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## Why life speeds up: Chunking and the passage of autobiographical time

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### ABSTRACT

Time seems to speed up as one ages, and it affects how people find meaning in life and plan their future. What creates this perception? We examine the role of “chunking” – mentally bundling individual moments of experience under broad categories. With age, people group experiences into progressively bigger chunks (e.g., *work, family*). Consequently, fewer things seem to have occurred in a given period, so it seems to have passed faster in retrospect. Supporting this account, three studies (overall  $N = 324$ ) show that people led to chunk (vs. not chunk) their past year perceived it as passing faster. The effect of chunking emerged reliably across converging operations and specifically accelerated the chunked period, not other periods. Furthermore, chunking increased the appeal of nostalgia, suggesting that processes that accelerate time instigate a compensatory urge to reflect on momentous occasions of one’s life. Implications for the “self across time” are discussed.

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Self; time; nostalgia;  
meaning; routine

Each year seems to pass faster than the one before.  
I cannot believe I’ve worked here 10 years already.  
This semester flew by much too quickly.  
Where did this summer go?  
Life is passing me by.

Like a ball rolling down a hill, time often seems to pick up momentum, going faster and faster as we get older. As children and adolescents, a summer or school year stretched on for eternity. Now, in adult life, six weeks fly by almost unnoticed, and we are astonished how quickly the years have passed. These are not trivial perceptions. The way people experience the passage of time is bound up with their sense of life’s meaning, and the perception that time is rapidly slipping away has repercussions for goal engagement and life satisfaction, among other outcomes. What causes this phenomenon? Although temporal perception relies on many cognitive and affective processes, one process – termed “chunking” – may play a decisive role in the subjective acceleration of autobiographical time. This article reports initial experimental tests of this possibility.

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## Life speeds up, and it matters

Across the globe, adults from all walks of life perceive their time as passing faster than it once did (Friedman & Janssen, 2010; Janssen, Naka, & Friedman, 2013; Wittmann & Lehnoff, 2005). For example, compared to adolescents and young adults, middle-aged adults reported that their last 10 years passed more quickly. This perception matters for several reasons. For one, people are motivated to believe that their lives are meaningful and that they have, or eventually will, contribute something of lasting worth to society (Arndt, 2012). Threats to these beliefs elicit anxiety. The perception that life is flying by makes it difficult to regard oneself as a significant contributor to a meaningful cultural drama. It also raises the specter of one's inevitable death, further shaking faith in life's lasting value.

Temporal perception also impacts self-regulation. People's choice of which goals to pursue depends on a subjective sense of how much time they have left and what they can feasibly accomplish within that span. Events that shorten future temporal perspective – which include illness, unemployment, and relocation – change how people of all ages choose to spend their time (Carstensen, 2006). Rather than invest in long-term plans that span many years, they focus on the immediate rewards of close friends and family. One implication is that life's quickening pace may decrease investment in goals that take many years to achieve, such as professional training or starting a family.

Explaining why life appears to speed up may thus help illuminate the self's nature and functioning. Of course, this perception is likely to be multiply determined, so it is worth mentioning some contributing factors before presenting the current account. One is the decreasing value of a given interval of time in the context of one's entire lifetime. For a ten-year-old, a year is one-tenth of her life, but for a seventy-year-old it is a mere seventieth. Perhaps this smaller ratio equates to less value, and the less relative value attached to a given interval, the faster it seems to have passed by (see James, 1890, who built on Janet, 1877).

Another factor is the fear of death. Elderly individuals with high death anxiety have a more pronounced sense of time slipping away (Quinn & Reznikoff, 1985). Yet this does not account for the fact that time speeds up most in mid-adulthood, and not in later phases of life when the anticipation of life's end would seem to be more salient (Wittmann & Lehnoff, 2005).

Also relevant are feelings of control over patterns and cycles in everyday routines. According to self-determination theory (Deci & Ryan, 2000), people are motivated to explore their environment, master new challenges, and integrate those experiences with a core sense of who they are. However, when social situations thwart those tendencies, people see their actions as less self-determined, controlled instead by external forces. It is possible that when people are younger, the social environment better promotes their self-determined action. They view their activities as originating more in their own authentic desires. As the years and responsibilities add up, they view their actions as increasingly controlled by external demands. Running frantically on the hamster wheel of commitments and deadlines, sped up by technological and organizational advances, their time is consumed by tasks they *must* do. Because time is not "their own," they feel as though they "have no time" (Rosa, 2013; Wittmann, 2016).

Although these (and other) factors deserve attention, the purpose of the current research is to gain a better understanding of "chunking" and its influence on autobiographical time perception.

## Chunking autobiographical time

The philosopher Douglas Hofstadter (2001) speculated that the acceleration of time is the result of a lifelong process of chunking – packaging “small” experiences into bigger units (see also Draaisma, 2001; James, 1890; Wittmann, 2016). Our subjective experience unfolds continuously from moment to moment, but that is not how we organize autobiographical memory. Instead, we bundle individual moments of lived experience into categories. For example, a person looking back on an afternoon consumed with going to the market, the post office, and the bank might compress this multiplicity of actions and events into one generic chunk: *Errands*.

In the early phases of life, we had yet to accumulate many chunks, or schematic categories, so we experienced moments more completely. Every day offered novel, rich experiences: the first family vacation, the first move to a new house, the first encounter with a scary dog, and so on. Looking back, those periods seem *full* – many things stand out in memory as happening – and thus long. Later in adulthood, as we learn about the world and ourselves, we organize time using more – and more general – chunks: *work, chores, family, entertainment, sleep (repeat)*. We lump more and more moments under these chunks, so that few truly new things happen that demand a separate slot in memory. This has the benefit of conserving mental energy and helping us adapt to our surroundings, but the downside is we notice fewer experiences in a given period of time than we did before, making that period seem shorter.

To illustrate, imagine an elderly man and his granddaughter walking through a park. Afterwards, both are asked to make a retrospective judgment of the walk’s duration. The granddaughter’s time was packed with different and unfamiliar experiences. She took curious note of a strange new bug and a sad-looking man asleep on a bench, and when she touched the grass she was surprised how cold it felt. Each of these stimulating moments acquires a special significance and takes up a separate place in her memory. Because she remembers so many things happening, time appears to stretch out, and the walk seems to have lasted a long time. The elderly man experienced his surroundings and activity in a different way. A well-worn chunk sprang to mind: *Walk in the park*. Under that chunk he collapsed dozens of impressions, sensations, and events, so he retains them with less specificity. Aspects of experience that fell outside of that chunk received little to no consideration. In his memory only one thing happened, essentially, so the walk seems brief.

The idea of chunking is not new in psychology. It has been recognized, for example, as a technique for improving working memory (Miller, 1956). Yet, to the best of our knowledge, no prior research has tested whether chunking accelerates the perceived passage of autobiographical time. Some evidence supports this possibility indirectly. Laboratory experiments show that the more recalled events or contextual changes introduced during a period, the longer it seems to have lasted (Block & Reed, 1978; Poynter, 1983; Zakay & Block, 1997). Conversely, a couple minutes spent in a routine task (e.g., counting the number of times the digit 8 appears in a row of numbers) are remembered as shorter in duration than the same period engaged in a nonroutine task (Avni-Babad & Ritov, 2003). Related studies show that stimuli that are more engaging and trigger highly arousing emotions – whether positive or negative – are remembered as lasting longer than neutral stimuli. For example, presentations of erotic images seem to last longer than bland images (Kim & Zauberman, 2013). Also, images that appear to be moving toward the self are estimated to take more time than the

same images moving away, suggesting that approaching stimuli are automatically interpreted as a potential danger, and with that presumed captivation, are judged to progress more slowly (van Wassenhove, Wittmann, Craig, & Paulus, 2011).

These findings are consistent with the current claim that a highly-chunked period offers fewer, less stimulating experiences that can be recalled, and thus appears to have passed faster in retrospect. Still, this cognitive research tends to measure time estimations on the scale of seconds and minutes, not the larger autobiographical scale of current interest. In one exception, Avni-Babad and Ritov (2003) showed in two field studies that routine influences time perception. In one study, Club Med vacationers rated how quickly time passed during the beginning, middle, and end of their 3 or 4-day holiday. The researchers reasoned that as people settle into a vacation routine, they should feel that the first day or two of their vacation stretch out whereas subsequent days get shorter and shorter. This is exactly what they found.

Chunking and forming a routine are related but distinct processes. On the one hand, habitual or unstimulating experiences are more likely than distinctive experiences to be bundled together into chunks. On the other hand, chunking does not necessarily involve being engaged in a repetitive pattern of predictable actions and events. More centrally, it is a process of reinterpreting the *number of things* that occurred during the remembered period. Routine is associated with feelings of monotony and even boredom (Sansone, Weir, Harpster, & Morgan, 1992), whereas chunking may be an emotionally “cooler” process of collapsing experiences into abstract categories so they take up less space in memory. These points call for direct tests of chunking’s influence.

## Study overview

The foregoing account yields the main hypothesis: If mentally grouping experiences into broad categories (i.e., chunking) contributes to a subjective acceleration of autobiographical time, then people led to chunk a period will perceive it as passing faster than those who do not chunk that period. The current three studies test this hypothesis, examining perceptions of one’s past year as a case study.

To ascertain the effect’s reliability and generalizability, the current studies employed two operationalizations of chunking to induce people to think about their past year in terms of broad categories of experience. The subjective passage of time was then assessed using previously validated measures. The studies were also designed to inform the predicted effect’s discriminant validity. If, as proposed, chunking is psychologically distinct from other cognitive processes, it should accelerate time compared to other ways of reinterpreting the same period (Study 1). Also examined was whether chunking affects the subjective passage of the chunked period, specifically, or instead spills over to change perceptions of any recollected period. The current theorizing suggests that chunking’s effect is localized. If so, then chunking the past year, but not yesterday or today thus far, should accelerate the past year (Studies 2 & 3). Furthermore, chunking the past year should not make other periods (e.g., last week) seem to pass more quickly (Study 3).

Complementing the focus on time perception, the present studies offer an exploratory inquiry into chunking’s influence on other autobiographical phenomena that have important implications for psychological well-being. Specifically, Studies 2 and 3 examined the appeal of nostalgia – a sentimental affection for the past (Wildschut, Sedikides, Arndt, & Routledge,

2006). Nostalgia provides a means of situating one's self-concept in a coherent and progressive life narrative (Sedikides, Wildschut, Routledge, & Arndt, 2015). Indeed, people who engage in nostalgia are better able to protect themselves against threatening thoughts about life ending (Routledge, Arndt, Sedikides, & Wildschut, 2008), and limited temporal horizons can trigger feelings of nostalgia (Hepper, Wildschut, Sedikides, Robertson, & Routledge, 2016). Further, nostalgia provides resources that benefit psychological functioning (Sedikides, Wildschut, Routledge, Arndt, et al., 2015). Thus, if chunking accelerates life by compressing individual experiences into broad categories, it may instigate a compensatory valuing of nostalgia and an urge to engage nostalgic memories.

## Study 1

In an initial operationalization, Study 1 asked participants in the chunking condition to describe events and activities from the past year that occurred regularly in preceding years. This was intended as a means of classifying those experiences into well-learned categories. Participants in the comparison condition wrote about counterfactual alternatives to occurrences in the past year – that is, how their year could have been different. In this way, Study 1 examines whether the predicted effect is simply the result of reinterpreting experiences within a given period or specifically due to chunking. Participants rated how quickly last year passed compared to both a year as measured by the calendar and their subjective sense of an average year of their life.

## Method

As part of a class exercise, 107 undergraduates (72 women, age range 18–39;  $M_{\text{age}} = 21$ ) at a large Midwestern university completed a survey ostensibly investigating personality (the same cover story was used in all current studies). In this and the following studies, preliminary analyses returned no main effects or by-condition interactions involving participant gender ( $F_s < 1$ ;  $p_s > .34$ ) or age ( $F_s < 1$ ;  $p_s > .80$ ). We do not discuss these factors further.<sup>1</sup>

## Chunking manipulation

Participants randomly assigned to the *chunking* condition ( $n = 53$ ) received instructions to write about how last year's events and activities were similar to those of years' past, and thus fit into familiar categories of experience:

Think about last year. Think of it as starting in fall of 2014 (around September), continuing on through that winter, and ending just before summer 2015. Then think about how last year was *similar* to years past. For example, think about how something that happened last year happens pretty much every year. What are some experiences or events from last year that you are used to having by now? That were very familiar to you? Think about this for a few moments and go to the next screen [Next screen]. Now, we'd like you to describe three ways that last year was pretty much like every other year. In this box, describe a familiar, expected experience that you had last year [Next screen]. Describe a second [third] way that your experiences last year were very familiar and like other years in the past.

Participants randomly assigned to the *no chunking* condition ( $n = 54$ ) received instructions to write about how events and activities from their past year could have turned out differently:

Think about last year. Think of it as starting in fall of 2014 (around September), continuing on through that winter, and ending just before summer 2015. Then think about things that *could have happened* last year but didn't happen. For example, think about a public event that didn't turn out like people had expected. What could have happened in politics last year that didn't? What could have happened in the world of sports or entertainment? Think about this for a few moments and go to the next screen [Next screen]. Now, we'd like you to describe three things that could have happened last year but that did not happen. In this box, describe something that could have happened last year [Next screen]. Describe a second [third] event that could have happened last year but didn't.

After writing about their past year, participants responded to a single manipulation check item: "How similar was this past year to other years?" (1 = *Not at all similar*; 7 = *Almost exactly the same*). As expected, participants in the chunking condition viewed their past year as more similar to prior years ( $M_{\text{chunking}} = 2.60$ ,  $SD = 1.61$  vs.  $M_{\text{no chunking}} = 2.09$ ,  $SD = 1.05$ ),  $F(1, 105) = 3.80$ ,  $p = .05$ ,  $\text{partial-}\eta^2 = .04$ .

### Time passage measure

Two items measured how quickly last year seemed to pass. One compared last year to objective calendar time: "How slowly or quickly did last year pass compared with the actual amount of time on the calendar?" The second drew a comparison with an average year: "How slowly or quickly did last year pass compared with an average year for you?" Responses were made on the same 5-point scale used in prior research on time passage judgments (Wittmann & Lehnoff, 2005):  $-2 = \textit{Very slowly}$ ;  $-1 = \textit{Slowly}$ ;  $0 = \textit{Neither fast nor slow}$ ;  $1 = \textit{Fast}$ ;  $2 = \textit{Very fast}$ .

## Results

Submitting time passage judgments to separate one-way ANOVAs returned the predicted results: Participants who chunked (vs. did not chunk) their past year perceived it as passing faster than a year according to objective calendar time ( $M_{\text{chunking}} = .94$ ,  $SD = .89$  vs.  $M_{\text{no chunking}} = .46$ ,  $SD = .97$ ),  $F(1, 105) = 7.18$ ,  $p = .01$ ,  $\text{partial-}\eta^2 = .06$ . They also perceived last year as passing faster than the average year ( $M_{\text{chunking}} = .75$ ,  $SD = .83$  vs.  $M_{\text{no chunking}} = .37$ ,  $SD = .94$ ),  $F(1, 105) = 5.04$ ,  $p = .03$ ,  $\text{partial-}\eta^2 = .05$ .

Study 1 offers initial support for the main hypothesis. Participants saw their past year as passing more quickly after construing the year's events and activities as falling into familiar categories of experience compared to imagining how those parts of the year could have been different than they were. Study 1's operationalization of the chunking manipulation has the advantage of controlling for participants' overall elaboration on the target period. Participants in both conditions dwelled on three aspects of their past year. However, only in the chunking condition were they led to think of those aspects in terms of recurring categories. Also, with this method, the effect of chunking on time perception is shown to hold across the diversity of idiosyncratic chunks participants generated.

One drawback of this operationalization, however, is that it could have manipulated some other aspect of reflecting on similarity vs. what might have been. Time durations can seem longer when people shift mental contexts (Block & Reed, 1978), and thus it may be that chunking did not accelerate time, but that counterfactual thinking slowed it.

Another limitation is that it is unclear whether the observed effect was the result of chunking the past year specifically, or merely chunking any past period (or simply thinking in terms of broad categories).

Addressing these ambiguities requires a more straightforward chunking operationalization. Toward this end, in Studies 2 and 3 we asked participants to think about either their past year or past day in terms of familiar categories before reporting their subjective passage of their past year. This comparison condition also informs whether chunking's effect on time perception is specific to the chunked period. If so, then chunking yesterday should not accelerate the perception of last year.

## Study 2

Study 2 conceptually replicates Study 1 using a converging operationalization of chunking. Depending on condition, participants were induced to think of their past year or past day in terms of a few broad, familiar categories of experience. This operationalization offers two advantages. First, it informs the alternative possibility that the disparity in time perception observed in Study 1 was due to another cognitive process (i.e., counterfactual thinking), because here all participants engaged in the same chunking process, just with respect to different periods. Second, it tests the alternative possibility that any act of chunking accelerates time. If, as proposed, chunking a given period affects the subjective duration of that period, specifically, then having participants chunk their past day should not influence perceptions of their past year.

An additional goal of Study 2 was to take an initial look at the downstream consequences of chunking for another aspect of psychological functioning. The present analysis suggests the sense of temporal acceleration that stems from chunking may signal an existential erosion of life's meaning, depriving people of appreciating life's moments that in turn help to bolster the significance of time's passage. If so, chunking might also elicit a compensatory effort to interject meaning to one's past. To the extent nostalgia has been implicated as serving a meaning-regulation function (Routledge et al., 2008), chunking may thus increase desire for nostalgia.

## Method

Participants were 115 Midwestern undergraduates (73 women, age range 18–29;  $M_{\text{age}} = 19$ ) who received partial course credit for taking part in an online study using a program developed with Qualtrics (Provo, Utah) software.

### Chunking manipulation

Participants randomly assigned to the *chunk year* condition ( $n = 56$ ) spent two minutes reflecting on how much time over the past year they engaged in four different activity categories: *School, Job, Socializing, and Other*. They then estimated the percentage of the past year they spent on each activity type by clicking points along four respective bars that represented percentages. Participants in the *chunk day* condition ( $n = 59$ ) were given the same task, except they reflected on their previous day (i.e., the day before their participation) and estimated what percentage of yesterday they spent on each activity type.

The computer program that implemented these tasks required participants' estimates add up to 100% before allowing them to continue with the study. This constraint enabled us to normalize the induction across participants, as it constrained them to reinterpret events from their assigned period into four broad chunks.

### Time passage measure

Next was a single item measuring how quickly last year seemed to pass compared to one's average year. Prior research has successfully measured time passage judgments using continuous scales that represent a period spatially as a horizontal line (e.g., Avni-Babad & Ritov, 2003; Wittmann & Lehnoff, 2005). Here, this procedure was adapted from its paper-pencil implementations into a computerized "slider" response whereby participants dragged a tab along a bar that spanned the width of the computer screen. The bar was labeled with  $-100 = \textit{Time passed slowly}$  to  $+100 = \textit{Time passed quickly}$ , with the midpoint of 0 representing the speed of one's *Average year*. These are the same anchor labels used in prior research (Joubert, 1984). In both conditions, the slider tab was initially positioned at the bar's midpoint, and participants moved it along the bar to indicate how much faster or slower last year seemed to pass relative to their average year.

### Nostalgia importance measure

Next were 5 items assessing the personal importance of nostalgia. Two items were taken from the Southampton Nostalgia Scale (Routledge et al., 2008): "How important is it for you to bring to mind nostalgic experiences? How significant is it for you to feel nostalgic?" Three new items were added: "How strongly do you desire to reflect nostalgically on your past? Would you feel 'empty' if you were to lose the memories that make you feel nostalgic? Some say that feeling nostalgia is pointless or childish. How much do you agree?" (reverse scored). Following Routledge et al. (2008), responses were collected on a 7-point scale (1 = *Not at all*; 7 = *Very much*) and averaged ( $\alpha = .79$ ).

## Results

Submitting time passage scores to a one-way ANOVA revealed the predicted effect: Compared to participants who chunked their past day, those who chunked their past year perceived that year as passing faster relative to an average year of their life ( $M_{\text{chunk year}} = 47.46$ ;  $SD = 23.29$  vs.  $M_{\text{chunk day}} = 35.29$ ;  $SD = 31.17$ ),  $F(1, 113) = 5.59$ ,  $p = .02$ ,  $\text{partial-}\eta^2 = .05$ .

Also as predicted, *chunk year* participants felt that nostalgic reflection was more important than did *chunk day* participants ( $M_{\text{chunk year}} = 4.59$ ,  $SD = .94$  vs.  $M_{\text{chunk day}} = 4.12$ ,  $SD = 1.10$ ),  $F(1, 113) = 6.04$ ,  $p = .01$ ,  $\text{partial-}\eta^2 = .05$ .

Study 2 lends further support to the main hypothesis. It is worth noting that participants in the comparison condition also chunked their experiences, but with reference to a period other than the evaluated period. This supports the claim that chunking's effect is specific, at least on the predictor end of the equation. That is, it appears that perceiving a given period as passing faster partly depends on whether one chunks that period, and not just any recollected period. Further, Study 2 offers initial insight that chunking may elicit desire for nostalgic reflection on the past.

Still, ambiguities remain as to the discriminant validity on the outcome end of time perception. The present analysis suggests that chunking the past year should accelerate the subjective passage of the past year, but it should not globally influence the perceived passage of any period. This possibility was tested in Study 3, as was further assessment of a potential link between chunking and nostalgia.

### Study 3

Study 3 sought to replicate the predicted chunking effect and further assess its specificity. Participants were asked to report the subjective passage of not only their past year – the chunked period – but also their past week and month. The guiding analysis suggests that, after chunking the past year, only the past year should appear to speed up. Study 3 was also designed to replicate chunking's effect on the valuing of nostalgia.

#### Method

A female experimenter approached 105 adults in public areas of a college campus, inviting them to complete a paper-pencil survey in exchange for candy. Three non-native English speakers reported having difficulty understanding the instructions and were excluded from analyses, leaving a final sample of 102 adults (63 women, age range 18–86;  $M_{\text{age}} = 30$ ).

#### Chunking manipulation

As in Study 2, participants assigned to the *chunk year* condition ( $n = 53$ ) estimated how much time they spent in their past year on four activity categories: *School*, *Job*, *Socializing*, and *Other*. Rather than provide numeric estimates, as in Study 2, they were asked create a personalized “pie chart.” They were presented with a blank circle labeled “Your Year” and instructed to draw lines dividing that “pie” into four pieces representing the time spent on each activity type. Participants in the *chunk day* condition ( $n = 49$ ) completed the same task with respect to their day so far (rather than yesterday, as in Study 2), dividing a pie labeled “Your Day.” All data collection occurred after 4:00 pm to ensure participants in the *chunk day* condition had experienced a sufficient number of events that day upon which to reflect.

#### Time passage measure

Using items developed by Wittmann and Lehnoff (2005), the subjective passage of three periods was measured: “How fast did the previous week [month; year] pass for you?” Responses were made on the same 5-point scale used in Study 1:  $-2 = \textit{Very slowly}$ ;  $-1 = \textit{Slowly}$ ;  $0 = \textit{Neither fast nor slow}$ ;  $1 = \textit{Fast}$ ;  $2 = \textit{Very fast}$ .

#### Nostalgia importance measure

Next were the 5 nostalgia importance items described in Study 2 ( $\alpha = .74$ ).

### Results

As predicted, *chunk year* participants perceived the past year as passing more quickly than *chunk day* participants ( $M_{\text{chunk year}} = .85$ ;  $SD = .91$  vs.  $M_{\text{chunk day}} = .33$ ,  $SD = .92$ ),  $F(1, 100) = 8.32$ ,  $p = .005$ ,  $\text{partial-}\eta^2 = .08$ .

In contrast, and also as predicted, participants who chunked their past year did not perceive other periods of time speeding up. There were no significant differences by condition in judgments of the past week or the past month ( $F_s < 1$ ;  $p_s > .82$ ).

*Chunk year* participants also placed more importance on nostalgia than *chunk day* participants ( $M_{\text{chunk year}} = 4.62$ ,  $SD = .99$  vs.  $M_{\text{chunk day}} = 4.10$ ,  $SD = 1.09$ ),  $F(1, 100) = 6.39$ ,  $p = .01$ ,  $\text{partial-}\eta^2 = .06$ .

Study 3 replicates the prior studies using different procedures. After thinking about their past year (compared to their day so far) in terms of broad activity categories, participants felt that their past year passed more quickly. Attesting to this effect's specificity, chunking the past year did not influence judgments of the passage of other recollected periods. Replicating Study 2, chunking also increased the value of nostalgic reflection.

## General discussion

### Overview of findings

The novelist Karl Knusgaard (2013) reflects on how his experience as a boy differed from that of his father:

While my days were jam-packed with meaning, when each step opened a new opportunity, and when every opportunity filled me to the brim, in a way which now is actually incomprehensible, the meaning of his days was not concentrated in individual events but spread over such large areas that it was not possible to comprehend them in anything other than abstract terms. "Family" was one such term, "career" another. Few or no unforeseen opportunities at all can have presented themselves in the course of his days, he must always have known in broad outline what they would bring and how he would react. . . . That is when time begins to pick up speed. It no longer meets any obstacles, everything is set, time races through our lives, the days pass by in a flash and before we know what is happening we are forty, fifty, sixty . . . (pp. 9, 11)

The current research provides experimental evidence for an old answer to an even older question: Why does life speed up as we get older? Although many processes combine to create this perception, the current account builds on the scholarly theorizing of Hofstadter (2001), James (1890), and others to propose that "chunking" plays a decisive role. As Knusgaard (2013) reflects, time accelerates when it is "not concentrated in individual events but spread over large areas." Over the life span, we learn more about the world and ourselves, which enables us to organize experiences into progressively broader, more abstract categories. As a result, when we look back on a given period we recall fewer things happening. Consequently, that period seems to have flown by.

This account was supported in three studies. After thinking about their past year in terms of broad, familiar categories of experience, people perceived that period as passing faster than did participants in comparison conditions. This effect emerged across two operationalizations of chunking, computerized and paper-pencil procedures, and laboratory and field settings, attesting to its robustness and generalizability. Also, chunking's effects were distinct from the effects of alternative ways to reinterpret the same period (counterfactual thinking in Study 1) or chunking other periods of autobiographical time (yesterday in Study 2; one's day so far in Study 3). Furthermore, chunking a given period accelerated that period, specifically, and did not generally influence judgments of the passage of other recollected periods (Study 3).

The current findings are consistent with cognitive research on time passage judgments, but go further to isolate the chunking process and measure judgments at the autobiographical scale of years, rather than seconds and minutes spent in artificial laboratory-based tasks. It is worth noting the inductions used here are meant to simulate a chunking process that, we suspect, takes place spontaneously. Research would thus benefit from trying to capture some of the naturalistic ways people chunk their lived experiences. Nevertheless, the current

results point to the conclusion that chunking is a major factor in a person's perception of the passage of autobiographical time.

Of course, the present findings – while providing novel initial evidence – are likely just the tip of the proverbial iceberg and invite questions to be addressed by future research. Many of these pertain to what might be expected from any burgeoning research program. That is, studies are needed to further inform the internal validity of chunking as an operative process in temporal acceleration; to examine the mediational mechanisms underlying the effect as well as its moderation; and to examine the downstream consequences it might precipitate. We briefly comment on each.

### *Further testing chunking's parameters*

Although the present studies contrasted chunking inductions for a specific period with an alternative construal of the same period and parallel chunking inductions for other periods, further comparison conditions are needed to identify the parameters of the effect. For example, it remains to be seen whether the effect of chunking on accelerating time is the result of familiarity-based categorizations. To be sure, time passes more quickly when one is engaging in routine and familiar activity (Avni-Babad & Ritov, 2003). Yet the current analysis suggests that chunking is not reducible to routine. As long as experiences are grouped under broad chunks – even those that are unfamiliar or idiosyncratic – then the respective period should seem faster in retrospect. Evidence supporting this claim comes from an unpublished study in our laboratory. When participants were asked to chunk last year's experiences into those that involved law enforcement or not – likely an unfamiliar categorization for most people – they perceived that year as passing faster compared to participants who did not chunk in this manner (Bultmann, Swanson, Landau, & Arndt, 2017). Although preliminary, this finding points to the importance of chunking beyond just the recollection of familiar routine.

In a related possibility, chunking's observed effect may stem from other processes associated with simply dwelling on one's past, such as cognitive fluency (Alter & Oppenheimer, 2009). Study 1 casts doubt on this interpretation because although all participants dwelled on their past year, those who thought about how typical the year's events were felt the year passed faster than those who generated counterfactual events. More direct tests come from unpublished studies in our laboratory (Bultmann et al., 2017). In one, participants who categorized their past year's events into two activity-based categories perceived the year as passing faster than those who grouped the same number of events into 14 activity-based categories. Presumably, participants given 14 categories to choose from reflected on their year as much as or more than those given just two broad categories. Hence, the effect is unlikely to be due to mere reflection. More likely, the larger number of categories better preserved the distinctiveness of each remembered event, thus attenuating the accelerating influence of broader categorizations.

In another study, participants who chunked the year's events into two broad activity categories perceived the year as passing faster than those asked to judge the same number of events as globally positive or negative. This latter task involved an equivalent degree of overall reflection on the same period, and using the same number of labels, as in the key chunking condition. Our interpretation is that the activity-based chunking task flattens the distinctive shape of individual events whereas assigning events a global valence does not.

These findings are consistent with the proposed account of chunking's unique influence in time perception, yet are difficult to explain in terms of mere reflection, cognitive fluency, or related mechanisms.

### **Mechanism**

The question then becomes: Why, exactly, does chunking accelerate autobiographical time? The present analysis suggests that it does so because after chunking, *fewer things seem to have occurred* in a given period. Recall the hypothetical example of the elderly man and his granddaughter. Whereas her afternoon featured an introduction to a previously un-encountered insect, a visage of a person sleeping in sorrow on a bench, and the touch of cool blades of grass, his afternoon featured but a walk in the park. Hence, this reduction in the quantity of experience may lead to the sense that time passes more rapidly from a subjective viewpoint, perhaps because with fewer experiences, there is less cognitive effort expended toward attention and memory of the period in question (Wittmann, 2016). Of course, this mechanistic account remains speculative. Future work should test it directly with mediational designs and measurement.

### **Moderation**

It is also likely that various conditions can mitigate or exacerbate people's propensity to chunk. For example, individual and situational variation in need for structured knowledge (Neuberg & Newsom, 1993) or elevated needs for epistemic closure (Kruglanski & Webster, 1996) should lead people to seize on simple interpretations of their experiences – that is, interpretations that are easily labeled and filed under large chunks. A strong desire for accurate knowledge, in contrast, should decrease the appeal of clear-cut interpretations and thus prevent runaway chunking. In a similar vein, individual differences such as self-complexity (Linville, 1987), whereby an individual has a sense of many distinct “selves” doing different types of activity with different relationship partners in different settings, may predispose resistance to chunking. Another possible antidote is mindfulness, whether dispositionally high or situationally induced. When the individual resides more fully in the moment, she or he may also better appreciate the uniqueness of those moments once they have passed, making it less likely those moments are summarily compressed into a generic chunk (although see Hansen & Trope, 2012, for evidence that concrete-level construals can accelerate time). Future research should examine pathways to a more mindful relation to one's experience, such as meditation and engaging with art. These experiences have the potential re-sensitize us to the satisfactions of simple things and, perhaps, counteract life's quickening pace.

### **Downstream consequences**

From the current perspective, chunking is not just a quirk of temporal perception. It has ramifications for identity, self-regulation, and psychological well-being. Indeed, Studies 2 and 3 provide preliminary insights into how chunking may impact other autobiographical phenomena with wide-reaching downstream consequences. In both studies, participants who were led to chunk their past year (relative to those who chunked days) indicated greater

valuing of the emotion of nostalgia. Such a finding adds to previous research showing that nostalgia increases when people are faced with limited time horizons (Hepper et al., 2016). Although chunking does not limit temporal horizons per se, it does appear to speed up an individual's sense of how swiftly time flows. Nostalgia may thus emerge in part as a way of "putting the brakes on" this temporal acceleration, allowing people to maintain the meaningfulness, coherence, and continuity of individual autobiographical experiences. A connection between chunking and nostalgia hints at how chunking may reverberate to impact different aspects of psychological well-being and quality of life. Despite being originally conceptualized as a psychological malady, the last decade of research has shown that nostalgia is a vital psychological resource whose ripples fill life with a sense of social connectedness, continuity, self-determination, esteem, and inspiration (e.g., Baldwin, Biernat, & Landau, 2015; Sedikides, Wildschut, Routledge, & Arndt, 2015). Thus it may be informative to consider how chunking impacts these and other self-relevant outcomes.

Yet it is important to acknowledge the effect of chunking on nostalgia may well be complex. On the one hand, if chunking accelerates life by compressing individual experiences into broad categories, it should prompt a compensatory sense of the importance of nostalgia and an urge to reflect nostalgically on one's temporally expansive past. This hypothesis led Studies 2 and 3 to focus on participant's *valuing* of nostalgia, and the results were consistent with this reasoning.

On the other hand, by accelerating or glossing over the intricacy of distinct life experiences, chunking may disrupt focus on the distinctive moments that are candidates for sentimental reflection, and thus decrease the *experience* of nostalgia. Broadly consistent with this is evidence of contrasting life-span trajectories for autobiographical time perception and engagement with nostalgia. The sense that one's life is speeding up is most pronounced in middle adulthood (Wittmann & Lehnoff, 2005), whereas nostalgia tends to be lower in middle adulthood (Hepper et al., 2016). This contrast makes sense if nostalgia puts the breaks on temporal acceleration. The present studies did not examine the experience of nostalgia and thus this dissociation between chunking induced nostalgic desire and experience is only speculative, awaiting future research.

### ***Use caution when slowing down***

Why study the processes behind life's apparent acceleration? The current studies were partly inspired by the notion that perceiving life as rapidly slipping away is psychologically harmful: unpleasant, demotivating, and possibly even hostile to the sense that life is meaningful. Empirical evidence resonates (e.g., Wittmann, 2016), as do several anecdotal observations, from common complaints that a vacation vanished in the blink of an eye to the romanticizing of children's apparent obliviousness to time and their ability to harvest a cornucopia of experience from any given afternoon; and to the profusion of self-help campaigns promising to correct our harrowed relationship with time by intentionally slowing down how we work (Honoré, 2013), eat (Petrini & Padovan, 2006), teach (Berg & Seeber, 2016), and have sex (Richardson, 2011).

Still, slow-moving time can itself be harmful. A prime example is the experience of boredom. In some cases, boredom is worse than unpleasant; it poses a profound existential threat. Feeling bored can make the current situation seem purposeless (van Tilburg & Igou, 2011) and life seem meaningless (Fahlman, Mercer, Gaskovski, Eastwood, & Eastwood, 2009),

motivating people to alleviate oppressive boredom by finding ways to reinject life with meaning (van Tilburg & Igou, 2012).

Although boredom is a multifaceted state involving dimensions other than time, it is demonstrably tied to the perception that time is moving too slowly, often resulting from repetition or a lack of stimulation (Csikszentmihalyi, 1990; Sansone et al., 1992). Your current author recently experienced this while recovering from an injury. As I sat motionless on my couch for four weeks, the hours and minutes slowed to an excruciating pace. Each moment was like a stranger staring at me, and I stared back in disgust, waiting for sleep to deaden my consciousness.

All this raises a question: Are these two existential threats – *too-fast* time and *too-slow* time – psychologically distinct, or do they result from a shared process? It is possible that both stem from chunking. The difference may lie in temporal perspective. When one chunks *retrospectively*, lumping past experiences into well-worn categories, time (and life) seems to rapidly slip away. This is what we see in the current studies, for example. But when one chunks *synchronously* – that is, concurrent with the experience being chunked – time seems to drag. Each moment feels like a hollow echo of the preceding moment. That explains why one can alleviate boredom by finding something in the current situation that yields distinctive detail or value, thereby dissolving the overbearing chunk that forces each present moment into stale conformity. This possibility fits William James (1890) observation that the sameness of experience has divergent effects on estimates of length of time depending on perspective:

In general, a time filled with varied and interesting experiences seems short in passing, but long as we look back. On the other hand, a tract of time empty of experiences seems long in passing, but in retrospect short. A week of travel and sight-seeing may subtend an angle more like three weeks in the memory; and a month of sickness hardly yields more memories than a day. The length in retrospect depends obviously on the multitudinousness of the memories which the time affords. Many objects, events, changes, many subdivisions, immediately widen the view as we look back. Emptiness, monotony, familiarity, make it shrivel up. (p. 624)

Tracing *too-fast* time and *too-slow* time to a common source has the advantage of explaining why people reach for similar strategies to compensate for both existential threats. Perhaps the most interesting of these is nostalgia. In the current studies, we saw that people were more motivated to engage nostalgia after chunking accelerated their past year. In complementary research by van Tilburg, Igou, and Sedikides (2013), nostalgia reestablished life's meaningfulness when people felt bored with the activity at hand. Specifically, induced boredom instigated a search for meaning in life, which mediated the effect of boredom on nostalgia. Also, nostalgic engagement effectively restored meaningfulness in the face of boredom.

Bridging these findings, it is possible that nostalgia's existential utility lies in lifting one out of stale experiential categories by evoking momentous occasions and, in this way, keeping the present flowing at a stimulating pace *and* stocking the past with distinctive memories that make life seem full. Future research could test whether retrospective vs. synchronous chunking has diverging effects on perceptions of autobiographical time.

These are just some of the many directions along which future research might proceed. By providing initial evidence for a role of chunking in subjective autobiographical time perception, the present studies provide an empirical foundation for classic theorizing as well as a generative invitation for future discovery.

## Note

1. We suspect the lack of effects for age may be due to the focus on a singular age-group (college-group) across studies.

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