Chapter 1

When Time Slows Down: Subjective Duration

When we queue at the post office or listen to a boring lecture, something happens to the texture of time: it becomes viscous, drags and almost comes to a standstill. Most of us are familiar with this feeling of time slowing down and do not give it a second thought. However, the mechanisms at work in such everyday experiences also govern more dramatic events, when time slows down to the extent that we seem capable of almost superhuman perception. Let us look at an especially dramatic example from a police officer's report:

> During a violent shoot-out I looked over, drawn to the sudden mayhem, and was puzzled to see beer cans slowly floating through the air past my face. What was even more puzzling was that they had the word *Federal* printed on the bottom. They turned out to be the shell casings ejected by the officer who was firing next to me. [1]

The policeman must have thought twice before handing in his report. Seeing beer cans flying in slow motion does not look good in such a document. But, in fact, his account was taken very seriously indeed, for he was by no means the first officer in the force to have reported a distorted perception of time in a stressful situation.

In his book *Into the Kill Zone*, David Klinger describes similar experiences of officers caught in moments of high stress, such as armed confrontations. Many of them reported, like the officer who saw the beer cans, that time had slowed down: "Then the guy reached down towards

the bulge in his waistband. At that point, things went into slow motion, and I said to myself, 'If he reaches under the shirt, I'm gonna shoot him'." [2]

Some also described the sensation of "tunnel vision" – that is, the field of vision being reduced to a small blob, as when looking down a tunnel: "Another thing I remember is that when the guy turned and started firing, I got tunnel vision on him." [3]

Another common feature of these confrontations was loss of hearing – or, more exactly, a shutdown of auditory perception.

> I knew the guy was shooting at us because I saw him shooting, but I didn't really hear the rounds going off. The audible start-up and 'BANG!' that usually happens when you pull the trigger wasn't there. (...) At the time, I didn't know my partner fired because I didn't hear his shots. [4]

Tunnel vision, failing to hear pistol shots, reading an airborne shell casing – how can distortions like these be explained? What actually happened to that officer when time slowed down and he thought he saw beer cans floating past?

Before taking up these questions, let's look at the experiences of some other types of people who have reported a narrowed focus and a slowing down of time.

Buddhist monks in meditation, for example. Some have talked of a stretching-out of time. There are cases, indeed, of individuals for whom, when focussing on a single object in meditation, time has come to a standstill.

According to the *Mahabharata*, a Sanskrit epic from ancient India, the senses become so inhibited in this intense contemplative state that the individual does not hear, smell, taste or see, nor does he experience touch. All his ideas revolve around the object of meditation – a literal example of single-mindedness. As a result, sensory stimuli are excluded, the mind ceases to imagine – and time slows down.

Exponents of Japanese martial arts have described a condition they call being "in the zone". This, too, is a state of slowed-down time – one which can often be brought about at will. In Aikido and Taekwondo, for

example, the focus is on the use of energy to fend off the opponent or to gain control over him. For practitioners of such forms of combat, to enter "the zone" is to be able to see the opponent's movements in slow motion. Consequently, he can be observed in more detail and the observer can react more quickly. [5]

Professional baseball players, too, have reported the sensation of being "in the zone". For them, the tempo and the action of the game slow down, and they become acutely aware of what is happening. American batter Tom Gwynn says that when he was "in the zone", the pitched ball appeared to come in so slowly that he could actually see the seams on it.

This state of total immersion is also known as "flow", a term used by psychologist Mihály Csíkszentmihaílyi. [6] In this state, a person is fully involved in and focused on what he is doing. The experience of flow is accompanied by a high degree of concentration on a narrow focus and complete absorption in a task, up to the point of merging awareness and action.

Fig. 1.1. Absorbed in play.

It is marked, too, by a distorted sense of time and the idea of clear goals which can be effortlessly attained. For instance, musicians – whether as individuals or as part of a group – may experience flow when playing

their instrument. Similarly, athletes may achieve their best performances without feeling any pressure. And children can become totally immersed in play to the extent of being lost in it.

Observing the seams of a flying ball or the writing on a floating shell casing, perceiving the tactics of an opponent in decelerated motion, meditative time-stretching – such intense sensations may not have been shared by many of us. But still, the experience of time slowing down is familiar to everyone.

In movies, for example. We readily accept slow motion on the screen, as in the scene in *The Matrix* which features so-called "Bullet Time": a computer-generated form of extreme slow motion, during which details become visible which are normally imperceptible because they happen too fast. For instance, flying bullets move through the air so slowly that they can be intercepted or evaded.

Computer games use similar effects. For instance, "The Bourne Conspiracy", an espionage video game, simulates a slowing down of time: The player can build up the avatar's [7] adrenaline and then spill it in the game to slow down the action, so that everything around the avatar appears to happen in slow motion. During the few seconds that a slowing down of time is simulated, the player can react at what, to other players and their avatars, may seem like lightning speed, as they do not experience the same temporal distortion. [8]

Most of us know how palpably time can slow down when we are deep into an especially absorbing task or activity: a yoga practice or a meditation session are examples of "positive" time dilation, that is to say, a pleasant experience of time stretching. But we also know how mercilessly time can drag out when we are waiting for an overdue bus or trapped in a slow-moving supermarket queue. When we wait for something specific to happen or when we are bored, the texture of time becomes sticky, loses pace and almost comes to a standstill.

How do these distortions come about? To find an answer to this, let's revisit our witnesses to slow motion time – the monks, law enforcement officers, martial arts exponents and baseballers – and see what they have in common and where they differ.

Clearly, one thing they shared in their varied experiences is that parts of their perceptual system shut down and left open a very narrow focus.

For the meditating monks, cutting out sound, smell, vision, taste and touch left them with nothing but their thoughts, in pursuit of *dhyana*: the "single flow of ideas". For the police officers, much of their perceptive apparatus closed down in a state of stress, leaving them to focus on just one aspect – beer cans, a bulge under a waistband, a flying shell casing.

Fig. 1.2. Bored taxi driver [9]: a case of slowed down time.

The Aikido and Taekwondo combatants deliberately induced time to decelerate by focussing on nothing but their opponent's movements. And for the baseballer "in the zone", focussing on the speeding ball, an unexpected amount of detail suddenly became visible.

But how to explain the slowing down of time which was reported in all of these cases? One commonly held belief is that adrenaline activity is responsible – as seems to be the case with the playstation player who spills a quantity of the hero's virtual adrenaline. It is true that, in circumstances of high pressure – in a serious accident, say, or in armed combat – the sensation of time slowing down is often accompanied by an adrenaline rush. Parts of the body can shut out: the heart rate may fall, sensitivity to pain may be lost, together with peripheral vision and the capacity to register sound. And attention can become geared to one tiny aspect of the world, as in tunnel vision. It may be tempting, then, to see a causal relation between adrenaline rush and the slowing of time.

A stressful, intensely dangerous situation, such as an impending car accident, is often accompanied by large adrenaline spillage and by the

experience of slow motion time. We have all heard – and, perhaps, can testify from personal experience – how time seems to slow down in such moments. Events and actions seem to pass more slowly than we are accustomed to. This sensation is very often described cinematically: "everything seemed to slow down, like in a film".

Slow motion film scenes are, of course, the result of high-speed photography. The increased number of frames are run through at the regular rate of frames per second, so that a slowing down of time is induced. To put it another way, the temporal resolution of the photographic images is deliberately distorted.

Could our experience of slow motion time under stress also be explained in terms of temporal resolution – like the increased number of frames photographed and projected in a movie? Neuropsychologist David Eagleman tried to find out whether the slowing-of-time experience could be linked to "neural snapshots clicking faster during a high-adrenaline situation" [10]. He asked test subjects to take part in an experiment in which they had to jump off a 50-metre tower into a net. Each subject was asked to estimate the duration of the fall. In contrast to bystanders, the jumpers invariably overestimated the duration. So a correlation between adrenaline spillage and time dilation was shown to exist in this, as in other stressful situations.

Next, the question as to whether these perceptions were due to high-speed neural snapshots was put to the test. All the jumpers had a small computer strapped to the wrist which displayed numbers moving in succession. They flashed by slightly faster than the maximum speed at which individual digital numbers can normally be distinguished. The subjects were asked to read those numbers during their free-fall. But none of them were able to do so, nor were they better at making out the flashing numbers than the bystanders were. So Eagleman concluded that the jumpers did not perceive that time slowed down as a result of being in a high-adrenaline situation – did not, in Eagleman's words "obtain increased temporal resolution during the fall." [11] Instead, he concluded, "because memories are laid down more richly during a frightening situation, the event seems to have taken longer in retrospect." [12]

Eagleman's findings suggest that temporal resolution is not increased as a result of "snapshots" being taken at a faster rate during stressful situations. To put it another way, we do not seem to perceive a larger number of successive stills when we spill adrenaline. While this would rule out higher temporal resolution as the cause of slow motion time in such situations, Eagleman attributes slow motion time to the fact that we lay down more memories when we are under stress. We shall return to this question in Chapter 7 when we look the impact of global and local perspectives on our perception of duration and show that laying down more memories can be a result of higher temporal resolution.

Fig. 1.3. High-speed photography: Higher temporal resolution allows us to perceive more detail. [13]

Although high-adrenaline situations may correlate with the perception of time slowing down, no causal connection has as yet been established. An argument against such a simple causal relation is the fact that no such adrenaline activity occurs in case of the Buddhist monks who inhibit their senses at will. So this cannot be the fundamental cause of the phenomenon of time distortion. To find a general explanation, it is worth turning aside from physical impacts – such as adrenaline rush – and looking, instead, at how time itself is structured.

In normal circumstances, we can hear, see, smell, taste and touch things simultaneously. To put it another way, there is a high degree of

simultaneity in the way we perceive the world around us. If we shut out any of our senses or thoughts, then this will automatically reduce the number of things we perceive at the same time. If we go further, and focus on one thing only – like a Buddhist monk focussing on a mantra – then we create even less simultaneity. Our Now is, so to speak, reduced to a one-dimensional perspective, with no other stimuli at work.

Focussing on a reduced perspective means, to all intents and purposes, that fewer things are happening at the same time. For a police officer, a colleague nearby may be firing a gun which, in other circumstances, would be extremely audible as well as visible. But, for a man under stress, with tunnel vision and his hearing shut down, his Now is a highly limited, focussed experience, with no sound to be heard and nothing else to be seen.

Before we go further, there is a surprising effect we should look at. It concerns the question of how we remember the length of time periods. Retrospective time judgement is generally attributed to memory storage or contextual change. The greater the content stored or embedded into a context, the longer is the time interval judged to have been in retrospect. [14]

In his so-called "Armageddon experiments" [15], psychologist J.H. Wearden sought out to test our perceptions of duration. In the experiments, participants were asked to watch a scene from the film *Armageddon* and to spend the same time in a waiting room. Wearden asked participants to estimate the length of time spent in these activities.

According to his findings, participants felt that time seemed to fly during the scene-watching, while it dragged during the waiting period. However, when they had to make a *retrospective* judgement, the results were the opposite. [16] That is to say, despite feeling that time had flown while they were watching the film scene, participants later judged that period as being longer than the time spent in the waiting room.

We may say that, for the participants, time passed subjectively more quickly while watching the film scene because its visual effects and sounds created a lot of contextual change. That is to say, events were nested into ever-new contexts, so that a high degree of simultaneity was created. In the waiting room, on the other hand, there was little

contextual change: participants basically concentrated only on waiting. In their Now, deprived of simultaneity, time slowed down.

Why is this so? Why might we judge the length of an event differently, depending on whether we experience it within our Now or we remember it later? The amount of content and contextual change, i.e., how much is happening and is embedded in our Now, seems to be crucial to our judgement of duration. Wearden suggests that judgements made in retrospect are based on how much information was processed during the actual experience: Not much happened in the waiting room, therefore time passed slowly. But we remember a period which did not contain many events as having passed faster than a less eventful one. On the other hand, time may pass quickly while we are watching an action-packed film, but when we look back on it, we judge it to have been long-lasting.

Far from being limited to isolated events, this phenomenon may be extrapolated to the span of a lifetime. Thomas Mann's novel *The Magic Mountain* contains a beautiful account of how differently we judge the duration of eventful and uneventful years. His protagonist Hans Castorp muses on the topic of time and memory in this way:

> Emptiness and monotony may dilate the moment and the hour and make them 'tedious'; the great and greatest periods of time, though, they shorten and fade away even into nothingness. Conversely, rich and interesting content is capable of shortening and quickening the hour and even the actual day; on a large scale, though, it endows the course of time with breadth, weight and solidity, so that eventful years pass much more slowly than those poor, empty light years which the wind blows before it, and which fly away. So, actually, what we call tedium is, rather, a pathological diversion of time, resulting from monotony: in conditions of uninterrupted uniformity, great periods of time shrivel up in a manner which terrifies the heart to death .... [17]

"Rich and interesting content" may be interpreted as "a lot happening at once", i.e., a high degree of simultaneity. We may also say that "breadth,

weight and solidity" result from an increase in simultaneity. This simultaneity may include new during-relations which arise in the act of recollection itself: the old content is embedded in new Nows. [18]

In a nutshell, our perception and memory of duration can be described in terms of the degrees of simultaneity experienced (see Table 1.1). To account for these notions, a theory of time is needed which takes account of the way in which simultaneity arises. In pursuit of this, we shall – in Chapter 2 – take a closer look at the nature and structure of our Now – our only window to ourselves and the rest of the world.

Table 1.1. Duration now and in retrospect.

	Duration perceived in the Now	Duration remembered in retrospect
Eventful moments/years: high simultaneity (many parallel events)	Time is contracted, speeds up, "flies"	Long time span
Uneventful moments/years: low simultaneity (few parallel events)	Time is dilated, slows down, "drags"	Short time span

References

1. Alexis Artwohl: Perceptual and Memory Distortion During Officer-Involved Shootings, in John E. Ott (Ed.), *FBI Law Enforcement Bulletin*, Oct. 2002, Vol 71, No 10, FBI, Pennsylvania Ave., Washington, DC.
2. David Klinger: *Into the Kill Zone*. Jossey-Bass, San Francisco, 2004, p. 68.
3. ibid, p. 60.
4. ibid, p. 60.
5. In esoterically tinted literature, this phenomenon is also referred to as "lentation" or "chronokinesis".
6. Mihály Csíkszentmihalyi: *Flow – The Psychology of Optimal Experience*. HarperPerennial, New York 1990.
7. An avatar is a graphical representation of a computer user in computer games or other virtual realities to allow the him to identify with a hero or villain.
8. *The Bourne Conspiracy* by Sierra Entertainment 2008. Developed for Playstation 3 and Xbox 360.
9. Photograph courtesy of Rachel Crawford

10. The Eagleman Lab (http://neuro.bcm.edu/eagleman/time.html)
11. ibid.
12. ibid.
13. Photograph courtesy of Jeffrey Clement
14. J.H. Wearden: The Wrong Tree: Time Perception and Time Experience in the Elderly, in: Measuring the Mind: Speed, Control and Age. Edited by John Duncan, Louise Phillips and Peter McLeod. Oxford University Press 2005, pp. 137ff.
15. ibid.
16. They were asked to read a novel for ten minutes to create a break between the two experiments.
17. Thomas Mann: *Der Zauberberg* Fischer, Frankfurt, 1984, pp. 110-111. First published in 1924. (my translation)
18. Hans Castorp's experiences can be described in more detail against the background of a fractal concept of time, which will be introduced in Chapter 2. For now, the notion of simultaneity is sufficient to explain the differences in perceived and remembered duration.