ARTICLE

Experiencing time in daily life

Why does a watched pot never boil, or time fly when you're having fun?
Dan Zakay has some answers

Time shapes human life and behaviour. Physical events proceed according to objective time and biological cycles are controlled by internal pacemakers, but psychological time – how humans experience it – differs in various important ways. Psychological time is discrete and non-continuous, non-linear, highly context-dependent and, as in a dream, does not necessarily flow from the past to the future. Psychological time is crucial in shaping a plethora of human behaviours, and this article examines the part it plays in many everyday activities.

question

The population is becoming older and older due to the increase in life expectancy. There are some indications of a phenomenon called 'slowing down' of the pace of time in the elderly, whereby time is perceived to be going slower than for young people. How might this phenomenon influence the daily life of elderly people?

resource

Grondin, S. (Ed.) (2008). *Psychology of time*. Bingley: Emerald.

Psychological time is a complex notion reflected in many types of experiences. Consider the last time you made a cup of coffee. Perhaps you wondered whether you had enough time to do it before your meeting; you recalled a particularly good recent cup of coffee you had, and how long ago that was; you recalled the order of events in time necessary to make the coffee; you perceived a rising tempo in the sound of the boiling kettle, almost like music; you planned (automatically and without awareness) the exact time to reach out and catch the falling spoon as it fell off the kitchen top; you estimated the duration of that process, and therefore whether it was time to go into the meeting.

These examples reflect a range of dimensions of time, to which humans must attend. Here we will focus only on the perception of duration, which is one of the most important aspects of psychological time.

How humans perceive duration

The dimension of time is of clear importance for adaptation and orientation in the physical and social environment. So it's something of an evolutionary enigma that we are not equipped with a direct time perception mechanism. Researchers assume that time perception is derived indirectly via certain physiological and cognitive processes, and as a result our sense of time is inaccurate and easily biased. You can demonstrate this by asking a group of people to clap 17 seconds after you do. You may be surprised to find that there will be a wave of hand clapping, and the diversity of accuracy in estimating the duration of time will be high.

Before going on to describe and explain the phenomena in time-duration judgements, I would like to draw a general picture of time perception and the processes underlining it.

Retrospective timing

Imagine you try to recall how long a film was, or how much time it took you to type a report. In such cases the interval itself doesn't exist any more; what is left of it are only memory traces. The outcome is 'retrospective duration'.

The main model that explains retrospective timing is called the 'contextual change model'. The idea is that our cognitive system is trying to retrieve from memory all the data we stored there during the target-interval whose duration we are trying to estimate. Retrospective estimation of a past event's duration is based on the naive assumption that the more data that was stored in memory during an interval, the longer that interval should be. Thus, retrospective estimation of duration assigns longer durations for intervals when the amount of retrieved information is high, than for intervals for whom the amount of respectively retrieved information is low.

The problem is that in reality, during identical clock-time intervals, more or less information can be stored in memory depending on factors other than actual duration itself. One factor is the intensity of information processing in which one is engaged. For example, when one is asked to solve difficult arithmetic problems such as complex multiplication, more data will be stored in memory as compared with a same clock-time interval during which one is asked to perform simple addition problems. The result will be that the retrospective 'multiplication interval' will be estimated to be longer than the 'addition interval'. In a classic study,

references

Block, R.A. & Reed, M.A. (1978). Remembered duration: Evidence for a contextual-change hypothesis. *Journal of Experimental Psychology: Human Learning and Memory, 4*(6), 656–665.

Block, R.A. & Zakay, D. (1997). Prospective and retrospective duration judgments: A meta-analytic review. *Psychonomic Bulletin & Review, 4*(2), 184–197.

Brown, S.W. (1994). Attentional resources in timing: Interference effects in concurrent temporal and nontemporal working memory tasks. *Attention, Perception & Psychophysics, 50*(7), 1118–1140.

Droit-Volet, S., Brunot, S. & Niedenthal, P.M. (2004). Perception of the duration of emotional events. *Cognition & Emotion, 18*(6), 849–858.

Loftus, E.F., Schooler, J.E., Boone, S.M. & Klein, D. (1987). Time went by so slowly: Overestimation of events' durations by males and females. *Applied Cognitive Psychology, 1*, 3–13.

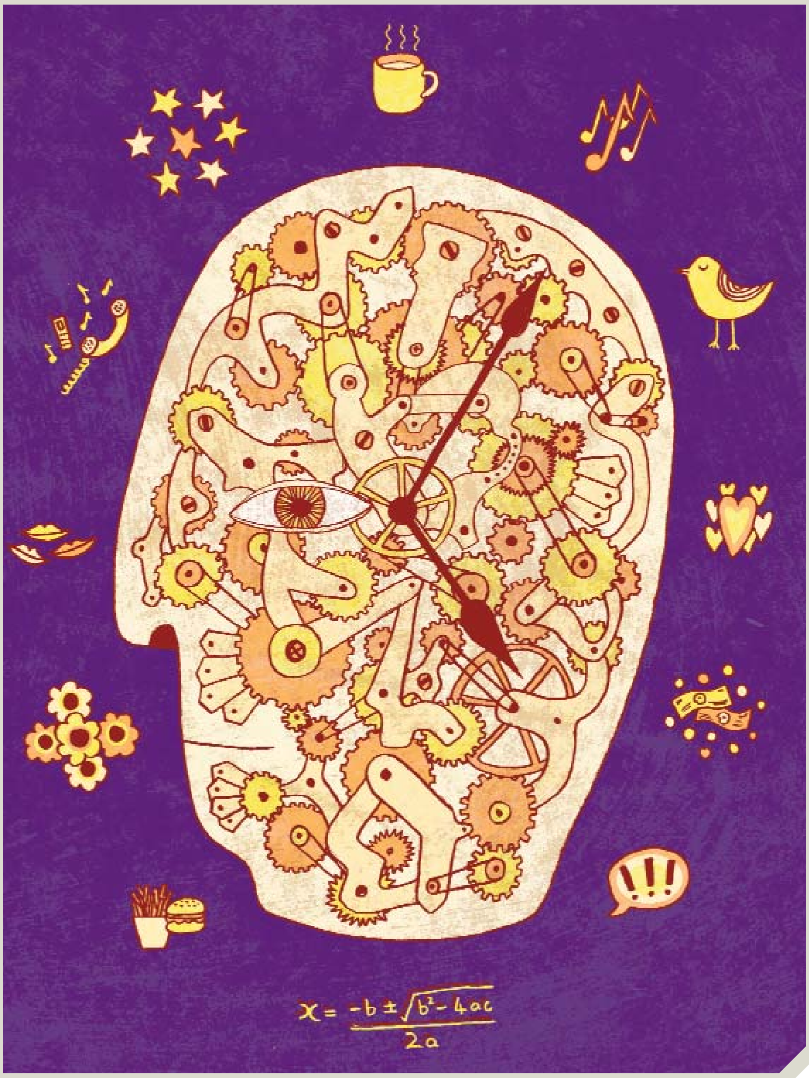
Ornstein, R.E. (1975). *On the experience of time*. New York: Penguin.

Poynter, W.D. (1983). Duration judgment and the segmentation of experience. *Memory & Cognition, 11*(1), 77–82.

Roy, M.M. (2011). The return trip effect: Why the return trip often seems to take less time. *Psychonomic Bulletin & Review, 18*(5), 827–832.

Wearden, J.H., Norton, R., Martin, S. & Montford-Bebb, O. (2007). Internal clock processes and the filled-duration illusion. *Journal of Experimental Psychology: Human Perception & Performance, 33*(3), 716–729.

Zakay, D. (1998). Attention allocation policy influence prospective timing.



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Suppose that one person is asked to perform arithmetic exercises for a given duration; another is asked to do nothing for the same interval. Who will give the greatest estimate?

Ornstein (1975), presented participants with either a simple or a very complex figure (a circle or an irregular polygon, respectively) and asked them to memorise them. Later on the participants were asked to retrospectively estimate the exposure duration of each figure. Though exposure was identical in terms of clock-time, those participants who were exposed to the simple figure estimated exposure duration to be significantly shorter when compared to participants exposed to complex figures: much less information needed to be stored in memory.

A second factor is the amount of contextual changes occurring during the interval. The reason is that contextual changes (e.g. changes in background noise or level of lighting in room) are encoded and stored in memory alongside any other task-related information. While trying to make a retrospective estimation of duration, contextual changes are retrieved together with other information types, thus compounding the overall amount of retrieved information. Block and Read's (1978) experiment involved participants engaging in identical information-processing tasks for a fixed interval. Some participants were exposed to changes in room lighting, the other participants were not exposed to any contextual changes. Consequently, the group exposed to change estimated the duration of the target interval as significantly longer than those not exposed.

A third factor refers to the level of segmentation into meaningful sub-intervals. The more an interval is segmented, the longer its retrospective duration estimation will be (Poynter, 1983). Intervals are segmented by high-priority events (HPEs), which attract attention, are stored in memory and are easily retrieved later on. Such HPEs act as cues, facilitating the retrieval of information from memory, thus enabling the retrieval of a larger amount of information leading to longer retrospective duration estimations. Contextual changes are most probably acting as HPEs.

Indeed, Block and Read (1978) suggested that changes in the type of information that should be processed, the context or the mood one experiences during an interval have a high probability of being retrieved, and they concluded that retrospective duration judgement is actually based on the amount of changes of any sort that occurred during the target interval. This is an interesting conclusion because it suggests that the notion of retrospective time is very similar to the notion of physical time: they both reflect change, which might be mental or physical, respectively. The 'Filled-Time Illusion' (Wearden et al., 2007), which refers to the common experience that in retrospect intervals filled with intensive mental activity are recalled as longer than same clock-time intervals that were 'empty' of mental activity, is well explained by the contextual change model.

Prospective timing

Suppose that one person is asked to perform difficult arithmetic exercises for a given duration; another is asked to perform a simple arithmetic exercise; and a third is asked to do nothing during the same interval. Before beginning, all three are told that upon the completion of the interval they will have to estimate its duration as accurately as possible. What will the outcome be?

Many similar studies using different types of mental activities have been performed (Brown, 1994; Zakay, 1998). Results indicate that the identical intervals will be estimated as longest by the person who was doing nothing during the time, the second longest estimation will be given by the person engaged in simple arithmetic

Psychonomic Bulletin & Review, 5(1), 114–118.
Zakay, D. (2000). Gating or switching? Gating is a better model of prospective timing. *Behavioural Processes, 50*, 1–7.
Zakay, D., Tsal, Y., Moses, M. & Shahar, I. (1994). The role of segmentation in prospective and retrospective time estimation processes. *Memory & Cognition, 22*(3), 344–351.

and the shortest will be provided by the one who was occupied by the difficult arithmetic. This is a powerful finding: remember, if the duration estimation was done retrospectively – if the three participants were not told in advance that they would have to estimate the duration – the inverse effect would be obtained (Block & Zakay, 1997).

These findings indicate that retrospective and prospective timing are based on different cognitive processes. Whereas retrospective timing is based on memory processes as explained earlier, prospective timing is based on attentional processes. This conclusion was further supported by Zakay et al. (1994), who showed that level of segmentation of an interval only has an impact on retrospective duration estimation, not on prospective ones.

“in many situations it is advantageous to cause people to experience durations as short”

The attentional gate model (Zakay, 2000) provides an explanation for prospective timing. It is based on the scalar expectancy theory (SET) model, which is an internal clock model that successfully predicts and explains time-based behaviours (e.g. time conditioning) in animals. In this model, the internal clock consists of some sort of a pacemaker that emits signals continuously and with a constant, steady tempo. The signals emitted in a given interval are read and counted by a component called an accumulator. The count of signals during a target interval is stored in memory and can be used to represent the duration of that interval. An organism can repeat certain durations by counting the signals until there is a match between the new count and a former one. This does not require any awareness of the passage of time.

Humans, on the other hand, are aware of the passage of time and are highly influenced by attentional demands during a target interval. Thus, another component should be added to the SET model in order to fit the human prospective duration estimation. This component is called the ‘attentional gate’, which regulates the amount of signals emitted by a pacemaker and subsequently counted by an accumulator during a given interval. The gate can become ‘wide’ or ‘narrow’ depending on the amount of attentional resources allocated for timing. The more attentional resources allocated for timing (like in cases in which the passage of time is very important, such as waiting for an important meeting) the wider the opening of the gate, the higher the count in the accumulator in comparison to a case in which time is not important (such as relaxing during a long vacation). In these cases only few attentional resources are allocated for time and the gate becomes narrow, allowing for a low number of signals to be accumulated by the accumulator during a given interval. Assuming that the feeling of an interval duration is a function of the count in the accumulator, the same objective interval (say, 30 seconds) will be perceived as longer while waiting than while relaxing.

There are two major factors that determine the amount of attentional resources allocated for prospective time. The first is ‘temporal relevance’, which indicates how important it is in a specific situation to be aware of the passage of time. The higher the temporal relevance, the more attentional resources will be allocated, the wider the opening of the gate and therefore the longer the estimate of duration. The second factor is the amount of attentional resources required for performing a concurrent nontemporal activity. Attentional resources are limited and have to be divided between all the activities taking place simultaneously. Therefore when facing a demanding nontemporal task, more attention is consumed by the task and less attention is allocated for timing.

Now we can explain why prospective duration judgement produces a mirror effect to retrospective judgement. Take, for example, the Ornstein study (1975). In retrospect, the exposure duration of a complex geometrical figure is longer than the exposure duration of a simple figure because in the complex figure more information was processed, sorted and later on retrieved from memory than in the simple figure case. However, if exposure duration estimation is done *prospectively*, then memorising the complex figure demanded more attentional resources than memorising a simple figure. The result is that in the first case fewer attentional resources are left for timing than in the second case. This will lead to a narrow gate and low count of signals in the first case and a wider gate, leading to a high count of signals in the second case.

Explaining daily time-dependent experiences

So let’s summarise the principles that determine the perception of durations:

- If awareness to time is not important, duration estimation will be retrospective. As such, it will be longer for intervals in which high information-processing load was required, when compared to intervals for which the information-processing load was low.
- Whenever the relevance and importance of time is high, timing automatically becomes prospective. In such situations the more attention that is allocated directly for time, the longer the duration will be experienced.
- When duration judgement is prospective and is accompanying a concurrent nontemporal task, the more demanding the concurrent task is the shorter the duration estimation of the interval during which the task was performed will be.

So how can we apply these principles to some common situations?

A ‘watched pot’ never boils, and earthquakes feel longer than they are

When one is watching a pot waiting for the water to boil, time is of the utmost relevance – the person is occupied with the question ‘When will the water boil?’. This means that timing will be prospective, the gate will be widely open and the count of signals in the accumulator will be high. This will cause the ongoing experience of the passage of time to become very long. Similarly, when waiting for a friend to join us, for a traffic light to turn green or a call centre to answer us, we focus our attention on when it will happen: there’s high temporal relevance.

Similarly, some studies indicate that people experience the duration of earthquakes in the range of minutes, as compared with its actual range of 30–40 seconds (Loftus et al., 1987). The passage of time during an earthquake is highly relevant: it is a threatening event and people want it to terminate as soon as possible. They focus on ‘When will it be over?’, the attentional gate is wide open and the duration estimation becomes longer.

The ‘return trip’ feels shorter

When we have to be somewhere at a certain time for an important event, on the way there time relevance is high. That is why prospectively we experience the duration as being longer. Returning to the starting point, although it is exactly the same distance, feels in many cases shorter than going there because time is not that important and so our attention is diverted or distracted by events occurring around us (Roy, 2011).

Time flies when we are having fun, but a boring lecture never ends

When we focus our attention on a good

book, a movie or that special someone, and we don't have any obligations, the time relevance is low. The gate will be narrow and the signal count low. We may feel that time is not passing, but if we look at our watch we will be amazed to see how much clock time has elapse without our noticing.

Attending a boring lecture is like being in 'empty' time, because the information seems to be not useful for us so we are not processing it. Most of our attentional resources will be allocated to prospective timing, and again the gate model provides an explanation for the experience of duration in such cases.

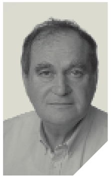
Time slows when we are in pain

When we are in pain, temporal relevance becomes high, leading to the feeling that the pain is going on and on. Emotions in general are known to influence and sometimes distort time perception. For example, Droit-Volet et al. (2004) found that exposure duration of pictures of emotional faces were overestimated compared to neutral ones. The attentional gate model might explain why we are relatively inaccurate in making timing judgements during emotional experiences. In some cases emotions demand attentional resources for coping with them, and then duration estimations will be underestimated. In other cases, especially when emotions have a threatening meaning like in the case of fear or pain, time relevance will be high. In such cases the duration estimation will be overestimated.

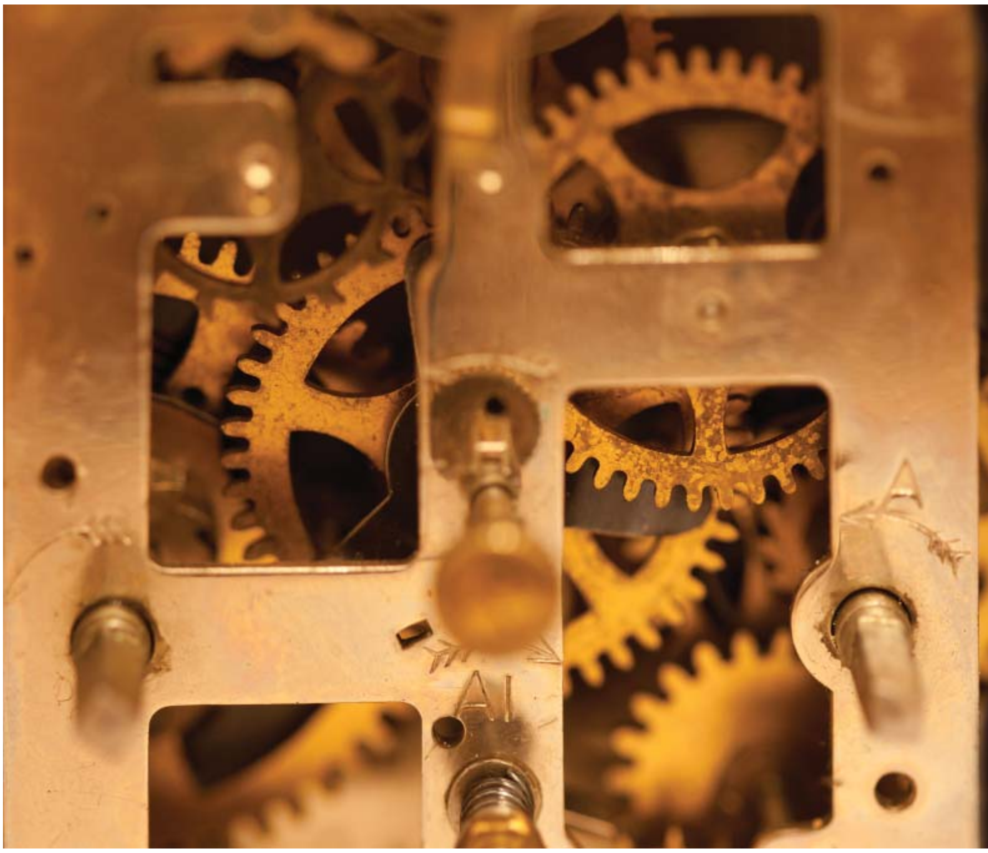
Conclusions

What are the implications of all this? Well, in many situations it is advantageous to cause people to experience durations as short. Think of shops, call centres or in amusement parks. If people experience boring, long waits they might leave, taking their money with them. So such venues might attempt to shorten duration experiences by, for example, diverting attention from time to nontemporal, interesting attractive events. In amusement parks there are usually activities such as TV screens showing cartoons distributed along the queue, or clowns going around; in a call centre, background music will be used. Such activities divert people's attention away from time.

The nature of the cognitive processes involved in duration estimation causes the experience of time to be relativistic: in psychological time, the same clock interval may be over- or underestimated depending on the factors we have explored. Retrospective time-duration estimations are based on the amount of information about changes retrieved from memory, while prospective time-duration estimations are based on the 'reading' of the internal clock. As a result, our sense of time is not accurate, though in most cases it is sufficient for our needs. The contextual change model and the attentional gate model provide explanations for most of our daily experiences of duration, but there are so many important dimensions of time that further research will continue to deepen our understanding of the field for many years to come.



Dan Zakay
is Professor of Cognitive Psychology at the Interdisciplinary Center, Herzeliya, and Tel-Aviv University, Israel
dzakay@post.tau.ac.il



Extra time

In addition to four more pieces in this issue, we also have two online-only articles.

For Clare Allely (University of Glasgow) on how emotions cloud our sense of time and Luke Jones (University of Manchester) on time and information processing, see www.thepsychologist.org.uk