Chapter 9
The Time of Experience and the Experience of Time

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Abstract Philosophers have usually approached the concept of timing of experiences by addressing the question how the experiences of temporal phenomena can be explained. As a result, the issue of timing has been addressed in two different ways. The first, similar to the questions posed in sciences, concerns the relationship between the experienced time of events and the objective time of events. The second approach is more specific to philosophers' debates, and concerns the phenomenology of experiences: how is the apparent temporal structure of experiences constituted? In regard to both questions, this article shows why and how philosophers' views differ from those held by most scientists. To conclude, I present a combination of views that is not only compatible with that of scientists, but also addresses the problems that engage philosophers.

[Keywords: Timing of experiences; Specious present; Time consciousness; Postdiction effects; Brain-time]

9.1 Introduction

This chapter focuses on the timing of experiences as it has figured in philosophy. More precisely, the topic of interest concerns the general principles that, considered from both an objective and subjective point of view, determine the moment when some experiential content is experienced.[1] Due to the nature of philosophical investigations, this topic has been approached through the general principles related to timing and philosophers' views have been strongly shaped by the other debates in which they are engaged. For example, philosophers are more concerned with the phenomenology and the metaphysics of time than scientists who often focus on performance in particular time-order tasks and measure the timing of experiences in milliseconds (Arstila 2011). Accordingly, philosophers' views are best understood by examining the positions they oppose and problems they try to address. Let us therefore begin our consideration by explicating a view that, while simple and initially plausible, is endorsed by no philosopher.

Presumably, the simplest view on the temporal properties of experiences is the following: The presentation of a stimulus is first registered by sensory receptors, after which information about the stimulus is transmitted to the cortex. The main processing takes place in the cortex and—assuming that we experience the stimulus in the first place—we experience the stimulus as soon as the processing is completed, and it is experienced to occur at this time. Moreover, the experience ends when the neural processing is no longer sustained. In other words, our experience is an "online … phenomenon, coming about as soon as a stimulus reaches its 'perceptual end point'" (Eagleman and

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[1] By experience I mean the whole phenomenology of one's subjectively experienced moment regardless of whether that moment is subjectively speaking temporally extended or not. If not otherwise mentioned, (experiential) content refers to a conscious inner occurrence that is an individual element of an experience.

Sejnowski 2000, 2036). Thus, if a stimulus reaches this hypothetical perceptual end point before another stimulus reaches the end point the two are experienced to occur in this order.

This view is defined by three theses about the temporal properties of our experiences. The first, *the thesis of minimal delay*, concerns the temporal relationship between the objective time of occurrence of experiences and the events our experiences are about. It states that our experiences of external events are only delayed by the time it takes for light and sound to reach our sensory receptors and for our neural mechanisms to process the stimulus. To put this somewhat differently, because we experience events as soon as the processing is completed, that which we experience always occurred a bit in the past.

According to the second thesis, which I call *the thesis of temporal isomorphism* (see Mölder 2014), the time when something is experienced to occur is isomorphic to the time of the neural processes realizing the experiences. This thesis thus concerns the relationship between the apparent or subjective time of an experience and the objective time when its neural correlates take place. Because the thesis claims that the time of the neural correlates of experiences matches the apparent time of experiences, the relationship is the simplest one possible. For example, because the apparent temporal order of experience simply mirrors the temporal order of neural events that underlie the experiences, we experience that A occurred before B because this is the order in which the cortical analyses are completed. This means that the temporal properties such as time-order do not need to be represented separately in experiences. Thus, this position has been referred to as the *time as its own representation view* (Kiverstein and Arstila 2013). Other expressions, e.g., *the braintime view* (Johnston and Nishida 2001) and *the brain-time account* (Yarrow and Arnold, this volume), emphasize how experienced temporal properties are determined by the temporal properties of neural events.

Finally, if experience is an online phenomenon in which the experiential contents reflect what is processed at the perceptual end point, then without additional arguments, this view also suggests that the experiential contents are confined in moments. After all, once something is not processed at the perceptual end point, it is not part of our experience anymore. Thus, all that we experience we experience as occurring now. This leads to the last thesis, *the thesis of instantaneous contents,* according to which the contents of our experiences are confined in an instant.

These three theses make the approaches to the timing of experiences simplest possible one and I will hence refer to them collectively as *the simple view on the temporal properties of experiences* (in short, the simple view).[2] Despite its tempting simplicity, this view is almost unanimously rejected by philosophers. The reason for this will be discussed in the next section. It begins by discussing the thesis of instantaneous contents, which has drawn the most attention from philosophers. The remaining two theses, which relate more directly to the issue of the timing of experiences as the issue is often considered, will be discussed afterwards. If the thesis of instantaneous contents is rejected, then our experiences appear to us as temporally extended. How this apparent temporal structure of experiences is explained is the topic of section three. The simple view, and how it can meet the objections raised against it, will be revisited in the final section.

[2] Rick Grush (2008) refers to the similar view as *the standard view*. There are, however, two differences between the views. First, Grush is "not concerned with" the small processing delays and thus do not differentiate between minimal delay and extra delay positions as regards the thesis of minimal delay. Second, whereas the thesis of temporal isomorphism is understood here as a claim that concerns the experienced temporal order of events and the temporal order of neural processes realizing these experiences, Grush makes this an issue of passive registration versus active construction of experiences. Given that one endorsing the simple view can hold both active and passive views on perceptual experiences, Grush's claim is an additional issue within the thesis of temporal isomorphism.

9.2 Three Theses of the Simple View and Philosophical Theories of Time Consciousness

9.2.1 Instantaneous Contents of Experiences

Philosophical theories of time consciousness, which aim to account for how time and temporal properties figure in our consciousness and as contents of phenomenal states, can be classified into roughly three groups. The first, called *the snapshot view*, is similar to the simple view. Both are committed to the thesis of instantaneous contents, which is the idea that our experiences are both objectively and subjectively confined to practically momentary points in time—to snapshots. Many scientific theories concerning the timing of experiences concur with this thesis as well, even if they reject the other theses of the simple view (e.g., Eagleman and Sejnowski 2000; Eagleman and Sejnowski 2007).

The snapshot view is rejected by all but a few philosophers because accounting for temporal experiences has proven difficult within this framework. Temporal experiences are those that imply the passing of time. Husserl's favorite example was the experience of hearing a melody. More recently, philosophers have focused on experiences of motion, succession and persistence. Thus consider, for example, an experience of motion. If we only experience what is taking place on a snapshot, then our experience of a moving object consists of the object in only one of its just-past (or predicted) positions—the experience of movement is missing. Likewise, while the snapshot view allows for a succession of experiences, this does not yet amount to the experience of succession. If succession is something that we can experience, then it seems that the snapshot view cannot account for it. Similarly, we could never really experience melody if our experience only consisted of the notes being currently played.

This line of reasoning has led philosophers to associate the snapshot view with the idea that, strictly speaking, we do not experience temporally extended events. Instead, motion, for instance, is merely inferred based on our memories of the previous positions of a stimulus and our perception of its current location. Hence, the snapshot view "reduces" to the view that our experiences are literally like frames in a movie—just like a single frame, an experience contains colors and shapes, but it does not contain anything that entails change, motion or succession. Barry Dainton (2010a) calls such a position *Phenomeno-temporal Antirealism*.

Despite this, the snapshot view does not entail the rejection of temporal experiences. Indeed, as will be discussed in the last part of the chapter, it is also possible to subscribe to *Phenomeno-temporal Realism* within the framework of the snapshot view. Nevertheless, because such possibility is very rarely mentioned (see Dainton 2010a), and the only existing well-developed version of the snapshot view denies the reality of temporal experiences, the two are not usually separated. To separate the snapshot view from this more restrictive form, which denies the reality of temporal experiences, I will follow Dainton and refer to the latter as *the cinematic model*.

Contemporary philosophers, however, almost take for granted the phenomenology related to temporally extended events. Thus, they maintain that we can experience change, motion and other dynamic events with the same immediacy that we experience colors and shapes. As a result, the cinematic model is outright rejected. Given that the model is not usually separated from the snapshot view, the latter is also rejected. Consequently, most philosophers argue that the contents of an experience are not confined in practically durationless moments, as the simple view holds, but rather that the contents of our experiences are temporally extended. This idea is known as *the doctrine of the specious present*.

The idea that an experience covers a temporal interval allows experiential contents that appear (for a subject) to occur at different times to be parts of a single experience. In this framework, the experience of one flash succeeding another can be explained as follows: At the time we experience the latter flash, the first flash lingers in our consciousness as past or preceding content. Because we

are conscious of both flashes during the same specious present, we also experience the succession. Correspondingly, James (1890, 574, his italics) argued that "It is only as parts of this *duration-block* [i.e., specious present] that the relation of *succession* of one to the other is perceived." Similarly, listening to a melody does not reduce to hearing one note at a time in isolation. Rather, the previous notes still linger in our consciousness in some way when we hear that which is currently being played.

If our experiences indeed cover an extended interval, it follows that the contents of experiences appear to one as temporally (or dynamically) structured. Otherwise, all things within one specious present would be experienced as simultaneous. This does not mean that the experience itself would be temporally structured in a sense that it has temporal parts—only that, to a subject, the experiential contents within one specious present appear as if embedded in a temporal or dynamic structure. Nevertheless, the apparent temporal structure is usually considered separate from the contents embedded within it. In James' (1890, 630) words, the contents of a specious present are "in a constant flux… Meanwhile, the specious present, the intuited duration, stands permanent, like the rainbow on the waterfall, with its own quality unchanged by the events that stream through it."

Saying that the contents of an experience are temporally extended is more a description of temporal experiences than an explanation of them (see, e.g., Gallagher 2009; Mölder 2014). In addition, an explanation of how the specious present itself is implemented is required. This is usually understood as the task of explaining the relationship between the objective temporal properties of a specious present and its apparent temporal structure. (A related task, namely how the contents of one specious present appear as temporally structured, is less discussed and will be elaborated upon in the third section.)

The provided explanations come in two main models, which form the remaining two groups of the philosophical theories of time consciousness. The first is the *retentionalist model* (or *intentionalist model*), according to which experiences take place, objectively speaking, in snapshots. However, true to the doctrine of the specious present, the contents of experiences are temporally extended. In more concrete terms, our experience of succession is thought to come about by having two experiential contents appear to be in succession on a single near-momentary experience. This is achieved when the first experiential content is presented as something that just occurred (retained content) while the other is presented as current content (primal image). The competing view, the *extensionalist model*, maintains that both the experiences and their contents are temporally extended. Thus, our experience of succession comes about when two experiential contents which really take place in succession are perceived as the contents of a single experience. So, what separates the two models is their stance on the relationship between the properties of an experience and its contents. Whereas the retentionalist model maintains that our experiences have longer subjective duration than they in fact have—experiences are (near-)momentary while their contents are temporally extended— the extensionalist model maintains that experiences and their contents share an identical temporal structure.

9.2.2 Temporal Isomorphism and Minimal Delay

The two other theses of the simple view are those of temporal isomorphism and minimal delay. The thesis of temporal isomorphism claims that the contents of our experiences and the neural states that underlie them share the same temporal properties. Thus, if the thesis is correct, the order in which stimuli is experienced to occur is the same in which the processing related to contents is completed.[3]

[3] The thesis of temporal isomorphism is not the same as the inheritance principle, which states that an experience possesses the same temporal properties as those which are apparently presented in the experience (Phillips 2014a; Phillips 2014b). For example, while the thesis of temporal isomorphism concerns the temporal relation between an experiential content and its neural basis, the inheritance principle concerns the relationship between an experience and what is being experienced. That is, the inheritance

The thesis of minimal delay concerns the temporal relation between external events and our experiences of them. It takes as its starting point the necessary delays in perceiving the events and assumes that such a delay is not compensated for in any way. Accordingly, although we appear to experience events immediately—as they happen—the contents of our experiences are always slightly delayed. Together, these two theses imply that the timing of our experiences is simply a matter of neural latencies. Each stimulus (or their features) are processed in parallel, and once the processing is completed—i.e., once the perceptual end point is reached—the stimuli (or their features) are experienced and they are experienced to occur in that very moment (e.g., not half a second ago).[4]

This position, i.e., the combination of the thesis of temporal isomorphism and the thesis of minimal delay, is challenged by the postdiction effects. These are effects in which a stimulus presented at a certain moment (e.g., objectively speaking at t_2) influences how we experience what occurred before the presentation of the stimulus (t_1). The postdiction effect that has drawn the most attention from philosophers is that of apparent motion (e.g., Grush 2005; 2008; Dainton 2008; Hoerl 2012), whereas scientists have focused more on the metacontrast masking and the flash-lag effects.

Consider, for example, an apparent motion experiment in which subjects are shown two brief, spatially separate flashes (flash F_1 in location L_1 and flash F_2 in location L_2) with an empty screen between the two flashes. In such experiments, subjects often report seeing one stimulus flash (rather than two) moving from L_1 to L_2. This is thus an illusion of movement caused by two stationary stimuli, not an illusion of perceived temporal properties per se. Yet, the mysterious part of the phenomenon is temporal: subjects report perceiving motion before the second stimulus. This is puzzling because the movement from L_1 towards L_2 cannot begin before L_2 is somehow determined. This means that the second stimulus must have been processed to some extent before the motion processing can begin. Accordingly, it is reasonable to assume that the processing of the second stimulus also ends before the apparent motion related processing has been completed. Thus, the simple view conflicts with these reports, as it predicts that the second flash should be experienced before the motion itself is experienced.

One response to this problem is to reject the thesis of temporal isomorphism. Just as our experiences can represent the color blue without the experience itself being blue, it is possible that the temporal properties as experienced differ from the temporal properties of the experiences. Thus, it could be that the experience of succession, for instance, does not require one to have two experiences in succession. Of course, this then means that the temporal properties of events need to be indicated or (re)presented in some fashion (e.g., by means of separate content). Accordingly, this position has been called *the temporal indicator view* (Mölder 2014), and it has also been referred to as *the event time* (Johnston and Nishida 2001). Although this view is less widely held among scientists than the braintime view, it is not without supporters (Nishida and Johnston 2002; Eagleman and Sejnowski 2007).

The first proposal along these lines, by Dennett and Kinsbourne (1992), is compatible with the thesis of instantaneous contents. It simply states that while, objectively, the experience of the second flash can occur before the experience of the movement, subjectively, the order can be

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principle does not take a stance on the neural processing. Then again, since the thesis of temporal isomorphism concerns the experiential contents, not experiences per se, it does not take a stance on the temporal structure of experiences. Moreover, whereas the snapshot view makes the inheritance principle trivially true, it does not make the thesis of temporal isomorphism true. Finally, while the inheritance principle has been used in arguments for the extensionalist model and against the retentionalist model, the thesis of temporal isomorphism is neutral between the models. (One could argue, for example, that the thesis holds for the primal images but not for retained contents because the latter are not really experiential contents.) See also Soteriou (2010); Hoerl (2013); Lee (2014). The claims discussed in these papers are not exactly the same as the inheritance principle, however. For example, Lee (2014) discusses *the mirroring view* and explicitly associates it with the idea that temporal experiences unfold over time. Hence, unlike the inheritance principle, the mirroring view would be incorrect as regards the snapshot view.

[4] This position is (often implicitly) held by scientists working on, for example, the perceptual simultaneity (Kopinska and Harris 2004), duration estimation and reproduction (Reutimann et al. 2004; Wittmann et al. 2010), and the flash-lag effect (Whitney and Murakami 1998; Whitney et al. 2000). For other examples, see Pfeuty et al. (2005); Arnold and Wilcock (2007).

reversed. This is because the latter is determined by the time-markers (temporal indicators) that accompany these contents (flash and movement). Laurie A. Paul (2010) also appears to argue for this position, as her description of apparent motion does not incorporate the doctrine of the specious present either.

However, the best-developed position rejects both the thesis of temporal isomorphism and the thesis of instantaneous contents. This is Rick Grush's trajectory estimation model. In short, he argues that our experience at t_2 can include, say, contents that represent interval $t_{0\text{-}2}$, and that our experience at t_3 has contents that represent interval $t_{1\text{-}3}$. While both experiences include contents covering t_1 and t_2, those moments are represented in two separate experiences. This means that the interval $t_{1\text{-}2}$ "can be re-interpreted" (Grush 2007) and hence, the way in which $t_{1\text{-}2}$ is constructed in experiences which are taking place at t_2 and t_3 can be different. In particular, our experience at t_2 may represent that an empty screen was presented at t_1, while at t_3 we experience that there was movement at t_1. Thus, in this explanation, the empty screen is initially experienced in the apparent motion experiments. However, once the second flash is registered and sufficiently processed, the experience of an empty screen is rewritten to represent (apparent) movement.[5]

While this alternative position is compatible with both the snapshot view and the retentionalists model, it is not compatible with the extensionalist model. The reason for this is that, in this alternative position, the experience of the empty screen is really already in the past at the time when the need for the revision arises. Thus, the extensionalist model needs to account for the apparent motion by other means. This can be done by rejecting the thesis of minimal delay and maintaining that our experiences are delayed more than the neural processing necessitates. One reason to hold this view is based on the idea that our experiences are underdetermined by sensory signals and that in order to make experiences more accurate, our sensory system makes use of the sensory signals of events occurring before and after each signal. Thus, our experiences of events that happen in t_1 would be influenced by the events that occur at t_0 and t_2, which in turn requires that the neural correlates of experiences of events at t_1 are delayed until the events at t_2 are taken into account (Eagleman and Sejnowski 2007; Eagleman 2010).

In this framework, the experiences of apparent motion are explained by postulating that the information related to F_2 is taken into account before we experience the empty screen. Although at one point we have registered F_1 and the empty screen, we never become conscious of them as such. Instead, "as soon as the second flash [F_2] registers, our visual system reaches the conclusion that the likely source is a moving light, and this is what we experience" (Dainton 2010b). In other words, the order of the processing related to conscious experiences corresponds with the experienced order of events—the thesis of temporal isomorphism is held—whereas the pre-experiential processing corresponds with the temporal structure of stimuli. Unlike the previous alternative, this one is compatible with all three positions on temporal experiences because the differences between them concern the nature of experiences and their contents, whereas in this alternative the revisions occur pre-experientially.

In short, the problem that the postdiction effects pose for the simple view is due to the combination of the thesis of temporal isomorphism and the thesis of minimal delay—it appears that one can subscribe to one but not both. Neither of the presented solutions is ideal, however. On the one hand, the notion of temporal indicators remains underdeveloped (see the next section). On the other hand, the idea of added delay in perception is implausible based on what we know of latencies in neural processing (Arstila forthcoming; Dennett and Kinsbourne 1992) and it has been argued that delays in perception could be costly (Grush 2007).[6]

[5] Grush's view resembles Dennett and Kinsbourne's idea of Orwellian revision. However, Grush maintains that the experience of the empty screen is revised, whereas in Orwellian revision it is the memory of the empty screen that is revised.

[6] Grush argues that our behavior in the world would be more effective if the processing delays were compensated for. Nijhawan (1994) likewise proposes that our sensory system extrapolates the trajectory of a moving stimulus, and this extrapolated position is what we experience. For a similar suggestion, see also (Changizi et al. 2008). It is worth noticing, however, that the compensated

Consequently, one might be tempted to reject the correctness of the subjects' reports in the postdiction experiments. Hence Dennett (1992, 44), for example, rejects the idea of "filling in," namely that subjects' experiences include a "continuous (or even roughly continuous) representation of the motion" between locations L_1 and L_2. Christoph Hoerl (2012) agrees with Dennett's view in this respect, but also proposes that subjects still have an experience of pure motion (i.e., a feeling of movement without an experience of something changing its location continuously as a function of time). However, the rejection of the idea of filling-in appears questionable in the light of empirical evidence. For example, when subjects experience motion in apparent motion experiments, there is a continuous representation of motion in the primary visual cortex (Larsen et al. 2006; Sterzer et al. 2006). Likewise, the trajectory of apparent motion causes the same kind of motion masking as the real motion (Yantis and Nakama 1998; Schwiedrzik et al. 2007). In regards to the other postdiction effects, it is worth noting that Dennett and Kinsbourne (1992) are also incorrect in their claim that psychophysics does not tell us whether the target stimulus is initially perceived in the metacontrast masking experiments (Breitmeyer et al. 2004; Todd 2009). Consequently, it is doubtful that the simple view can be saved by denying these reports concerning the postdiction effects.[7]

9.3 How is Subjective Time Constructed?

The thesis of temporal isomorphism and the thesis of minimal delay touch upon the issue of the timing of experiences in relation to the objective measures of timing: How does the experienced time of events relate to (i) the real time of events and (ii) the time of neural processes underlying the experiences? If the thesis of instantaneous contents is rejected, one can also ask another question as regards the timing of experiences: how is the time when the experiential content is experienced determined when considered purely from the subjective point of view?

In effect, this is a question about the nature of the apparent temporal structure of experiences because the experiential contents in question are embedded in such a structure, and this structure enables us to have an experience whose contents appear as being in some temporal relation to each other (e.g., one content preceding another). Once we have an explanation of how the temporal properties of experiential contents within specious present are expressed in our phenomenology, we also have an explanation of how we can have an experience with two contents in a way in which one of them appears to us as preceding the other.

Concerning the question of how the contents within specious present are experienced as temporally ordered, the first response appeals to the idea of a necessary dynamic character of experiences, i.e., the experienced flow or passage of time. This flowing character is assumed to be common to all experiences, and thus Dainton (2000, 114) suggests "perhaps this is why a strictly durationless sensory experience, existing all by itself, seems impossible to conceive." Pelczar agrees, and argues that each experience possesses some kind of dynamic content (e.g., change, succession, or something as enduring)—all conscious experiences include "earlier and later parts or phases" (Pelczar 2010, 52).

Furthermore, Dainton argues that this intrinsic dynamic character explains our temporal phenomenology. The flowing character makes the apparent temporal structure of experiences directionally asymmetrical. This means that the dynamic character is understood as a sort of mental momentum that automatically orders items within the specious presents. Hence, the structure is explained by appealing to the idea of the dynamic and directed characteristic of experiences.

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processing delays themselves cannot account for the postdiction effects when the effects occur in situations that cannot be predicted beforehand.

[7] For a more detailed discussion on the apparent motion and different explanations for it, see (Arstila forthcoming).

This response is rather disappointing, however. While it is true that it explains how the contents within specious present are experienced as temporally ordered, the explanation relies upon the dynamic temporal nature of specious presents which is a "fundamental and inexplicable feature of conscious experience" (Pelczar 2010, 58). This makes the response more like a description of the apparent temporal structure of experiences rather than an explanation of it. Whereas previously our temporal experiences remained unexplained, now the structure that explains our experiences is unexplained. This "solution" simply pushes the problem to another level of explanation.[8]

Moreover, the similar "explanation" would hardly be satisfactory in regards to the apparent spatial structure of experiential contents. Patients with visual orientation disorder, for example, see objects and recognize their shapes. However, they are often unable to estimate how far away objects are, and they cannot estimate the relative size and position of objects placed before them. It is therefore unsurprising that they repeatedly run into objects—even walls!—although they are able to describe and recognize the objects by sight (Holmes 1918). This disorder brings forth two issues. First, some mechanism is responsible for the apparent spatial structure of our (visual) experiences, and thus, there is a story to be told concerning how this structure is achieved. One aspect of the story is whether experiential contents are embedded in some pre-existing subjective coordinate system or whether the spatial structure of a visual field is subordinate to the experienced spatial relations between the contents. Second, there is an open question about whether all experienced spatial properties should be treated similarly, given that this disorder does not prevent patients from seeing some spatial properties.

If such questions regarding the apparent spatial structure of our experiences can be asked (and in fact answered), then similar questions can justifiably be asked concerning the apparent temporal structure as well. For example, it is reasonable to expect an answer to the question of whether the apparent temporal structure (or the intrinsic dynamism) is primary to the experiential contents—as James, Gallagher and Dainton appear to argue in most places[9]—or whether it is subordinate to the experiential contents—as Dainton and Gallagher's discussion on the flexibility of the duration of specious present suggests. Likewise, it can be asked whether all temporal experiences should be treated similarly or whether some temporal phenomena can be experienced without specious present. Moreover, it is also interesting to ask whether two contents could be part of the same specious present without us being able to discern their temporal order. In some theories (as in Dainton's view) this is not possible, whereas in others (possibly in Grush's view) some kind of comparison might be needed.[10]

The second way to account for the apparent temporal structure of experiences allows us to make progress on these issues. This response appeals to explicit temporal properties of subjective time which are similar to those Dennett and Kinsbourne suggested as a solution to the postdiction effects. According to this response, the contents of experience are accompanied by a time marker that represents when they were perceived. Consequently, the time markers form and order the apparent temporal structure of experiences.

Before this view can be properly evaluated, however, the notion of time markers needs to be developed more. For example, the idea can be interpreted in two ways. On the one hand, the time markers could be fixed by temporal coordinates, which would mean that there is a pre-existing

[8] In accordance with this, Gallagher (2009, 200) points out that "[if] we say that the phenomenal contents have an intrinsic flow structure, is that anything more than saying that consciousness itself just has an intrinsic flow structure?"

[9] E.g., James (1890, 630) argues that the "intuited duration, stands permanent" although its contents are in constant flux. Likewise, Gallagher (2009, 200) argues that according to the retentionalist model, which he holds, retention is "not a particular thing in consciousness" but a structural aspect of consciousness that together with other aspects "is taken to be one of the things that require explanation." See also Dainton (2000; 2008).

[10] Thus the theories of the first class need to somehow explain empirical results which suggest that we can tell that two auditory stimuli are asynchronous, but cannot tell their temporal order. E.g., one could argue that performance in these experiments is not based on the experienced temporal properties per se. Instead, they could be based on (i) a difference in the perceived spatial locations of synchronous and synchronous stimuli, or (ii) the two stimuli appearing different in some other respect.

temporal coordinate system on which perceived objects are located. This is one interpretation of retentionalists' notions of "now," "just-past," and "past." On the other hand, the time markers could also be relative, meaning that the temporal location of an experiential content is determined in relation to other experiential contents—the experiential contents always appear to be simultaneous or succeed each other. The totality of such relations then organizes the apparent temporal structure of specious present. Pelczar appears to hold a view similar to this, and it is presumably compatible with the extensionalist model as well. (That is, adopting a notion of time markers does not necessarily mean that the thesis of temporal isomorphism is rejected.)

Although both positions need to be developed more[11], it seems safe to say that the lack of certain deficits argues against both and the existence of mechanisms responsible for time markers in general. Insofar as time marking is caused by some mechanism, it is susceptible to breaking down at some point, with corresponding loss. For example, due to deficits in naming color, recognizing faces, and being able to understand spoken language, scientists have been able to postulate the existence of neural mechanisms related to these abilities. In a similar way, if time markers (the time as represented) determine when something is subjectively experienced to happen, one would assume that corresponding deficits exist. As regards the mechanism for allocating absolute or literal time markers for each experiential content, this would mean that there should be cases in which time markers will always be somehow mixed. For example, one would always experience—separated from cognition—things in the past. Or all temporal markers could be incoherent, and consequently, all the experiences could be in temporal disarray. If the time-markers are understood in relative terms, then there should be cases in which subjects will never experience simultaneity or temporal order. Concerning both possible forms of the time marker, it could also be that no experiential content is time marked at all. Given that there are no known empirical cases that resemble these hypothetical cases, the picture provided by the operation of time markers remains unsubstantiated.

The third explanation for the nature of specious present is consistent with those previously mentioned in that all contents of a specious present are experiential (or as it is sometimes expressed, sensory). Differing from the previous explanations, however, it holds that the contents are presented under different temporal modes. (Dainton calls this *modal conception of specious present*.) In other words, the claim that we experience one content "as present" and another as "just past" should not be understood as having two contents with the same phenomenal presence but accompanied by different, explicit time markers. Instead, the apparent temporal structure of specious presence is brought about by temporal modes; we experience A as preceding B because A is presented as "having occurred already" and B is presented as "currently occurring."

Although this view has been held, or at least entertained, by some of the best philosophers working on time consciousness, it has proven most difficult to state clearly what the temporal modes of presentation are. C.D. Broad (1938), for example, characterizes the temporal modes in terms of different degrees of presentedness, but he never really defines what presentedness means. Husserl (1991), on the other hand, is explicit in how the temporal modes of presentation (especially retention) differ from memory or imagination. He also explains that the temporal modes of presentation are not a matter of the vivacity experiences, because we can experience a weak stimulus and a strong stimulus as simultaneous—the experienced difference in their vividness does not make one of them more "current" and the other more "past." Nevertheless, such claims do not amount to a positive characterization of temporal modes of presentation, and it is indeed something that Husserl did not provide either. The difficulty of explaining the temporal modes of presentation

[11] The first one, for example, must answer the question of whether or not there needs to be a mechanism responsible for interpreting the time markers and determining the order or time of events. The second one, for example, must tell how a single experiential content can be experienced to have duration, given that in this case there are no relative temporal markers that bring about the temporal structure. Clearly, these issues do not refute the view but only illustrate that the notion of time markers remains underspecified by philosophers (and scientists).

is possibly due to the fact that, for Broad and Husserl, the modes cannot be reduced to or explained by means of other modes of consciousness. However, if this is the case, then this explanation of apparent temporal structure would be as explanatory as the explanation provided by Dainton.

In the previous three explanations there has been an assumption that the contents within a specious present are experiential. Thus, the task has been to explain how experiential contents that belong to the same specious present can appear to a subject as being in some temporal order. The fourth and final view on the nature of apparent temporal structure holds that the contents in question are intentional, not experiential. They are something that can be thought of as providing context for current experiential contents. Gallagher (2009, 201) expresses this idea, which originates from Husserl's later view, as follows:

> [R]etention does not keep a set of fading images in consciousness. Rather, at any moment what we perceive is embedded in a temporal horizon. What I see is part of or a continuation of, or a contrasting change from what went before, and what went before is still intentionally retained so that the current moment is seen as a part of the whole movement. Consciousness retains the just past with the meaning or significance of having just happened.

Most philosophers, if not all, would agree that we usually have a sense of what just happened and that past perceptions can influence our current perception. The problem with this response is that it can also be accepted by philosophers who subscribe to the thesis of instantaneous contents. For example, Mellor (1998, 144), who is one of these philosophers, argues that "[f]or me to see *e* precede *e*,* my seeing *e** must include something like a memory-trace of my seeing *e*. It need not be explicit or a conscious memory, but some trace of the earlier perception must somehow be incorporated in the later one." Hence he argues, just like Gallagher, that prior experiences can influence our current experiences. The difference between him and Gallagher is that for Mellor, past perceptions do not need to be conscious. Mellor's position is also empirically sound in the light of priming studies, in which an unconscious perception of stimulus can influence current experiences.

In other words, there are good reasons to believe that we do not need to perceive past events consciously in order for them to influence how we perceive current events. Moreover, even if we did perceive them consciously, there is no reason why the effect could not be due to memory effects. Accordingly, one can agree with Gallagher's assertion that the significance of what just happened influences what is currently experienced without accepting the doctrine of the specious present. This means that the assertion is neutral as regards the doctrine of the specious present. As a result, it does not address how the apparent temporal structure of consciousness would be constituted.

To summarize, temporal experiences have been explained by means of specious present. In order for an explanation to be truly explanatory, it must also explain how contents within specious present are experienced as temporally ordered. Four different proposals have been put forward, but all of them provide inadequate explanations concerning the temporal organization of the contents within a specious present. It is worth emphasizing that this shortcoming cannot be used as an argument against the extensionalist model or the retentionalist model. This is because, although there is no good explanation for the apparent temporal structure, it does not mean that such an explanation could not emerge in the future—and if such an explanation emerges, it could be compatible with both models, as most of the current proposals are.

9.4 Simple View Vindicated

As mentioned before, for reasons related to temporal phenomenology, philosophers have been rather univocal in their rejection of the thesis of instantaneous contents. Moreover, because of the postdiction effects, they reject either the thesis of temporal isomorphism or the thesis of minimal delay. Thus, philosophers reject at least two of the three theses that comprise the simple view.

I think the simple view can be defended, however. Such defense comes in the form of two other views, which in my opinion are theoretically sound and at least as empirically well-grounded as their alternatives. The first one, *the dynamic snapshot view*, explains the temporal phenomenology in the framework of the snapshot view—in the framework that the thesis of instantaneous contents affords us. The second one, *the non-linear latency difference view*, explains the postdiction effects in a way that is compatible with the thesis of temporal isomorphism and the thesis of minimal delay.

9.4.1 Dynamic Snapshot View

The dynamic snapshot view, as its name implies, subscribes to the thesis of instantaneous contents. This thesis has been rebuffed by most philosophers because, it has been claimed, it leads to Phenomeno-temporal Antirealism. Hence, a philosophical model endorsing the thesis needs to either provide a convincing argument of why there is no temporal phenomenology, or demonstrate how the thesis can be compatible with the realism about temporal phenomenology. While the cinematic model takes the first route, and has had little success in doing so, the dynamic snapshot view attempts to provide the demonstration of compatibility referred to above. That is, according to the dynamic snapshot view, we have immediate experiences of change, motion and other temporal phenomena, just like most philosophers claim. This means that a snapshot can (but does not have to) include contents that a frame in a movie does not allow (namely, temporal phenomenology).

The main problem here is, of course, that the temporal phenomenology cannot be explained in the same way as in the extensionalist and retentionalist models. Because the dynamic snapshot view maintains that the contents of our experiences are not temporally extended, it cannot appeal to the idea that a single experience includes contents that subjectively appear to occur at different times. Instead, the dynamic snapshot view holds that such contents are not required for temporal phenomenology to occur.

The dynamic snapshot view explains the temporal phenomenology by means of "pure" phenomenology. The meaning of this is best explained with examples, one of which has already been mentioned in relation to Hoerl's view on the apparent motion experiments. To remind, Hoerl holds the view that subjects of apparent motion experiments have a feeling of movement without an experience of something changing its location continuously as a function of time. Such experience of motion is called pure motion. Whether such experiences occur in the apparent motion experiments is open to debate, but they are reported to occur in similar kind of experiments in which the interstimuli interval is zero milliseconds (these are sometimes called the pure motion experiments). Other motion illusions corroborate with the separation of motion "qualia" and the perceived change of the location of an object. In waterfall illusions, for example, an object appears to move and not move at the same time, whereas in the rotating snake illusion a stationary stimulus brings about an experience of movement.

The next step is to explain an ordinary experience of motion by means of the phenomenology of pure motion. Here we can follow Robin Le Poidevin (2007). By drawing from psychology, Le Poidevin argues that two independent neural mechanisms are involved in the waterfall illusion. The first mechanism detects motion while the second detects changes in the object's position.[12] Because the mechanisms are independent, the two can give incompatible impressions. In the waterfall illusion, for example, the first mechanism gives us the impression of movement while the second gives the impression that the object's position remains the same. (As we have the experience of

[12] The dissociation of experienced motion and position of an object is well supported by the studies showing that it is possible to experience stimulus as moving in one direction while its position is experienced as shifting in the opposite direction (Bulakowski et al. 2007).

motion without seeing anything move, this is a case of pure motion.) Notably, these two mechanisms also figure in Le Poidevin's explanation of the experience of ordinary motion, but in this case the second mechanism gives the impression that the positions of objects change.

The importance of accounting for the motion phenomenology by means of pure motion, which in turn depends on an independent mechanism, is this: the experience of motion is explained in a framework where the experiential contents can be, subjectively speaking, confined to an instant. This is due to the fact that, as the waterfall illusion exemplifies, we can have an experience of motion without an object appearing as being in different places at different times.

The dynamic snapshot view holds that all temporal phenomenology can be explained in a similar fashion, namely by appealing to the existence of mechanisms specific to different types of temporal phenomenology. Thus, our experiences of causality, change, motion, succession and so forth would be due to mechanisms separate from each other, and subsequently also separate from more general mechanisms such as working memory. This is where the dynamic snapshot view differs from Le Poidevin's position, as he accounts for temporal experiences other than motion by appealing to the memory.

Both claims—that other temporal phenomenology could also be "pure" and that such phenomenology is due to separate mechanisms—corroborate with empirical results. For example, it has been recently argued that our awareness of change consists of two separate things: One is the gut feeling that something has changed. Scientists call this "sensed change." Then, there is the awareness of what it is that has changed. This is called "seen change." Because the two are separate, people can have the experience of sensed change even though they have no visual experience of what it is that has changed (Rensink 2004; Busch et al. 2010). That is, analogously to the case of pure motion, where we have experiences of motion in the absence of any seen change in an object's position in space, in this case we have experiences of change in the absence of perceived change in an object's properties. Thus, the sensed change is best understood as an experience of pure change.

Psychologists also separate the experiences of causality (they call it perceptual causality) from attributed causality (causality that we judge to have occurred between two events). The brain imaging data suggests that the mechanism that accounts for our experiences of perceptual causality is analogous to the mechanism that provides the sensed change—both result from purely visual processes. Seen change and attributed causality, on the other hand, depend on a more central and general mechanism of working memory. Thus, although there have been no investigations into whether or not pure causality exists,[13] the mechanism behind perceptual causality supports the possibility of its existence. Moreover, just as motion perception is generally regarded to be largely modular (independent of other visual processes), Fonlupt (2003) argues that the mechanism of perceptual causality is modular as well.

It is worth emphasizing that the dynamic snapshot view does not forbid the existence of ongoing memories, that is, experiential contents related to the past. Instead, the claim simply asserts that such mental states play no role in establishing our temporal phenomenology. In other words, it is possible (and even probable) that in the usual situations in which we have an ongoing experience we can also have some kind of memory of what just occurred. However, according to the dynamic snapshot view, it is a mistake to conclude from this that the two types of mental states are intrinsically related in a way that memory is required for the temporal phenomenology to occur.

The noteworthy issue as regards the pure temporal phenomenology is that we can have it without having an experience whose contents appear to us as temporally spread. Pure motion, for example,

[13] In fact, this depends on what is meant by pure causality. If it means the impression of causality in the absence of the perception of any "causing" stimulus, then it has not been investigated. However, if pure causality refers to the impression of causality in situations where we would not normally claim that cause-effect relationship holds, then it is shown to exist. Consider, for example, perceptual causality experiments in which subjects are shown one moving stimulus (A) and two stationary stimuli (B and C). If A collides with B and B begins to move, it is easy to see why people say that A caused B to move. However, if it is C (not B) that begins to move when A collides with B, then the cause-effect relationship is more susceptible. Yet, people report having an experience of causality in these latter cases as well.

can be experienced even though an object does not appear to us as being in different places at different times. Because pure change does not depend on having an experience of what the change was, an experience of pure change does not require the past experiential contents to be part of the current experience. Obviously, in the usual cases, we have had a succession of experiential contents, which are in turn the reason why we have the temporal experiences in the first place, but their influence on the current perception can be unconscious (reminding us of the earlier remarks on Mellor and the priming studies). Having pure temporal phenomenology therefore does not require the doctrine of the specious present to be correct.

Furthermore, provided that the experiences of motion can be explained by appealing to pure motion, it is also justified to explain our experience of change by appealing to pure change and experience of causality by appealing to pure causality. Therefore, temporal phenomenology can be accounted for even if one holds the thesis of instantaneous contents to be true. Contrary to the claims made by those who endorse the doctrine of the specious present, accepting the snapshot model does not necessarily mean rejecting the reality of temporal experiences.

9.4.2 Non-linear Latency Difference View

As we saw above, the combination of the theses of minimal delay and temporal isomorphism has been difficult to reconcile with the postdiction effects. If the simple view is correct, then it appears unexplainable how the latter of two stimuli with the same latency can influence the perception of the first stimulus. As a result, one or both theses have been rejected.

Both theses can be subscribed to, however, once it is recognized that the arguments against the simple view are based on a (too simple-minded) view that the processing in sensory systems always proceeds linearly, in a feed-forward manner. The simple view does not necessitate this view on neural processing, however. Instead, the processing could also incorporate the possibility of non-linear influences. By doing so, the postdiction effects can be explained in the framework of the simple view, or so I shall argue next. The central assumption of such a position, which I call *the non-linear latency difference view*, is that the perceptual end point is defined by the means of reentrant activation of the primary visual cortex.

In general, there appears to be three possibilities what the perceptual end point could be. The first one is grounded on the fact that different features of the stimuli are processed in different areas of the visual cortex. According to this alternative, we become conscious of a feature once the processing related to it is completed in the area that is specialized in processing it. Thus Semir Zeki (Zeki and Bartels 1999; Zeki 2003; 2007) argues that we become conscious of colors once the processing in V4 is completed, and conscious of motion once the processing in V5 is completed. While this alternative relies on the feedforward processing from the primary visual cortex to later cortical areas, the other alternatives define the perceptual end point in terms of reentrant processing. In these later cases, the perceptual end point would be reached at the moment of activation of the primary visual cortex due to reentrant processing that originates from the later cortical areas. Here we need to separate two alternatives. The perceptual end point could be defined in terms of local reentrant loops, which originate within the visual cortex. Or, it could be defined in terms of global reentrant loops, which originate from later cortical areas, namely from the frontal lobe.

For our purposes, it is enough to assume that it is the local reentrant loops that determine the perceptual end point. This assumption receives support from the empirical results showing that such reentrant processing is required for the processing of even such elemental features as figure-ground perception (Lamme et al. 2002), surface segmentation (Scholte et al. 2008) and responses related to gratings (Shapley 2004). Likewise, motion perception depends on local reentrant processing—if the reentrant activation from V5 to V1 is disrupted, we do not have a perception of motion regardless of V5 activation (Pascual-Leone and Walsh 2001; Silvanto et al. 2005). Indeed, most

neurophysiological theories of consciousness postulate that the reentrant processing is necessary for perception to occur (e.g., Dehaene et al. 2006; Kouider 2009; Lamme 2006).[14]

Even if the local reentrant processing determines the perceptual end point, it does not mean that the processing is non-linear. The reentrant processing enables the violation of linearity however. This happens when the area of the primary visual cortex that is activated by the reentrant processing is also activated at roughly the same time by the feedforward processing originating from retina. In this case, our perception of the first presented stimulus (the cause of the reentrant processing) would be influenced by the latter presented stimulus (which is the cause of the feedforward processing) and not merely by the shorter latency of the latter.

Such influence can come in two forms. First, the feedforward processing can be fused together with the reentrant processing—the outcome being a combination of both. By using TMS, for example, it has been found that although the V5 modulated activation of V1 is necessary for motion perception, the experience resulting from such activation is also influenced by the properties of V1 neurons (Silvanto et al. 2005). Second, if the activation of the primary visual cortex by the feedforward processing is much stronger than that of the reentrant processing, and the properties of the used stimuli are suitable, the feedforward processing can inhibit or even disrupt at least some of the processes that depend on the local reentrant loop. One example of such is the figure-ground separation (Lamme et al. 2002).

The idea that the feedforward sweep and the local reentrant processing together determine our experiential content has the interesting consequence that the reentrant processing, which is necessary for perception to occur, does not need to be specific about its cause. To put this somewhat differently, if the idea is correct, the reentrant processing can bring about the perception of things other than those which caused the reentrant processing in the first place. This allows us to explain the postdiction effects. Because philosophers have focused on the apparent motion, I will only elaborate on this phenomenon.[15]

To remind, the puzzling part of the apparent motion is how we can experience motion before the second stimulus, given that the motion processing requires information about the location of the second stimulus. What the (mainly conceptual and philosophical) debate over the phenomenon has not acknowledged is, however, that for the purpose of motion processing it is enough if the retinotopic location of the second stimuli is determined.[16] In practice, this means that the (apparent) motion processing can begin at the same time that the processing of the second stimulus begins—namely in the retina.

Usual latency differences do not explain the apparent motion however, because the measured latency difference between moving and stationary stimuli in the primary visual cortex is only around 20 milliseconds. The non-linear latency difference view allows, however, for another possibility concerning the latency differences: the activation of V5 could be due to processing that bypass the primary visual cortex. After all, the view does not take a stance on the cause of the

[14] The views about the function of the two types of reentrant loops differ. In Victor Lamme's theory (2004; 2006) local reentrant processing brings about phenomenally conscious states, which is what Ned Block calls phenomenality (2007; 2011). In the global workspace model, it amounts to unconscious perception (Dehaene et al. 2006; Dehaene and Changeux 2011). In both theories, global reentrant loops bring about cognitive access to the sensory qualities that have been processed within localized reentrant loops. Given the difference regarding the nature of the local reentrant processing, the explanation of the postdiction effects based on this difference may already concern the level of unconscious perception.

[15] It should be mentioned though that the idea that the recurrent processing plays a role in apparent motion also receives support from the fact that such processing has been postulated to play a role in other postdiction effects as well. For instance, many theories of the metacontrast masking incorporate it, see (Bridgeman 1980; Enns and Lollo 1997; Enns and Lollo 2000; Di Lollo et al. 2000; Visser and Enns 2001; Lamme et al. 2002; Ro et al. 2003; Lamme et al. 2007). See (Arstila manuscript) for the more thorough explication of the non-linear latency difference view and how it accounts for the flash-lag effect and the metacontrast masking.

[16] In the retinotopic coordinate system, the location of a stimulus represents the location of corresponding cells in the retina. This system needs to be separated from the egocentric coordinate system that corresponds to the experienced location of things. When you are reading this text and your eyes move, for example, the retinotopic positions of the words and the page change. Nevertheless, you do not experience them as moving because, in an egocentric coordinate system, they continue to have the same positions in relation to yourself. The retina and early visual areas (including the primary visual cortex and V5) are retinotopic.

activation of the later cortical areas, and thus these areas could be stimulated by the sensory signals that bypass the primary visual cortex. Moreover, this possibility is not merely hypothetical because, although most of the information from the retina reaches the visual cortex via the primary visual cortex, V5 also receives visual inputs that do not come through V1 (Sincich et al. 2004). Since such information bypasses V1, a moving stimulus can activate V5 at roughly the same time as V1, or even sooner (Ffytche et al. 1995). The would mean that V5 is activated much earlier than any other area of the visual cortex specialized in the processing of particular features—when V5 is activated, other areas still need to receive an input from V1. Consequently, the processing of visual motion can take place faster than the processing of motionless stimuli.

Such direct activation of V5 due to processing bypassing V1 has been shown to occur when one uses stimuli similar to those used in the apparent motion experiments (Blythe et al. 1986; Azzopardi and Hock 2011). As a result, motion processing in the cortex can begin even before the sensory signals resulting in the perception of the second stimulus reach the cortex in the apparent motion experiments. Given that the apparent motion stimuli can induce V5 activation, which in turn activates the primary visual cortex by means of reentrant processing in a mere 20 milliseconds after the activation of V5 (Muckli et al. 2005; Larsen et al. 2006; Wibral et al. 2009), there is ample time for us to perceive (apparent) motion before the processing related to the perception of the second stimulus is completed.

It is worth emphasizing that this explanation rests upon the idea that we perceive motion and the second stimulus once the reentrant processing related to them terminate in the primary visual cortex. Hence, this explanation does not depend upon the separation of the moment when something is experienced to occur and the moment the neural processes realize the experiences—the thesis of temporal isomorphism can be accepted. It does not require any added delays in neural processing either (quite the contrary), which means that the thesis of minimal delay can be accepted as well. Therefore, this explanation is compatible with the simple view, as well as being based on empirical findings that are independent of the interests that motivated the formulation of the non-linear latency difference view in the first place.

9.5 Conclusions

Philosophers have approached the issue of the timing of experiences mainly through the question of how the experiences of temporal phenomena can be explained. The widely accepted view among philosophers is that this can only be done by means of the doctrine of the specious present. Accordingly, the philosophical issues regarding the timing of experiences relate to the postdiction effects and the apparent temporal structure of experiences.

Thus, the timing of experiences means two different things in the context of philosophical debates. For one, there are the questions concerning the relationship between the experience and (i) its external cause or (ii) the neural processes underlying the experience. Unlike scientists who address such questions in relation to, say, simultaneity or temporal order judgments (as illustrated by Yarrow and Arnold this volume; Yarrow et al. 2011) or EEG markers for consciousness (Sergent et al. 2005; Del Cul et al. 2007; Koivisto and Revonsuo 2010; Railo et al. 2011), philosophers have focused on particular postdiction effects (mainly visual and tactile apparent motion, i.e., cutaneous rabbit). Secondly, the timing of experiences can also be understood as a question of how the apparent temporal structure of specious present is constituted. This question, which concerns the phenomenology of experiences, is more specific to philosophers' debates and is largely ignored by scientists. The obvious reason for this is the fact that the question only becomes relevant if one endorses the doctrine of the specious present, which is something that scientists rarely do.

Overall, it can be concluded that because of their commitment to Phenomeno-temporal Realism and because of the results related to the postdiction effects, philosophers' views concerning the

timing of experiences contradict the views held by most scientists. However, as illustrated by the dynamic snapshot view and the non-linear latency difference view, this rift between disciplines is not necessary. On the contrary, if these two views are correct, the issues identified by philosophers as important to the matters at hand can be addressed in a framework that is also compatible with current scientific positions.

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