The temporal compression of continuous events in memory

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INTRODUCTION

Remembering the unfolding of past episodes usually takes less time than their actual duration.

Such **temporal compression** could emerge because of **working memory capacity limit in representing continuous events** during perception: when a too long period of time elapses without any significant change, the unfolding of the event could only be partially encoded in episodic memory (Leroy et al., 2023).

Our aim was to determine the duration above which continuous events starts to be compressed in mind.

- Research on temporal cognition suggests that the "subjective present" lasts about 3 s, which corresponds to the elementary units (i.e., temporal perceptual basic units) of the flow of consciousness (Wittmann, 2016).
- Beyond this time period, the maintenance of information in the field of consciousness would rely on working memory (Wittmann, 2016).
- In working memory, information is subject to a **temporal decay** as soon as it leaves the attentional focus (Barrouillet et al., 2004).

We therefore hypothesized that:

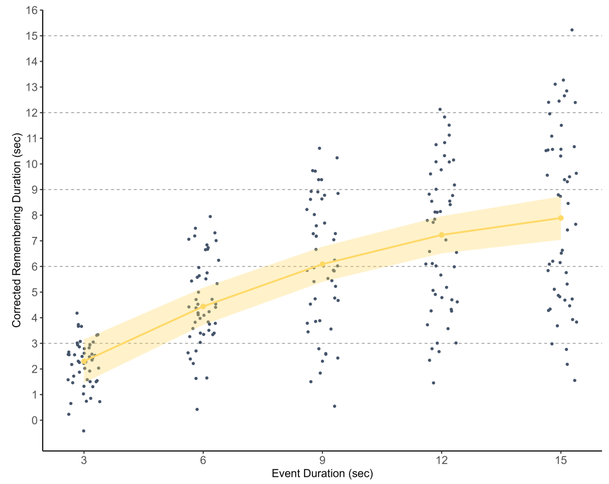
- Remembering duration may become shorter than the actual event duration (**temporal compression emerges**) for **events longer than 3 s.**
- Remembering duration may **still increase** with event duration, but this increase should be reduced when events become longer (due to the growing impact of temporal decay).

Pre-registration

osf.io/uzx8v

RESULTS

Figure 1. *Evolution of CRD as a function of event duration*



Note. Observed values (dark-blue dots) with model estimates and their 95% CIs (yellow dots and the ribbon surrounding them).

CRD increased with event duration
(linear term: b = 4.41, 95% CI [3.64, 5.19], $t(247) = 11.17$, $p < .001$)

but not proportionally
(quadratic term: b = -0.93, 95% CI [-1.15, -0.70], $t(247) = -8.05$, $p < .001$)

CRD was close to the actual stimuli duration for 3-s events (Figure 1, Table 1)

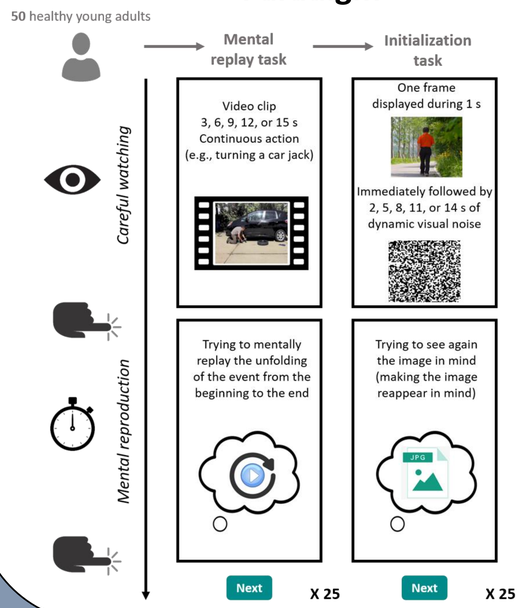
but significantly shorter for longer events (Figure 1, Table 1)

Table 1. *Estimated CRD across event durations*

Duration	Estimate	*SE*	95% CI
3	2.3	0.43	[1.46, 3.15]
6	4.44	0.37	[3.72, 5.17]
9	6.09	0.35	[5.40, 6.77]
12	7.23	0.37	[6.51, 7.96]
15	7.89	0.43	[7.04, 8.73]

METHOD

Paradigm



Analyses

Corrected remembering duration (CRD):
index taking into account the time needed to initiate remembering (i.e., to mentally visualize the starting point of events):

	Event Duration	Remembering duration	Initialization time	CRD
Participant 1	3	A	F	A – F
	6	B	G	B – G
	9	C	H	C - H
	12	D	I	D – I
	15	E	J	E - J

Growth Curve Analysis (Mirman, 2014):

Robust linear mixed-effects model (Koller, 2016) with CRD as outcome and a first and second order polynomial transformation of event duration as predictors.

Model formula:

CRD ~ (poly1 + poly2) + (1 + poly1 + poly2 || Participant_ID)

DISCUSSION

In the absence of meaningful change, events started to be temporally compressed when they exceeded 3 s.

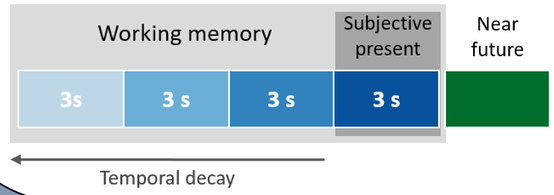
These results suggest that working memory is limited in its capacity to represent continuous events, leading to the **emergence of temporal compression when events exceed 3 s**.

Temporal compression of episodic memories could be a by-product of this temporal limit (i.e., resulting from the **partial encoding of continuous events longer than 3 s**).

CRD increased with event duration but this increase was reduced for longer events (e.g., the difference between the actual event duration and the CRD was be greater for 12-s videos compared to 6-s videos).

This **higher temporal compression for longer events** could reflect **working memory decay speed/forgetting rate** for basic temporal perceptual units: at the time of mental replay, for 6-s videos, the first basic perceptual unit (the first 3 s) only suffered from decay for 3 s, whereas in the case of 12-s events, the first perceptual unit suffered from decay for 9 s, the second one for 6 s, and so on (see Figure 2).

Figure 2.
Hypothesized temporal decay of event representations in working memory



Note. During online perception, new incoming information continuously needs to be processed, and basic 3-s perceptual units follow each other in an uninterrupted way. At any time, a new perceptual unit starts to occupy attentional focus and another starts to decay. As soon as information leaves the 3-s window of consciousness (i.e., subjective present), its working memory trace start to decay (unless attention is shifted from the new incoming information to it).

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