4 goes on to describe the specific event in detail. Despite the painful nature of this memory, P4 states, "It's kind of a story... Which no longer affects my emotions... (To me) it is just a story". This illustrates how the emotional impact of memories can diminish over time, shifting from vivid experiences to distant recollections.

Thus, whether joyous or painful, enduring memories shape participants' understanding of what is precious, meaningful, and significant in their lives. These reflections highlight the lasting impact of lived moments and the way they continue to influence individuals' perceptions of their past in the present, and shape actions in the future.

### 4.4 Exploring futures from present realities

Participants' discussions reveal a nuanced approach to the future, blending contentment with their present routines and an openness to exploring new experiences, all while navigating the challenges of dementia. The conversations also highlight how participants recognize and celebrate both small and significant achievements, and adapt to the evolving sense of self that comes with changing circumstances.

*4.4.1 Navigating familiarity and exploration.* Participants show an inclination towards either finding comfort in familiar routines or present a desire to explore existing favorites and new possibilities. This interplay between the known and the unknown reflects how they manage their present while considering the future.

For instance, when asked about her goals, P6 responds, "I wouldn't know what kind of goal, special goal I have". S6 remarks, "You have no ideas, no ideals, no goal to do (for the) upcoming week or month. Just normal. Just normal (and) nothing special." To which P6 agrees, saying, "Normal (is) what I will... what I always do. Normal. Yes. My set routine.. what I always do." This exchange highlights how dementia has shifted P6's focus from actively pursuing new experiences to simply getting through each day, and adapting to changes as they arise. When S6 gently probes further, P6 acknowledges her upcoming visit to the care facility, saying, "I'm going (to the care facility). When that is I don't know. Monday I believe, isn't it?". S6 confirms, and P6 concludes, "Monday to (care facility), and then the rest of the week I'll let that come over me".

A similar sentiment emerges in a conversation between P2 and S2 about upcoming goals. They both agree that they do not have a specific goal. S2 summarises, "No, there is nothing for a goal. Just enjoy the autumn evenings, right... I think that is a good idea. No, we don't have a goal. We did everything, we're ready for the winter". This conversation underscores the couple's contentment with their current state, focusing on simple pleasures like enjoying autumn evenings rather than seeking out new experiences.

In contrast, P5 and S5 exhibit a proactive approach to life, embracing new activities. During a conversation about past visits to [location], S5 says, "We have not been there either. I don't know what we have done in [location]", prompting the researcher to suggest planning a visit the following weekend. Looking at P5, S5 enthusiastically says, "Yes, yes, we can do that... those cards (cards with a subscription for train travel and museum entry) also expire and we really need to do that", and P5 agrees saying, "Alright". Their shared willingness about the opportunity reflects their openness to new adventures. Later, a discussion about an upcoming family reunion sparks S5's memory of an invitation, and when she asks P5 if he wants to attend, he immediately agrees. As they talk about who they might see and what they might do at the event, it further highlights their proactive mindset and willingness to plan and embrace new experiences together.

These varied approaches, whether through exploring new places or embracing the mundane, demonstrate how participants and their partners navigate the future through routines and aspirations.

*4.4.2 Celebrating wins.* Participants' conversations reveal that the perception of accomplishments can vary, especially in the context of dementia. While small, everyday tasks may not always be seen as significant victories, they are still important to recognize and validate. Similarly, long-term achievements tied to personal identity provide a profound sense of fulfillment and purpose.

A conversation between S5 and P5 illustrates this variability in how accomplishments are perceived. S5 prompts P5 to reflect on a recent small victory, asking, "Yesterday we went to the musical. Was that a victory?" P5, uncertain, responds, "Yes, I don't know that". S5 then mentions their Christmas decorating efforts, highlighting P5's contribution, "You helped me with carrying the boxes up and down. Was that a victory?" P5 replies, "No, actually not", and S5 says,

"Actually not, right?" This dialogue shows how everyday tasks, which might be seen as small victories by one person, may not be perceived as such by another. S5's attempts to identify and celebrate these small achievements reflect a supportive approach, aiming to validate and appreciate P5's contributions, even as P5 may not see them as significant. This conversation underscores the varying perceptions of what constitutes an accomplishment and the importance of recognizing and validating each other's efforts.

A similar theme of accomplishment is explored in a conversation between P2 and S2. When prompted by S2, P2 initially struggles to identify what makes him feel proud, "No, I have nothing", he says. However, P2 later recalls, "The renovation, I renovated", and S2 replies, "Yes, renovating this house... that's a very good one". S2 further suggests crossbow shooting as another achievement, "That was something you did very well. You won prizes with it. Are you proud of that? No? Okay". S2 is surprised and curious to which P2 responds, "(I) was busy with it for a long time". S2 emphasizes the value of the renovation, noting, "It is a part of ourselves... Something you made out of your own hands", highlighting the personal significance of long-term dedication. P2's ongoing engagement in activities like arts and crafts and crossbow shooting continues to provide him with a sense of purpose and joy, illustrating how meaningful achievements are often rooted in long-term dedication and the personal connections built through them.

These conversations highlight the importance of celebrating achievements, whether small or significant and the supportive role that partners play in fostering a positive and affirming environment.

*4.4.3 Adapting to Changing Self.* Participants with dementia reflect on the changes they experience in themselves as their condition progresses, highlighting the impact on their present and future outlooks.

Reflecting on the time when he first noticed something was wrong, P3 describes the progression of dementia, acknowledging his current state with a mix of optimism and concern, "It's not that serious yet, but... (it is changing) quickly, and (it is) a bit unnerving". Despite his efforts to cope, he confesses, "It really keeps me awake at night, but there is something there... That is sitting and nibbling". However, P3 remains hopeful, stating, "Luckily it's still small scale. And I, of course, hope... that stays like this for a while". This dialogue illustrates his ongoing adaptation to change, the uncertainties he faces, and his attempts to find stability.

Similarly, P6 navigates the challenge of maintaining a connection with her past self as her memory fades. She notes, "Memories are starting to become less [clear]" and observes that specific details are disappearing linking it to her future, "The exact memories of the things you did there will disappear." She further links it to losing the emotional intensity of those past experiences, remarking, "The feeling... will also disappear further". She explains that the vividness of past experiences is diminishing, stating, "What I had then and only then had I been there. But no, that has moved on, that is all disappearing again". Despite this, P6 retains a general sense of enjoyment and value from past experiences, "I do remember that it was all a lot of fun and a very yes, quite an experience, of course, to make such a trip". However, she acknowledges the difficulty in fully reconnecting with those past emotions, "But to really go all the way back? I can no longer achieve that. No, that is no longer possible".

These reflections underscore the ongoing process of adapting to change and the challenge of maintaining a vivid sense of self in the face of evolving conditions.

I feel the time cones should be introduced here as a way to make sense of the data visually. Then the examples from the themes above can be interlinked to argue why the visualisation makes sense. The themes are actually very strong already, and I feel they really have achieved a level of depth that contributes new insights.

## 5 Discussion

The findings from the Temporal Snapshots probe contribute to the understanding of subjective time in dementia by exploring how individuals with dementia and their partners discuss and experience both past and future moments. By unpacking these shared narratives, we emphasize the need to expand reminiscence practices and address temporal neglect to improve the design of technologies for people with dementia. We will also explore the potential of the Temporal Snapshots probe and Life Continuum Cones used in the study in fostering reflections across the entire temporal spectrum, offering practical insights and considerations for the development of temporal-aware technologies.

### 5.1 Expanding the scope of reminiscence

Participants' interactions with the Temporal Snapshots probe revealed that they think and talk about past, present, and future in an integrated manner. Their reflections span the entire temporal spectrum, extending beyond their own lifetimes to include thoughts about preceding and succeeding generations, reflecting on the lives of their parents and the anticipated experiences of their children and grandchildren. This emphasizes that while the capacity of people with dementia to think about the future may be diminished, it is not entirely lost [15]. Futures remain important to people with dementia, just as they do for others.

However, existing research methods often focus narrowly on the past, contributing to temporal neglect by overlooking the broader temporal landscape. While strategies like reminiscence therapy, which largely emphasize past experiences, have been effective in reinforcing identity and well-being [7, 54, 69], they limit the opportunity for future engagement in people with dementia. Additionally, a sole focus on past-oriented reminiscence can result in interpretations that underestimate individuals' ability to envision the future. To address these issues, it is essential to broaden reminiscence therapy to include reflections on the future as well as the past, and to extend the timeline beyond an individual's lifetime to encompass generations.

The Temporal Snapshots probe revealed that when participants spoke about the future, they articulated desires by exploring possibilities from their past and present interests, social connections, and routines. Although these discussions were often accompanied by self-awareness or reminders from their spouses about the diminishing capacities caused by dementia, they nonetheless showed a continued capacity for imagining possibilities. Interacting with the Temporal Snapshots probe allowed participants to explore possibilities in a way that was meaningful and connected to their ongoing lives. Moreover, while the fast pace of daily life often detracts from full engagement with the present [24], dementia can create an opportunity to slow down, heightening participants' awareness of everyday joys that might otherwise go unnoticed. Amid the uncertainties of dementia, familiar routines and mundane activities provided comfort and stability. Ritualistic practices, which link past, present, and future, gave participants a sense of structure and continuity in their lives, helping them maintain stability during difficult times [24].

This connection between past, present, and future was also evident in the way couples reflected on what brought them fulfillment. They jointly constructed possible futures informed by both past experiences and present realities, showing that reminiscing about the future naturally emerges as an extension of reflecting on the past and engaging with the present [70]. As individuals grow and change, their desires and emotional states shift, highlighting the importance of prioritizing present experiences over past aspirations [26]. Participants often discussed cherished memories with great detail, particularly those involving loved ones who had passed away, underscoring the deep emotional connections they still held. Objects tied to loved ones and special places became tangible embodiments of these memories, transforming

over time into heirlooms that served as bridges to the past. These objects acted as catalysts for memory, evoking associations and preserving the essence of meaningful relationships and experiences.

Ultimately, these cherished objects and vivid recollections not only preserve the past for participants but also enrich their present, providing a continuous thread that links their current selves with the people and moments that have profoundly influenced their lives. Memory, after all, is a constructive process, involving the reconstruction of past experiences rather than the retrieval of exact copies [38]. The intentional design of cues can enhance this process by facilitating the triggering of specific memories [58, 65]. By addressing temporal neglect and designing prompts that encourage reflection on both the past and future, a more holistic experience can be created, allowing individuals to engage with the full temporal spectrum of their lives.

### 5.2 Addressing 'Temporal Neglect' in design and research

A comprehensive approach that includes the full temporal spectrum-where futures are given equal importance as the past—is required for people with dementia. Overcoming the temporal neglect by incorporating opportunities for reminiscing about the future, alongside the past, can further enrich their lives. The Temporal Snapshots probe has shown potential in expanding the scope of reminiscence by encouraging individuals to reflect on and intertwine diverse narratives that connect people, places, time, objects, and emotions [63]. By prompting participants to delve into these interconnections, the probe facilitates a rich exploration of personal timelines, moving beyond past-focused reminiscence.

This reflective process not only deepens individual understanding but also enhances social interactions. The prompts from the Temporal Snapshots probe inspire both individual and collective sharing of narratives, fostering a collaborative environment where social bonds are strengthened through the exchange of personal stories and associations. In this way, the probe enhances the social dimension of reminiscence, transforming it into a socially rewarding and emotionally fulfilling experience. Even when confabulations or factual discrepancies arise, these do not detract from the value of the process; rather, they open up opportunities for discussion and further exploration, enriching the overall reminiscence experience. As such, the Temporal Snapshots probe broadens the scope of reminiscence, allowing individuals to connect with their past in meaningful ways while simultaneously strengthening their social connections in the present and enhancing their engagement with the future.

To further address temporal neglect in design and research, it is crucial to design prompts, technologies, and interventions that resonate not only with individuals' pasts but also with their present and future. A deeper understanding of personal life stories and the contexts that shape them is essential to achieving this goal. The Life Continuum Cones offers a starting step in this direction by making individual narratives visible and tangible. Inspired by future cone designs [25], which are effective in identifying trends and desires [3, 5, 67], the Life Continuum Cones contextualize key moments within personal narratives and preferences, integrating both linear and circular notions of time. This reflects the dynamic and non-linear ways humans experience time in daily life.

### 5.3 Limitations and Future Work

Addressing temporal neglect through novel design and research approaches, can allow for creating more inclusive and meaningful experiences for people with dementia, helping them engage with the full temporal spectrum of their lives. By integrating past reflections with future speculation, the Life Continuum Cones represent a start towards bridging the gap left by past-focused research, offering a more holistic approach to dementia care and design. However, further work is needed to refine and expand these tools, particularly in visualizing subjective experiences of time and making

personal narratives more visible. Currently, the Temporal Snapshots probe gathers narratives and associations from both individuals with dementia and their partners, while the Life Continuum Cones present a collective visualization of their shared experiences. Future efforts should aim to design probes and visualizations that not only capture collective narratives but also highlight the unique perspectives and stories of each person involved.

### 5.4 Implications for design

To effectively address temporal neglect in dementia care, it is essential to incorporate a more comprehensive temporal perspective. For this, we propose the following actionable steps as a starting point:

*5.4.1 Foster Reflection.* Reflecting on past experiences involves more than recalling specific moments; it is about understanding their significance and integrating them into one's life narrative. In addition to individual association, our results underscore the value of collective reflection by the couple. When individuals with dementia and their partners engage in shared reflection, they re-live past moments and create new, meaningful interactions in the present. This collaborative process not only enriches current experiences but also weaves individual stories into a shared narrative, enhancing relational bonds. To support this, technology needs to facilitate both personal and shared reminiscence, adapting dynamically to user needs. Additionally, incorporating human intelligence through the active involvement of partners can prevent the technology from becoming burdensome for people with dementia. The resulting interactions can help foster a coherent narrative and improve the quality of life for both individuals with dementia and their partners.

*5.4.2 Inspire Imagination.* Leveraging reminiscence to inspire future-oriented thinking is crucial for maintaining wellbeing and a sense of purpose. This requires assisting individuals to connect their past interests and achievements with future goals to spark imagination and explore new possibilities. The design of responsive technology design can help supporting this imaginative process by providing meaningful prompts, interactive experiences and narration opportunities. Unlike rigid tools such as traditional alarm clocks or calendar apps, technology needs to offer flexibility, allowing users to choose how they engage with time in the present and future. A well-designed approach can help balance personalized cues with opportunities for creative exploration in technology interaction. Drawing on strategies from peripheral interaction design can help create subtle, supportive cues that inspire and engage users, helping individuals with dementia envision and shape their futures while integrating their reflections into their current lives. Bakker et al

*5.4.3 (Re)create Memories.* Memories are dynamic and ever-evolving. Encouraging individuals to relive and reshape past events can allow for integrating these experiences into their present lives in empowering ways. This process can not only help in creating new memories but also enhance continuity and coherence in their personal narratives. Technology needs to embrace the fluid nature of memory rather than seeking a fixed, objective truth. Instead of focusing on the accuracy of details—such as confirming the specifics of a photograph—technology needs to evoke personal experiences, making room for diverse narratives. By focusing on facilitating individual experiences and interactions, technology can align more closely with the fluid nature of memory, providing meaningful engagement that respects what are believed to be personal and subjective truths.

*5.4.4 Etch the present.* Capturing and cherishing the present moment is essential, especially when interacting with individuals with dementia. The documentation of current experiences, emotions, and small joys through methods like journaling, visual reminders, or engaging in meaningful activities needs to be emphasized to help anchor the experience in the present. This approach, which we might call "share-flection", contrasts with traditional retrospective reminiscence by focusing on actively creating and documenting present experiences. Integrating such practices with

strategies for fostering reflection, inspiring imagination, and recreating memories offers a more holistic approach to engaging with time. Addressing temporal neglect in this way not only enhances the well-being of individuals with dementia but also enriches their navigation of the past, present, and future, fostering greater fulfilment.

## 6 Conclusion

In this paper, we present findings from a field study exploring how people with dementia experience time using the *Temporal Snapshots* probe. Our study contributes to the existing literature by demonstrating how engaging with subjective temporal experiences can enrich the lives of individuals with dementia. By employing image prompts and reflective questions, we facilitated meaningful interactions that blurred the boundaries between past and future, providing a deeper understanding of participants' lived experiences. The findings highlight the potential for designing assistive technologies that go beyond conventional time constructs, such as clocks and calendars. Through *Life Continuum Cones*, we propose a visual framework to unpack the subjective time of individuals that can inspire the design of personalized and intuitive interactions, ultimately enhancing the well-being of people with dementia. This study underscores the need for a pluralistic approach to time-related interactions in HCI, emphasizing the importance of integrating subjective experiences of time into the design of technological interventions. The results of this study could potentially be applied to people with other disabilities who also struggle with conventional temporal constructs in daily life. However, more research is needed to build on these exploratory findings and to further investigate how subjective temporal experiences can be used to develop more effective and empathetic assistive technologies. Future work should continue to explore the potential of temporal reflections in dementia care, involving both people with dementia and their caregivers in the design process. With this work, we aim to inspire future design research that prioritizes the subjective lived experiences of individuals, ultimately improving their quality of life and providing more comprehensive support.

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