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INTRODUCTION AND AIMS

In daily life, people are faced with a rich and continuous flow of events and experiences. Episodic memory does not retain a literal and complete record of this flow of information, but instead maintains summary representations of past experience (Conway, 2009). While recent research provides initial evidence that past experience is temporally compressed in episodic memory (Bonasia, Blommestein, & Moscovitch, 2016 ; Furman et al., 2007), the characteristics and determinants of this compression remain largely unexplored.

The **aims of this study** were:

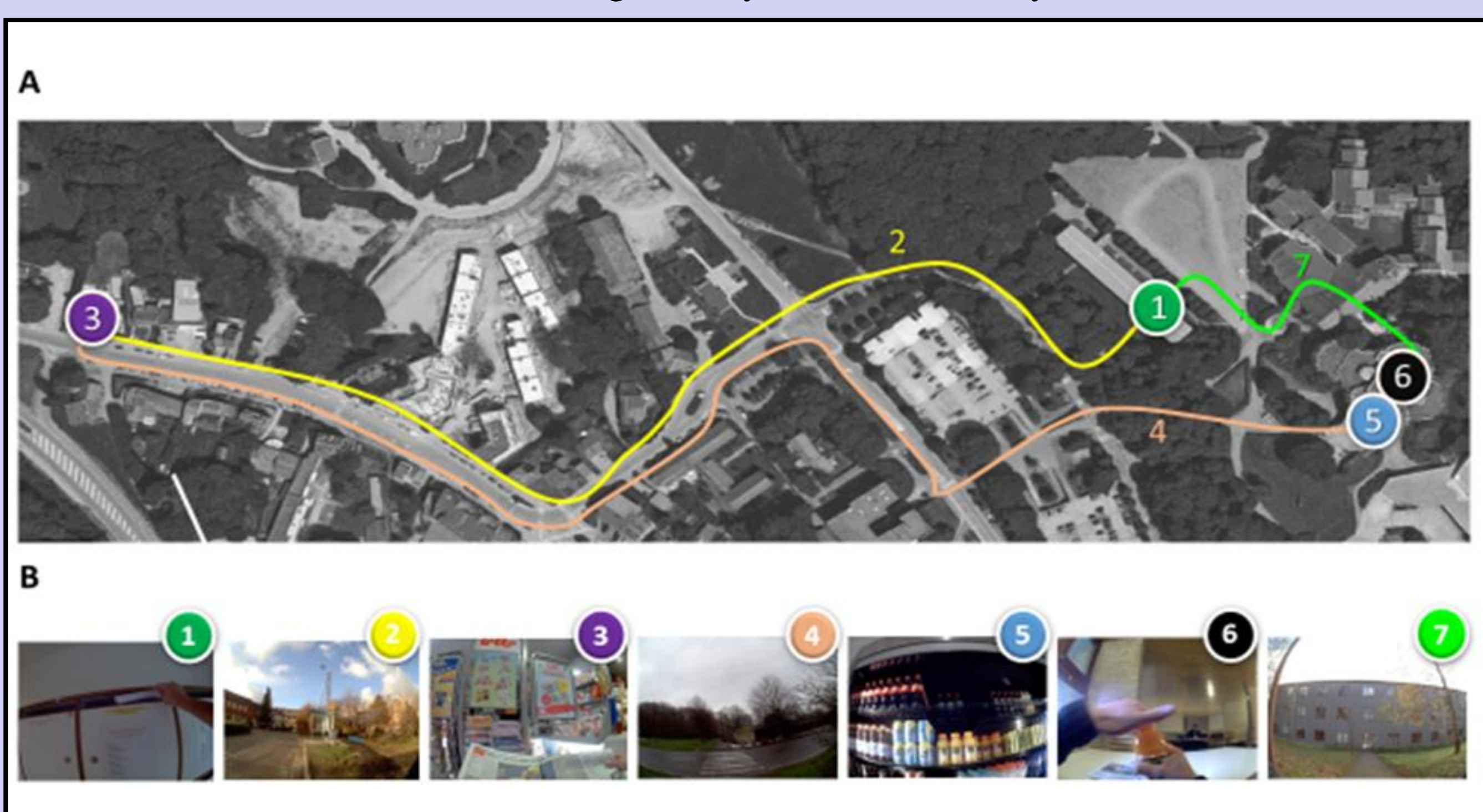
- To provide an estimation of the temporal compression of real-life events in episodic memory.
- To determine whether the rate of temporal compression in episodic memory is constant or whether it varies as a function of goal processing and changes in perceptual experience.
- To examine what components of experience are preferentially retained in episodic memory.
- To investigate time-dependent changes in the content and temporal compression of episodic memories.

To address these questions, we investigated memory for previously performed activities at different locations on the campus of the University of Liège while participants were wearing a lifelogging device (i.e. an *Autographer*).

METHOD

Walk on the campus phase

32 participants were selected in each delay condition (*immediate, 24-h, 1-week* and *1-month*), resulting in a total of **128 participants** aged between 18 and 31 years (74 females; mean age = 23 years, SD = 2.50 years).



Participants performed a walk on the campus of the University of Liège. (A) Locations in which activities were performed (color circles) and paths taken to go to these locations (color lines). (B) Examples of pictures taken by the Autographer during the different activities and paths of the walk.

Retention Intervals

None
24-h
1-week
or
1-month

Retrieval phase

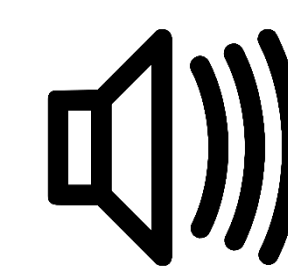


Free recall of every element of the walk on the campus

« ...I opened the door... »



The verbal descriptions recorded during the free recall task consisted of a succession of moments of experience or "experience units", each corresponding to a particular moment of experience during the walk.



« I opened the door »

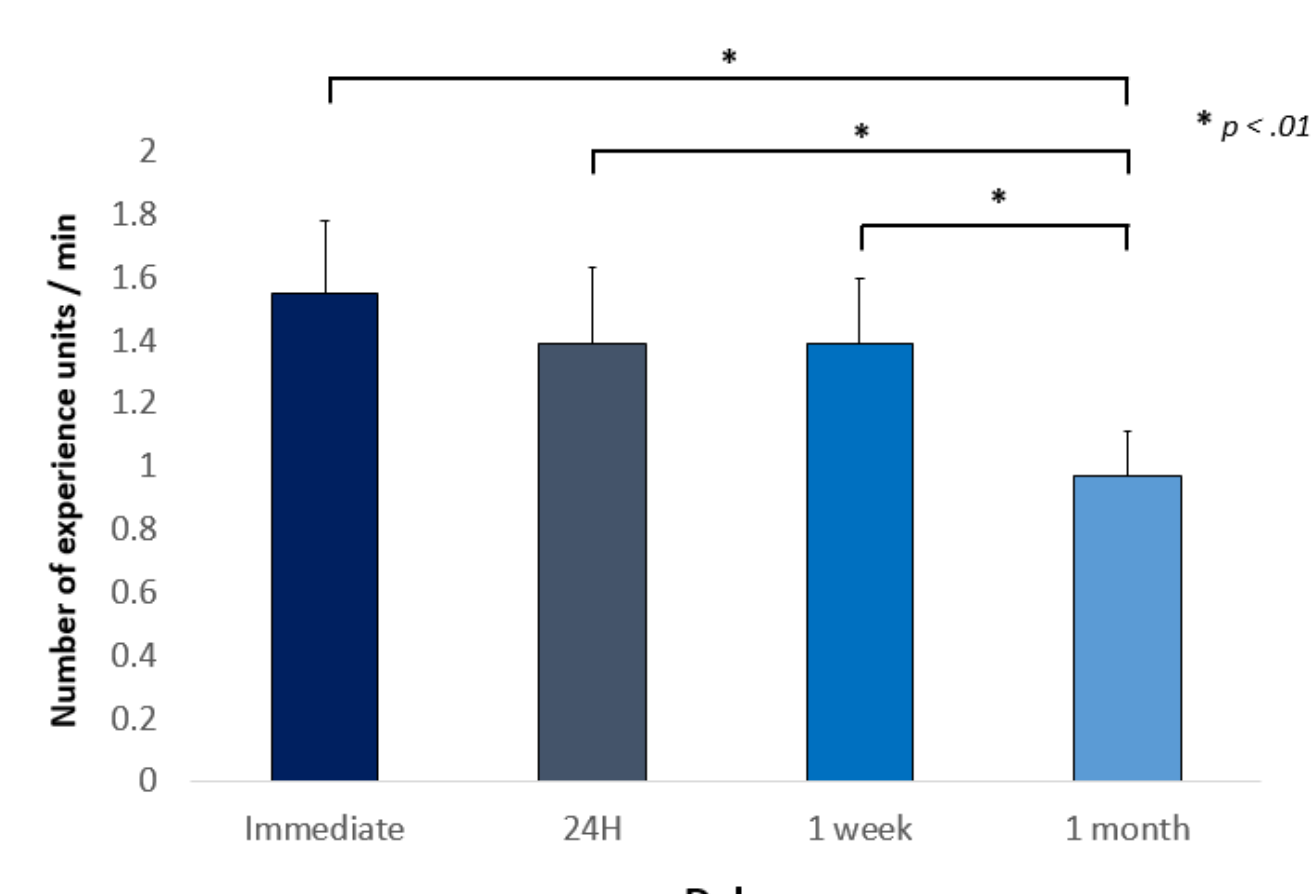


While playing back the audio recording, these experience units were considered one at a time and, for each unit, participants had to select the picture that best corresponded to their mental representation of this moment of experience while they attempted to remember the walk.

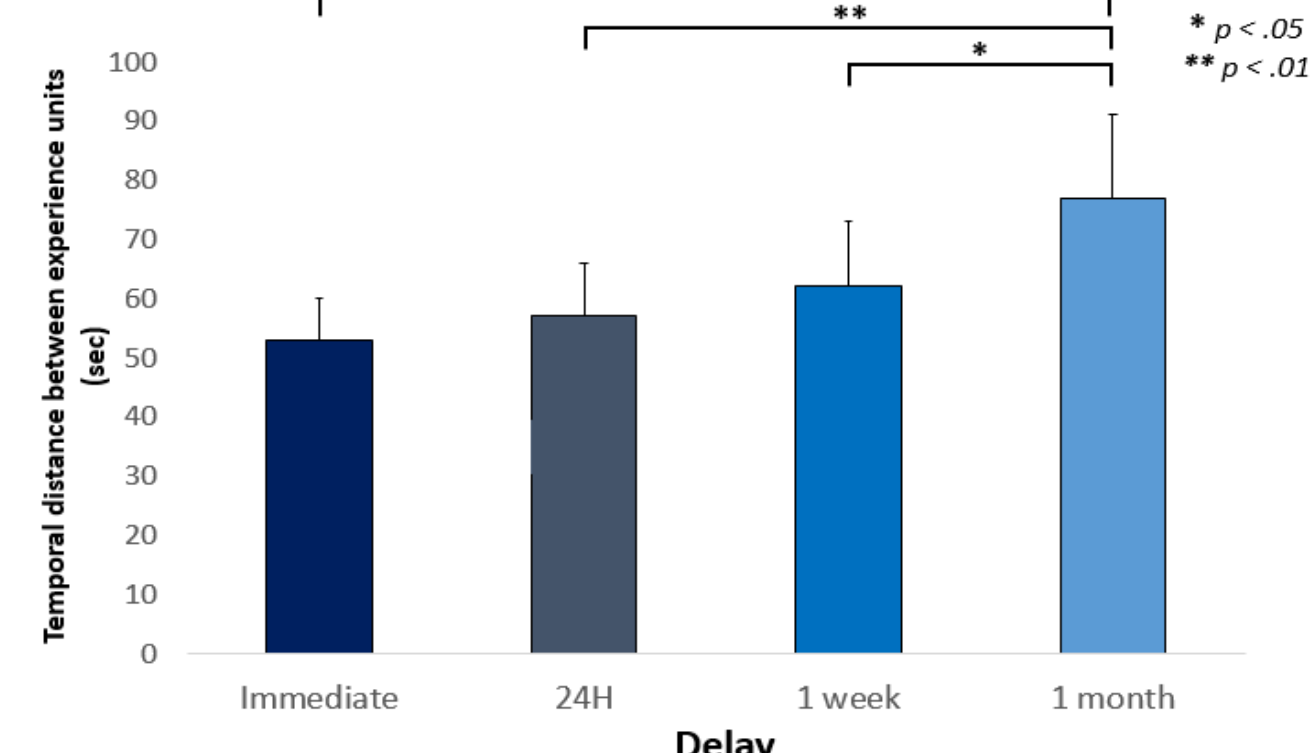
RESULTS

Temporal compression in episodic memory

Two indices of temporal compression were computed: the **number of experience units reported at recall per unit of time** of the actual events and the **time separating successive units of experience reported at recall**.



Main effect of delays
 $F(3, 124) = 5.58$
 $p = .001, \eta_p^2 = .12$

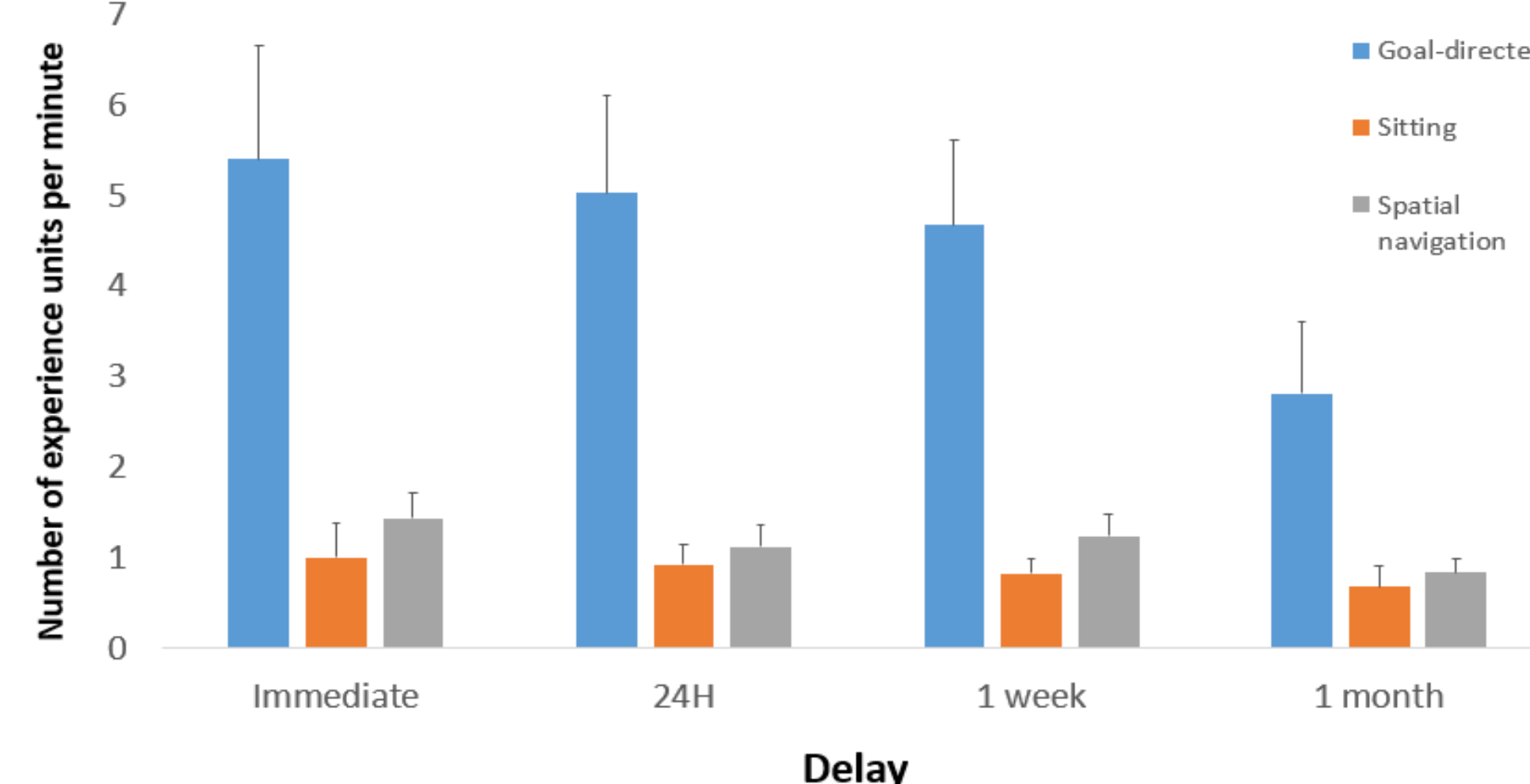


Main effect of delays
 $F(3, 124) = 4.12$
 $p = .008, \eta_p^2 = .09$

Influence of the characteristics of remembered events on compression rates in episodic memory

Temporal compression rates as a function of three kinds of segments of the walk:

- Goal-directed segments:** involved goal-directed actions while spatial location remained relatively stable (i.e., *buying the newspaper at the newsstand*).
- Spatial navigation segments:** involved changes in spatial location with no particular action to perform other than walking (i.e., *going from one building to another*).
- Sitting segment:** involved no particular action and no change in spatial location (i.e., *sitting at the table in the cafeteria*).

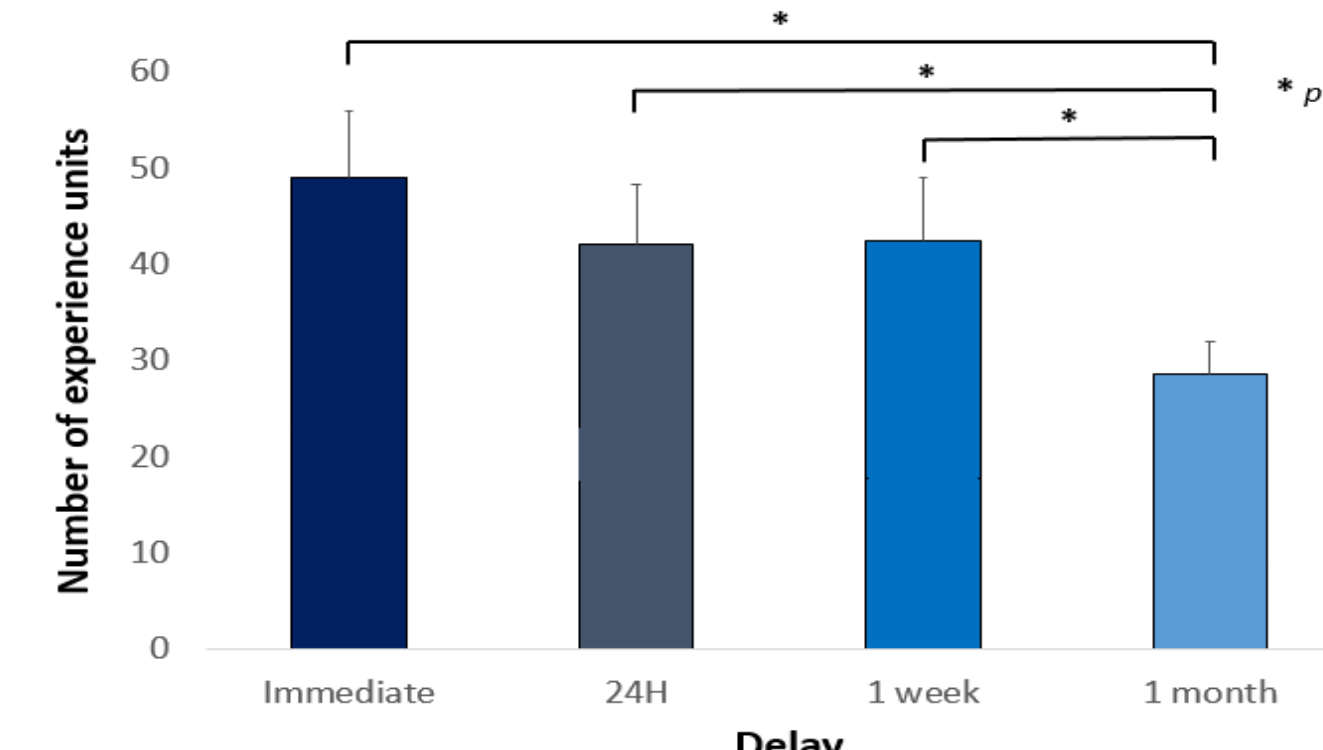


A Mixed ANOVA
4 (Delays) X 3 (Type of segments)

Main effect of delays	Main effect of type of segments	Interaction
$F(3, 124) = 5.94$ $p < .001, \eta_p^2 = .13$	$F(2, 248) = 213.06$ $p < .001, \eta_p^2 = .63$	$F(6, 248) = 4.16$ $p < .001, \eta_p^2 = .09$
Immediate > 1-month $p < .001$ 1-week > 1-month $p = .012$	Goal-directed actions V Spatial navigation V Sitting (all $ps < .05$)	Goal-directed segments One month < other delays (immediate, 24-h, and 1-week; all $ps < .01$)

Components of experience retained in episodic memory

To determine the impact of retention delay on the content of episodic memory, we computed the **mean number of experience units** reported in the four delay conditions. We also sought to determine **what components of experience are preferentially retained** in episodic memory. Therefore, we computed the mean frequency of different categories of components constituting experience units in the four delay conditions.



Main effect of delays
 $F(3, 124) = 8.80$
 $p < .001, \eta_p^2 = .18$

	Immediate		24H		1 week		1 month	
	M	95% CI	M	95% CI	M	95% CI	M	95% CI
People	0.16	[0.13, 0.19]	0.17	[0.12, 0.22]	0.15	[0.12, 0.19]	0.10	[0.07, 0.12]
Object	0.32	[0.29, 0.36]	0.34	[0.30, 0.39]	0.36	[0.32, 0.39]	0.32	[0.28, 0.36]
Thoughts	0.18	[0.12, 0.24]	0.14	[0.11, 0.17]	0.13	[0.10, 0.16]	0.11	[0.07, 0.15]
Actions with interaction	0.26	[0.23, 0.29]	0.26	[0.24, 0.29]	0.26	[0.22, 0.29]	0.24	[0.21, 0.28]
Spatial navigation	0.54	[0.51, 0.57]	0.51	[0.46, 0.55]	0.55	[0.52, 0.59]	0.59	[0.54, 0.64]

A Mixed ANOVA
4 (Delays) X 5 (Type of component)

Main effect of type of component
 $F(4, 496) = 289.40, p < .001, \eta_p^2 = .70$

Spatial navigation > objects > actions with interaction > thoughts = people

DISCUSSION

Episodic memory would not be functional if remembering an event took as much time as the original experience. A fundamental question, therefore, is: how are events summarized in episodic memory?

- The present study shows that, while the ongoing experience of real-life events involves a continuous flow of information, **memories for such events consist of a succession of psychological moments that reconstruct prior experience in a temporally compressed way**.
- The rate of temporal compression in episodic memory depends on the nature of remembered events, such that the **amount of information that is retained is particularly modulated by goal-directed actions but also by changes in perceptual experience**.
- Moments of experience that constituted episodic memories were themselves **composed of multiple components** representing diverse aspects of prior experience and occurring at different frequencies.
- The density of retrieved moments of past experience **remains relatively stable over one week and then decreases at a one-month delay**, particularly for goal-directed events.



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